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Why is there a Productivity Problem in the EU?

Francesco Daveri

Foreword by

Jørgen Mortensen

Thinking ahead for Europe

Abstract

Magazines and newspapers often refer to or even take for granted the economic decline of the EU, particularly when contrasting the EU data with US data. The first part of this paper poses the question of whether IT – as often alleged – is really the *only* cause for the EU's productivity slowdown. The conclusion is that *it is not*. The non-IT part of the economy has not only contributed to the slowdown but appears to have crucially contributed to the EU-US growth gap as well. There is thus little reason for the EU to target IT-diffusion as an intermediate goal, as implied by the Lisbon strategy. The second part of the paper, after showing that the growth slowdown comes from the reduction of non-IT capital deepening and the lack of acceleration in total factor productivity growth, argues that the slowdown of capital deepening will continue. The scarce resources available for enhancing growth should concentrate on *providing incentives to R&D and innovation at large*, rather than financing traditional infrastructures. This is at odds with the goals pursued by the EU within the framework of the European Growth Initiative.

Francesco Daveri is at the Università di Parma and IGIER (francesco.daveri@unipr.it). This paper draws on previous work for a CEPS report on the causes of the productivity slowdown in Europe, conducted on behalf of the European Parliament. Previous drafts of this paper have been presented at the LBS Conference "Digital Transformations" and at Carlos III in Madrid (Departamento de Empresa). The author is thankful to Daniel Gros and Juan Jimeno for discussion and very useful comments on previous drafts, and to Federico De Francesco for his dedicated research assistance.

CENTRE FOR EUROPEAN POLICY STUDIES

Place du Congrès 1 · B-1000 Brussels
Tel: (32.2) 229.39.11 · Fax: (32.2) 219.41.51
www.ceps.be · info@ceps.be

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Foreword by Jørgen Mortensen

The Lisbon strategy: Main features

In March 2000 in Lisbon, EU heads of state and government set the strategic goal of becoming the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion.

In the pursuit of excellence the EU should, according to the Lisbon conclusions, envisage a number of measures facilitating the shift towards an information society, such as stimulating R&D and the creation of small- and medium-sized enterprises (SMEs), taking further measures to complete the internal market and ensuring sustainability of public finance. Further, the EU should modernise the European Social Model by strengthening education and training, develop an active employment policy and modernise social protection.

More precisely, the European Council considered that the overall aim of the strategy should be to raise the employment rate from an average of 61% in 2000 to as close as possible to 70% by 2010, and to increase the number of women in employment from an average of 51% in 2000 to more than 60% in 2010.

As stated in the Lisbon conclusions, if "the measures set out […] are implemented against a sound macro-economic background, an average economic growth rate of around 3% should be a realistic prospect for the coming years" (European Council, 2000).

Since then the European Council has held spring summits specifically focused on evaluating the progress of the EU towards the achievement of the Lisbon goals. Thus, heads of state and government reviewed the progress towards the Lisbon goal at the Barcelona European Council in March 2002. At that Council meeting they agreed that investment in European research and development (R&D) must be increased to 3% of GDP by 2010, with at least two-thirds of the total investment coming from the private sector. This goal should focus the attention of the Commission and member states on the reforms necessary to deliver not only higher but also more productive business investment. To achieve this objective, in its recommendation for the 2002 Broad Economic Policy Guidelines (BEPGs) for the economic policies of the member states and the Community, the Commission called for better incentives for firms to invest in R&D while preserving sound fiscal policies.

In September 2002, the Commission adopted a Communication *More research for Europe: Towards 3% of GDP*, with recommendations for member states, industry and other stakeholders for achieving the 3% objective. The Brussels European Council in March 2003 reinforced the member states' commitment to the Barcelona objective, and called for concrete action to attain the 3% target and for strengthening of the European Research and Innovation Area to the benefit of all in the enlarged EU.

In response to a request from the October 2003 European Council, the Commission adopted a Communication on *A European Initiative for Growth.*[1] The Communication provided a 'roadmap' for boosting investment in networks and knowledge already outlined in an interim report to the October European Council by:

- moving ahead with the priority Trans-European transport projects requiring an investment of €220 billion by 2020;

[1] See European Commission, COM(2003) 690 final, 11 November 2003.

- accelerating the roll-out of high-speed, broadband communications in all parts of the European Union to meet the target of widespread access and use by 2005; and
- strengthening the EU's capacity to generate and use knowledge through specific action to boost investment in leading-edge technologies, from the use of hydrogen as a fuel to space technologies and their applications.

Specifically the Communication presented a 'quick-start programme' by mobilising around €60 billion to invest in networks, broadband communication and new technology between 2003 and 2010. On the whole, the growth initiative thus seemed to favour the boosting of *fixed* investment as the most appropriate way to 'prime the economic pump' following, in this approach, the guidelines of conjunctural policies of the 1960s and 1970s.

At the Brussels European Council in March 2004, the Presidency Conclusions stated that in March 2000 the EU had set itself ambitious goals and that four years later, the picture was a mixed one. It argued that considerable progress had been made and reaffirmed that the process and goals remained valid. It also stressed, however, that the pace of reform needed to be significantly stepped up if the 2010 targets were to be achieved. The European Council confirmed its commitment to demonstrating the political will to make this happen.

Towards the Lisbon and Barcelona goals?

The move forward towards the Lisbon and Barcelona goals was rather slow during the first three years of the Lisbon strategy. In fact, after a GDP growth of 2.7% per annum from 1995 to 2000 on average in the EU-15, economic growth slowed down to only 1.7% in 2001 and further to 1.1% and 0.8% in 2002 and 2003 respectively. Total employment, after an increase of 1.4% on average from 1995 to 2000, rose by 1.3% in 2001, but then stagnated in 2002 and rose by only 0.3% in 2003.[2] Labour productivity, which had risen by 1.3% on average from 1995 to 2000, rose by only 0.4% in 2001, 05% in 2002 and 0.6% in 2003.

An upturn in activity was manifested during the course of 2004 and both output and employment was expected to show faster expansion in 2004 and 2005. Nevertheless, even taking account of the more optimistic outlook, real GDP for the EU-15 is now estimated to show a rise of only 1.6% per annum between the years 2000 and 2005 on average, with employment up by 0.6% and labour productivity by 0.9% on average over this period.

The dismal growth and productivity performance of EU-15 over the first five years of the span of the Lisbon strategy represents a clear deterioration compared with the preceding five-year period, and also contrasts sharply with that of the United States.

As seen in Table 1, for the EU-15 the rate of growth of GDP on average from 2000 to 2005 is estimated to be more than 1 percentage point below that of the preceding five-year period. This slowdown was attributable partly to a 0.8 percentage-point slowdown of employment growth and partly to a 0.4 percentage-point slowdown of labour productivity growth. Between the two five-year periods, economic growth also slowed down in the US, from 4.1% on average from 1995 to 2000 to only 2.6% on average from 2000 to 2005. Yet, in the US productivity growth actually accelerated from 2.1% per year on average from 1995 to 2000 to 2.3% on average from 2000 to 2005. Growth of employment in the US, on the other hand, is estimated to show a sharp slowdown between the two five-year periods, from 2% to 0.4%. This deterioration of the employment content of economic growth in the US has given rise to

[2] The source for these data are the spring 2004 forecasts by the DG Economic and Financial Affairs.

some concerns. The shake-out of labour mainly took place, however, in 2001 and 2002 and was followed by a return to faster growth in jobs, albeit with maintained high-productivity advancement.

Table F.1. Growth, employment and productivity in EU, US and Japan, % change over previous average from 1960 to 1990 and for five-year periods

	1961-90	1990-95	1995-2000	2000-05
A: GDP in real terms				
EU-15	3.4	1.5	2.7	1.6
AC-10	–	–	4.1	3.3
EU-25	–	–	2.7	1.7
US	3.5	2.5	4.1	2.6
Japan	6.1	1.5	1.4	1.7
B: Labour productivity				
EU-15	2.9	1.9	1.3	0.9
AC-10	–	–	3.8	3.4
EU-25	–	–	1.5	1.2
US	1.5	1.3	2.1	2.3
Japan	5.1	0.8	1.4	2.0
C: Employment (persons occupied)				
EU-15	0.4	-0.4	1.4	0.6
AC-10	–	–	0.3	0.0
EU-25	–	–	1.2	0.5
US	2	1.1	2	0.4
Japan	1	0.8	0	-0.3

Note: AC-10 represents the 10 acceding states to the EU.

Source: European Commission, DG Economic and Financial Affairs, spring 2004 forecasts.

Nevertheless, given the EU's dismal growth and productivity performance during the first half of the period envisaged by the Lisbon strategy, it is already apparent that only an unlikely GDP growth of around 4.5% per annum during the second five-year period would allow the EU to reach the declared target of 3% growth for the whole ten-year period on average. It is thus already evident in 2004 that the Union is in no position to reach the growth targets adopted in 2000 in Lisbon.

Nature and causes of the productivity slowdown in the EU

In sharp contrast to trends during the period from 1960 to 1990, the EU-15 indeed appears to have entered a period with productivity growth distinctly below that of the US. Evidence presented in this paper suggests that a large part of this slowdown is attributable to a certain increase in the employment content of economic growth and, thus, to a slowdown of the process of capital deepening that characterised economic growth in the major EU countries during the years from 1960 to 1990.

In his paper Daveri examines several possible explanations for the productivity slowdown:

- delayed diffusion and use of information technology (IT) throughout the economy;
- underdevelopment of the IT producing industries; and
- other factors without direct connection to IT.

Delayed diffusion of IT?

After a detailed examination of productivity growth (here measured as output per hour worked) in different branches of the economy grouped according to the intensity of their use of IT, Daveri concludes that delayed diffusion of IT may account for some 38% of the total growth-gap between the US and the EU in both the first and second halves of the 1990s. Daveri's estimate is considerably lower than those obtained by Stiroh (2002) and van Ark et al. (2003), essentially as the result of the application of a more narrow definition of IT-using industries. In fact, Daveri excludes a number of traditional industries from this group that feature a below-average IT-capital services share of value added in both the US and the EU. Using this more narrow definition of IT-using industries, Daveri explains 0.65 percentage points of the total difference of 1.8 points between the acceleration of productivity growth of 1.1 points in the US and the slowdown of 0.7 points in the EU. With a broader definition Stiroh and van Ark et al. attributed 1.06 percentage points to this effect.

Underdevelopment of IT-producing industries?

Daveri then examines the alternative hypothesis, defended in a number of earlier studies, that the acceleration of productivity growth in the US was essentially attributable to the boosting of IT-producing industries in general or within the manufacturing industries. Nevertheless, the contribution of IT-producing industries to the productivity acceleration in the US amounts, according to various more recent estimates, to only about one-fifth of the overall acceleration of 1.1 percentage points.

In fact, as underlined by Daveri, in the EU the IT-producing branches during the five-year period from 1995 to 2000 accounted for 0.49 percentage points of a total growth of labour productivity of 1.71% as against a contribution of 0.24 percentage points of a total of 2.28% during the preceding five-year period. Yet in the US, IT producers accounted for 0.68 percentage points of a total rise of 2.25% in the second five-year period or comparatively less than the contribution of 0.43 percentage points to the growth of 1.1% in the first half of the 1990s. As underlined by a number of studies, a statistical bias may be introduced owing to the fact that the US and a few other countries adjust national accounting deflators for estimated quality changes for high-tech products. As stressed by Daveri, however, this effect can explain only a small fraction of the productivity gap between the US and the EU.

Daveri thus firmly refuses the hypothesis that underdevelopment of IT production can explain the productivity slowdown in the EU both in the absolute and as compared with the US.

Other factors without a direct connection to IT?

Adopting a broader perspective, Daveri then shows that the productivity slowdown in the EU-15 was in fact a widespread phenomenon, particularly found in non-durable manufacturing industries (a slowdown of almost 2 percentage points between the two five-year periods) and other industries (a slowdown of 1.1 percentage points). Manufacturing of durable goods showed only a modest slowdown of productivity growth (0.3 percentage points) and market services even some acceleration (0.47 percentage points). In this respect the evolution in the EU contrasts with the patterns of productivity developments in the US. In fact, in the US non-durable manufacturing showed an even more pronounced slowdown of productivity but this shortfall was more than compensated by a huge productivity improvement in durable manufacturing and a pronounced but smaller rise in market services. In other US industries productivity growth actually decelerated between the two five-year periods.

Digging further into the data, Daveri then examines the more precise nature of the productivity slowdown in the EU. By exploiting data for the four largest EU countries (Germany, France, the UK and the Netherlands – the EU-4) generated by the Groningen Growth and Development Center in the Netherlands and the National Institute for Economic and Social research in the UK, he finds that a slowdown of capital deepening (that is, a slowdown in the increase in fixed capital per person employed or hour worked) explained a large part of the productivity slowdown.

In fact, for these four countries on average, labour productivity growth for the five-year period 1995 to 2000 amounted to just above 2% or about 0.3 percentage points less than on average for the period from 1979 to 1995. During the latter period the increase in the IT capital stock per unit of employment accounted for 0.53 percentage points or more than a quarter of the productivity increase. Non-IT capital in contrast accounted for only 0.25 percentage points or much less than the 0.70 percentage points on average during the preceding 26 years. The contribution of labour quality (an increase in the level of education) also accounted for a small part (and falling) of the total productivity increase.

Thus, more than half of the overall productivity increase in the four EU countries during the five years from 1995 to 2000 was attributable to the increase in the ‘residual factor’, generally termed ‘total factor productivity’ (or TFP), that is the part of the rise in labour productivity that is not due to either an increase in capital per unit employed nor the rise in the level of skills of the labour force. The contribution of TFP for these five years in fact amounted to 1.07 percentage points or marginally higher than the 0.94 percentage points on average for the years 1979 to 1995. The productivity increase in the EU moreover compares favourably with the 1.05 points contribution from TFP in the US over the same period. In fact, the remarkable feature about this comparison is not the poor EU productivity performance but rather the pronounced improvement in the US, from only 0.26 percentage points on average during the years 1979 to 1995 to 1.05 percentage points on average from 1995 to 2000 (Table 2).

Table F.2. Decomposing aggregate labour productivity growth, business sector

	US		**EU-4**	
Business sector	1979-95	1995-00	1979-95	1995-00
Labour productivity growth	1.21	2.46	2.30	2.02
Contributions to labour productivity growth from:				
IT capital	0.46	0.86	0.33	0.53
Non-IT capital	0.35	0.43	0.70	0.25
TFP growth	0.26	1.05	0.94	1.07
Labour quality	0.13	0.13	0.33	0.18

Source: Table 11 of the report.

As stressed by Daveri, the European productivity slowdown is too recent for observers to be able to evaluate whether its nature is long or short term. In particular, there is a possibility that the declining growth contribution from capital deepening may not last. This may be the case if it is the result of the labour market reforms enacted in many European countries in the 1990s. Certain studies in fact show that Europe’s labour market reforms in the second part of the 1990s, although introduced in bits and pieces and often affecting the hiring and firing of temporary workers only, effectively encouraged the hiring of such, often unskilled, part-time workers.

As shown, employment and productivity in 1995-2002 grew at lower rates in the EU-15 than in the US. Nevertheless, in countries often taken as success stories in the European labour markets, such as Spain and the Netherlands, employment grew at more than 2% per year, but labour productivity stagnated. In a country such as Greece, with buoyant productivity growth, employment stagnated instead. The only exceptions on the positive side are Ireland and Finland, with Italy and Germany being the exceptions on the negative side.

There was thus a sharp turnaround in the pace of job creation in Europe after 1995. The growth rate of hours worked went from persistently negative growth rates of hours worked of about half a percentage point per year in the 1980s and almost 1.5 percentage points per year in the early 1990s to positive figures leading to an increase in the number of hours worked by 1% per year in the last few years. This is still slightly lower than in the US (where the growth rate of hours worked remained around 1.5% per year even in the productivity revival years before the current recession), but clearly indicates that the 1980s' chronic inability of the European economies to create jobs has been partly overcome.

In addition, the new entrants in the labour market, given their low human capital endowment, likely found themselves more easily employed in traditional industries. Hours increased by 2.3% per year in the market services industries in Europe (about the same as in the US). In the manufacturing industries, Europe's employment performance was less striking, for negative figures were still recorded in 1995-2001, at least for the growth of hours worked in non-durable goods manufacturing. Yet this compares with a negative rate of 2.6% per year in 1990-95 and a negative rate of 1.6% in the 1980s, and should thus be regarded, if anything, as a marked *improvement*. The same applies to durable manufacturing where the roughly zero-growth in the number of hours worked definitely improves upon the negative rates of growth of 3% or so in the first half of the 1990s and a negative rate of about 1.5% per year throughout the 1980s. Europe's employment outlook indeed dramatically changed in the last bit of the 1990s.

Some policy conclusions

Altogether, thus, productivity growth in the EU has been somehow hampered by the entry of unskilled workers in the labour market. This has possibly driven down the equilibrium capital-labour ratio. As long as this was simply the other side of the coin of the increased employment rate of the last five years (and possibly of the mismatch induced by the introduction of IT capital goods), the diminished capital deepening may just be transitional. If this is the case, governments should perhaps not be overly pessimistic about Europe's prospects of reviving labour productivity growth.

This is not the only possible view of the facts, though. A simpler but pessimistic view would instead stress that the declining productivity growth in non-durable (and mature) manufacturing industries signals insufficient reallocation of workers away from that declining sector into newer, more dynamic, industries. This latter view suggests that governments have to do something, namely continue along the undertaken path of market reform in the goods and labour markets, perhaps broadening their scope and enlarging their extent, in order to ease reallocation and raise efficiency.

It should also be recognised that achieving a durable acceleration in the growth of total factor productivity cannot be achieved by a 'quick-start procedure' but would require increasing emphasis on enhancing the rate of innovation in the EU economy, the level of education and skills of the labour force and intellectual investment in general, very much in line with the recommendations formulated in the report of the ‘Sapir Group’ published in the middle of 2003 (Sapir et al., 2003). The Sapir Report has advocated measures in three areas:

- creating an independent European agency for science and research;
- encouraging private sector R&D via tax credits; and
- re-focusing the structure of the – slim – EU budget away from agriculture into separate growth and restructuring funds. The growth fund would be the appropriate pool from which to fund supranational R&D, training and educational projects.

Indeed, as stressed by Daveri, taking advantage and adopting the US technology was best for Europe after the end of WWII. At that time, Europe was distant enough from the technological frontier and thus large enough gains from learning-by-doing, imitating and buying technological advances generated elsewhere – notably in the US – could be achieved.

Yet, as Daveri concludes, 25 or 30 years of convergence have made such mechanisms no longer apt to further feed growth in the now-advanced EU. This makes producing innovations in the EU today all the more necessary. In particular, the goal of producing more innovation would probably be best served by allocating more funds for R&D and improving their efficiency of allocation but, first of all, by stimulating business R&D. Consequently, raising R&D spending towards the goal of 3% adopted in Barcelona would appear to be the most promising route to raising the EU’s innovation potential and productivity growth.

Nevertheless, the consistency and credibility of EU policy-making would probably gain by recognising that an improvement of the productivity performance is a long-term goal and that in the short run, up to 2010, the highly desirable increase in the labour force participation of women and the elderly could hardly be achieved without accepting that this expansion of employment would be accompanied by a temporary slow rise in productivity, as new groups have to go through a learning process and acquire the skills required in the information society.

WHY IS THERE A PRODUCTIVITY PROBLEM IN THE EU?

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FRANCESCO DAVERI

1. Introduction

Magazines and newspapers often refer to or even take for granted the economic decline of the EU, in particular when contrasting EU data with US data. It has not always been like this. Until the first part of the 1990s, the EU, while struggling against unemployment, did not really have a productivity problem – quite the opposite. The debate about the productivity slowdown was an American and not a European business issue. Since then, something happened during the 1990s and things changed, quite radically. This paper is a contribution to understanding such important issues by summarising the evidence on the EU productivity problem and contrasting its alternative explanations, with an eye to discussing the ways out of it.

The very first point to address is whether an EU productivity problem really exists at all. From a worldwide perspective, this is not an obvious point to make. As documented in Maddison (2001), Europe[1] is an outstandingly productive area with productivity levels not too far from those of the US. Yet, today's productivity achievements are the outcomes of fast productivity growth *in the past*. As reported in Table 1, in the EU value added per hour worked has increased at a rate of 3.6% per year in the 1970s, before going down to the – still high – 2.5% per year in the 1980s through the early 1990s. Since then, European productivity growth has declined further to less than 1.5% per year, bottoming down to growth rates not far from zero in 2001-03.

This is enough to claim that today's productivity data, although not pointing to an absolute decline yet, are really a question mark about the sustainability of current productivity levels (and living standards) in the medium-term future of Europe.

The productivity slowdown in the EU may be seen from another angle, though. The European slowdown has been further enhanced by the parallel productivity acceleration experienced by the US economy since the second half of the 1990s. The real issue here is therefore that Europe has also seemingly lost an opportunity that has been caught by the US instead. The big question is *why*.

The prevailing common wisdom on the causes of the EU productivity problems comes in three steps. First, the EU growth gap with the US is attributed to a few business sector services, such as wholesale trade, retail trade and financial intermediation. Second, these industries are classified among those intensively using information and communication technologies (IT). Third – implied by the first two – the EU's productivity problem is said to essentially stem from delayed IT usage. Such a view (labelled the 'IT-usage hypothesis') is well exemplified by the following quote from van Ark et al. (2003b):

[1] 'Europe' here refers to the 15 countries in the European Union prior to 1 May 2004.

> With aggregate evidence showing that countries in Europe invest less in ICT and this new evidence that intensive ICT users have shown slower productivity growth in Europe, it appears that the slower diffusion of ICT is the principal factor in explaining the lower European productivity growth (van Ark et al., 2003b, p. 297)

The view expressed here is also shared by other studies and notably by the detailed cross-country study undertaken by McKinsey Global Institute (1997, 2002). Blanchard (2004), in his recollection of the main facts of European growth, may also be seen as sympathetic with such a view.

As any other one-sided view, this may have gone too far. In the first part of this paper, the total productivity growth gap between the US and the EU is decomposed at the industry level into three components, each representative of a different view of the slowdown. In addition to the IT-usage hypothesis, Gordon's 'IT-production' view and a residual view that might be labelled 'IT-irrelevance' hypothesis are scrutinised. The IT-production view points to the importance of high-tech industries as the ultimate engines of the EU-US growth gap. The IT-irrelevance hypothesis posits instead that neither IT usage nor IT production was the eventual cause of the growth gap.

The accounting evaluation of the three alternative views is carried out employing the latest version of the data set constructed at the Groningen Growth and Development Center (GGDC). These data have already served as a background for many papers, the most recent of which are those collected in the O'Mahony and van Ark (2003) *Report for the DG Enterprise of the European Commission* and the paper by Inklaar, O'Mahony and Timmer (2003). Slightly modified releases of these data have also been used by Jorgenson (2003) and the European Commission (2003).

The industry-growth accounting experiments presented here provide a numerical rendition of the various views. The key result here is that the common wisdom indeed explains a large fraction of the EU-US growth gap, but not as much as assumed by its proponents. The explanatory power of the IT-usage hypothesis in fact crucially hinges on the researcher's decision on how to classify individual industries in one industry group or another, the alternatives being IT producers, IT users, or non-IT related industries. Previous studies have granted an 'IT-using' status to the top 50% industries in an industry ranking based on IT-investment shares in the US economy. It is shown that this classification procedure has *exaggerated* the explanatory power of the IT-usage hypothesis. Fast-growing industries, such as retail trade and transportation equipment, have been controversially assigned to the group of the 'IT-using' industries. This has in practice occurred at the expense of the explanatory power of the IT-irrelevance view. An alternative classification of industries (which identifies only those industries with above-average IT capital services as IT users) indeed provides a more balanced picture and unveils that the IT-usage hypothesis may explain as much as 55% of the growth gap, with another 45% explained by the IT-irrelevance view. No explanatory power is instead left for growth gaps among IT-producing industries.

The issues discussed here are not an academic *curiosum*, but bear immediate policy relevance. If the IT-usage hypothesis is true, then the European Commission and the EU national governments should continue tracking IT diffusion as an intermediate policy target as they are currently doing under the Lisbon strategy. If instead IT diffusion is *not* the only engine of innovation and productivity growth, the destination of public funds need not be skewed in favour of IT.

The second part of the paper goes one step further in discussing these issues. By using another part of the GGDC dataset (the one developed with the British NIESR), the labour productivity slowdown is decomposed into its capital deepening and total factor productivity (TFP) components. This decomposition is so far available for four EU countries only (Germany, France, the UK and the Netherlands). The bulk of the EU growth slowdown in these four countries is explained by the reduced growth capital-deepening contribution from non-IT goods and a substantial lack of acceleration of TFP growth, with its sheer decline in the non-durable goods industries. This reinforces the idea that IT as such has *not* been the only cause behind the EU productivity slowdown of the 1990s.

In its final part, this paper asks whether something can be done to reverse the trends of the 1990s (slowdown of non-IT capital deepening and lack of take-off of TFP growth). It is concluded that the capital deepening slowdown may be temporary. This has in fact occurred in parallel with the labour market reforms of the 1990s, which are unlikely to be either further advanced or outright repealed. On the good side, as time goes by, EU economies will have more time to adapt to the diffusion of IT capital, which will cause less disruption to existing non-IT capital. Some room for optimism is there on the capital-deepening side of the EU's productivity problem. Yet a simple numerical exercise also shows that, if the Lisbon employment goal of raising the EU employment rate to 70% is taken seriously, the expected growth contribution from capital deepening will likely be small.

Optimism is not warranted either for the other policy goal, i.e. improving the EU's capacity to create and implement innovation. If one judges by actions rather than by the rhetoric of official declarations, it appears that the European Growth Initiative – on the way to being implemented in the future, with its focus on traditional infrastructures – may not conform to the EU's most urgent needs. Such an initiative does not seemingly take up the thrust of the approach implied by the Sapir Report, where more attention on innovation, research and higher education was advocated as crucial for growth. Unless some change is achieved in these still neglected areas, productivity growth may go back up somewhat, but really higher growth will not be resumed soon in Europe.

The paper's structure is as follows. In section 2, a brief recap of the main facts on the post-1995 European productivity slowdown and IT diffusion is presented. In section 3, the three main explanations of such slowdown are set out. In section 4, such explanations are quantitatively evaluated within a standard industry-growth accounting framework. In section 5, the nitty-gritty of the European productivity slowdown across manufacturing and services industries is analysed, and the standard decomposition in TFP and capital deepening is computed. In section 6, a discussion of the likely trends of capital deepening and TFP growth, with special emphasis on the promise of R&D spending is presented. In section 7, conclusions and policy implications are drawn within the broader perspective of the Sapir Report and the European Growth Initiative.

2. The productivity slowdown in Europe and the IT revolution[2]

2.1 The productivity slowdown in Europe

Around 1995,[3] something happened in the US economy, which triggered a marked rise in the growth rate of labour productivity (from some 1.1% to 2.2% per year) with respect to the

[2] Sections 2, 3 and 4 heavily borrows on Daveri (2004).

former 25-year average. In parallel, the growth rate of value-added per man hour declined to some 1.5% per year in the European Union. This is about 1 percentage point lower than in 1980-95, one-third as much as the growth rate in the 1970s and a bare one-fourth of the stellar 6% averaged in the same countries in the 1960s.

Table 1. Growth of GDP per hour worked in the EU and the US, 1979-2001

Total economy					
OECD	**1970-80**	**1980-90**	**1990-95**	**1995-02**	**(1995-02) minus (1990-95)**
European Union 11	3.6	2.3	2.6	1.4	-1.2
US	1.6	1.4	1.2	2.0	+0.8
EU-11 minus US	*+2.0*	*+0.9*	*+1.4*	*-0.6*	*-2.0*
O'Mahony-van Ark data set		**1979-90**	**1990-95**	**1995-01**	**(1995-01) minus (1990-95)**
European Union 15		2.3	2.3	1.6	-0.7
US		1.3	1.1	2.2	+1.1
EU-15 minus US		*+1.0*	*+1.2*	*-0.6*	*-1.8*
Big countries					
Germany		2.1	2.5	2.0	-0.5
France		3.0	1.6	1.5	-0.1
United Kingdom		1.9	2.9	1.8	-1.1
Italy		2.0	2.4	0.8	-1.6
Spain		2.9	1.7	0.7	-1.0
Small countries					
Austria		2.8	4.0	2.4	-1.6
Belgium		3.0	2.5	1.7	-0.8
Denmark		1.9	1.9	1.5	-0.4
Finland		3.3	3.3	2.2	-1.1
Greece		1.0	0.8	3.0	+2.2
Ireland		4.5	4.1	7.3	+3.2
Netherlands		2.3	1.3	1.1	-0.2
Portugal		3.4	2.2	2.5	+0.3
Sweden		1.6	2.1	1.8	-0.3

Source: O'Mahony and van Ark (2003) and the OECD Productivity Database, March 2004.

Table 1 reports the growth rates of value-added per hour worked for the European Union and the United States, as well as the individual EU countries, distinguished in two groups ('big' countries and 'small' countries), in the 1980s and the first and the second half of the 1990s through 2002. Although hardly a good indicator of labour productivity,[4] the behaviour of value-added per hour is a good starting point anyway to concisely describe the extent of today's productivity problem in the EU, with respect to the US as well as with respect to the EU itself in the past.

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[3] Why 1995 is so often taken as a watershed in the recent debate about productivity developments in OECD countries remains unclear. Even for the US, the evidence indicating that 1995 was a turning point is not terribly solid. Stiroh (2002) adopted Hansen's testing methodology of search of unknown breakpoints. This methodology helps single out candidate breakpoints. All of the identified candidate breakpoints turned out to be not statistically significant, except for one: September 1993, significant for the manufacturing sector but not for the economy. No such experiments have been conducted for Europe, except for Daveri and Silva (2004), where conclusions reminiscent of Stiroh's were reached as to Finland's productivity time series.

[4] The OECD productivity manual (2001) provides a full-fledged and accessible discussion of productivity measurement issues. The main measurement problem stems from the inclusion of non-market services – where productivity is hard to measure – in the calculation of GDP.

The first two lines in Table 1 are from the OECD Productivity Database and show the US productivity acceleration of about 0.8 percentage points and the parallel EU slowdown of about 1.2 percentage points in the last few years. Similar trends can be observed using the O'Mahony-van Ark data set. The discrepancies in the figures reported from the two data sources are because of two main factors: the OECD provides hours worked for 11 EU countries only, while the GGDC has full coverage of the EU-15. Moreover, the OECD data span through 2002, while the GGDC data in the O'Mahony-van Ark CD ROM stop in 2001.

To see what the recent productivity slowdown means in practice, a simple algebraic example may help. Suppose a country, starting from a productivity level of 100, keeps growing at 2.5% per year for ten years. As a result, productivity at t=10 is equal to 128. If the same country grows at 1.5% per year instead, its productivity level at t=10 would be 116. In other words, a growth slowdown of 1 percentage point cumulates into a loss of productivity potential of about 12 percentage points in ten years.

In parallel, Table 1 also provides evidence on two other facts: productivity growth rates have been higher in Europe in the past and are high in some parts of the EU today as well.

The 'US first, then EU' ranking is the reverse of the ranking prevailing in 1970-95. In the 1980s, labour productivity in Europe (literally: in *any* country in Europe, with the exception of Greece) used to grow faster than in the US, then trapped in the infamous productivity slowdown period.

The individual country picture also indicates that the slowdown is mainly but not exclusively a 'big' country problem. Germany, the UK, Italy and Spain all exhibit declining growth rates through the 1990s, with sharply declining rates for Italy and Spain. France's productivity slowdown is instead very mild.

Last but not least, Table 1 also substantiates a few of the European success stories, namely Ireland, Greece and Finland. Through a careful mix of tax-cutting and incentive-providing policies, Ireland took advantage of the outsourcing of manufacturing activities originating abroad in other OECD countries. Finland and Greece respectively based their success on the presence of a world-class technological leader in high-tech manufacturing such as Nokia and the rapid development of business sector services. Although the small size of these countries makes their good or excellent productivity performance not enough to counteract the continental tendency towards the productivity slowdown, their success is very instructive anyway.

Altogether, the historical growth precedents in the EU and the variety of paths towards successful growth signal a simple but very important message: it (i.e. achieving fast productivity growth) can be done. The problem is *how*.

2.2 The IT revolution

The United States has been experiencing very fast IT diffusion for a long time now. After all, Robert Solow's famous statement on how ubiquitous computers were in the US economy (except in the productivity statistics) dates back to a 1987 issue of the *New York Review of Books* – a long time ago indeed.

In Europe, IT diffusion has lagged behind the United States. In 1992, when the Internet protocol had just been signed, IT spending was about 7% of GDP in English-speaking countries, such as the UK, the US and Canada – about twice as much as in Italy and Spain, with France and Germany somewhere in between. While overall spending in IT goods and services reportedly caught up with the US levels in most EU countries by the end of the last decade, this does not seemingly apply for the spending item most directly linked to growth: investment.

As shown in Table 2, investment in IT capital goods kept lagging behind the US during the whole decade. This was initially documented through private data sources by Schreyer (2000) for the G-7 and Daveri (2000) for the EU-15. The private data picture was then, by and large, confirmed by Colecchia and Schreyer (2002) using national accounting data for nine OECD countries. Timmer et al. (2003) – based on the most complete data set available today – gives an updated and rather complete picture of what happened to IT investment in the US and the EU countries. The GDP share of IT investment has been steadily growing over time in the US economy, from 3.3% in 1990 to 4.2% in 2001. Instead, the GDP share of IT investment stagnated in Europe between 1990 and 1995, before the recent rise in the late 1990s. As a result, the EU-US gap, after reaching 2 percentage points of GDP in 1990-95, has stayed constant at 1.6 percentage points of GDP between 1995 and 2001. The evidence in Daveri (2002) and van Ark et al. (2002) is also suggestive that the growth contributions from IT capital goods have been roughly in line with accumulation rates, thus definitely higher in the US than in Europe.[5]

Table 2. IT investment over GDP in the EU and the US, 1990s

% points				
	1990	**1995**	**2001**	**(1995-01)-(1990-95)**
US	3.3	3.7	4.2	+0.5
European Union 15	2.2	2.1	2.6	+0.3
US minus EU-15	1.1	1.6	1.6	-

Source: Own calculations from Timmer et al. (2003).

The parallel evidence on IT investment and growth contribution from IT capital concisely exemplifies what is meant by a 'lag in IT capital accumulation' of the EU with respect to the US. To sum up, Europe appears to have enjoyed a sort of gentle type of IT revolution, not as pronounced as in the United States, but certainly present and visible in the European aggregate data as well. This was seemingly not enough, though, to counteract the overall tendency for productivity growth in the EU to decline about at the same time when productivity growth accelerated in the US. The issue taken up in sections 3 and 4 is *why* this was the case.

3. Interpreting the facts on IT and productivity

The EU's productivity slowdown has attracted the attention of several scholars and magazine commentators. At least three explanations of such productivity slowdown can be put forward and their implications contrasted. Two of them put IT, respectively its usage and production, at the centre stage. There is also a third view pointing to the irrelevance, or the second order importance, of IT as the ultimate engine of productivity growth. In what follows, these are referred to as the IT-usage, IT-production and IT-irrelevance views of the EU productivity slowdown and briefly described in turn.

[5] This is consistent with the idea that rates of return – at least the rates of return implied by the Jorgenson-Griliches (1967) calculation methodology – have not been too far apart across the two sides of the Atlantic Ocean.

3.1 The IT-usage hypothesis

If there is a common wisdom on the causes of the EU productivity slowdown, it is the IT-usage hypothesis, proposed by Kevin Stiroh and others to explain the US productivity revival and then adapted by van Ark et al. (2003) to account for the US-EU growth gap in labour productivity.

According to this view, the fast pace of IT adoption was at the root of accelerating productivity growth in the United States. This is hard to deny, even at first sight: the spectacular productivity performance of the US economy in the last decade or so has occurred in parallel with the widespread diffusion of IT throughout the economy. The growth accounting studies by Oliner and Sichel (2000) and Jorgenson and Stiroh (2000) – and their updates in Oliner and Sichel (2002), and Jorgenson et al. (2003) – led most experts[6] to conclude that the productivity revival in the US was indeed an IT story triggered by both capital deepening and enhanced TFP growth enabled by information technologies for about 80% of its extent.

The evidence based on aggregate data was importantly complemented at the industry level by both labour productivity evidence (Stiroh, 2002, Nordhaus, 2002a, 2002b) and TFP evidence (Triplett and Bosworth, 2002). Stiroh first found evidence that IT-using manufacturing and services industries had prominently contributed to the US productivity revival, showing that, absent their contribution, there would have been no productivity acceleration at all in the US economy. This provided the basis for the IT-usage view that the productivity revival has been mostly driven by the successful adoption of IT, at least in the US economy.

Such ideas have been taken up by Colecchia and Schreyer (2002) and van Ark et al. (2003a, 2003b) to explain the divergent productivity growth paths experienced by the US and the EU as a whole in the 1990s and tested against cross-country data for Europe. As part of a long-standing commitment to produce comparable data for the EU, data for individual EU countries and for the aggregate EU have been cleverly reconstructed on behalf of the European Commission and are now available in a CD ROM format (see O'Mahony and van Ark, 2003). This involved the integration of the sketchy industry data available from the OECD STAN data set with national sources and substantial imputation of sometimes non-existent industry data into a unified accounting framework to be contrasted with the available US data.

The main conclusion in van Ark et al. (2003a), based on an earlier release of such data, is that stagnating productivity in some IT-using business sector services (finance, wholesale and retail trade) is the source of the bulk of the EU-US productivity growth gap in the 1990s. Altogether, in the van Ark et al. paper, the EU-US gap in the post-1995 changes of labour productivity growth is fully accounted for by the (missing) growth contributions of wholesale and retail trade, and, less importantly, the brokers and other financial intermediation industries.

As these industries are identified as intensive IT users – a point to be further discussed below – these findings have been taken to imply that the slower diffusion of IT is the principal (or even the only!) cause of the lowering of productivity growth in Europe. This is clearly reminiscent of the ideas circulated by Stiroh and others with reference to the sources of productivity acceleration in the US economy.

[6] For a long time, Gordon (2000, 2003a) has been the only dissenting, though successfully vocal, voice. In a recent paper, though, even Gordon (2003b) has seemingly joined the group of the new economy optimists.

3.2 The IT-production hypothesis

In spite of its popularity and wide acceptance nowadays, the IT-usage hypothesis is not the only game in town. Another possible explanation, eventually attributable to Gordon's (2000, 2003a) papers, is that productivity growth in the information age is driven not so much by the pervasive diffusion of PCs, semiconductors, cellular phones and the Internet among firms, industries and households. Rather, it might be that growth gaps are essentially driven by the presence/absence of a few manufacturing industries or companies with a definite technological lead, such as the high-tech industries producing IT goods. This would attribute overwhelming importance to the fast development or continued fast growth of high-tech industries or firms as the main engine of growth, thereby shifting the emphasis away from the importance of technological diffusion.

Such ideas have not been much explored with OECD data, with the exceptions of the work in van Ark (2001) and Pilat and Lee (2001), where the scattered and often incoherent data available from STAN for a few OECD countries have been used. Altogether, such previous studies have pinpointed that the EU-US growth gap may be partly explained by the lower growth contribution of IT-producing industries. Even with their newly improved data set, van Ark et al. (2003b) provided some evidence not inconsistent with this view for the EU. Yet this finding has been clearly deemed of second-order importance by van Ark et al., when compared to their preferred IT-usage hypothesis described above.

The IT usage versus IT production controversy has also been tested by Daveri and Silva (2004), using a variety of techniques and industry data for the Finnish economy (including information from input-output tables and the price deflators of investment goods). Their findings provide empirical support against the IT-usage hypothesis: IT diffusion has not been seemingly behind the productivity success in Finland. Rather, productivity boomed in the industry where Nokia, the world leader in the production of cellular phones, is and in a few IT-related industries that mostly benefited from the (imported) reduction of the price of machinery and equipment.

3.3 The IT-irrelevance hypothesis

The former subsections have each emphasised a different idea about the way in which IT may have been the driving force underlying the EU-US productivity growth gap. A third option exists: it might simply be the case that something else and not IT has been the driving force underlying the productivity slowdown in the EU in the late 1990s.

Even though, as discussed above, the lower accumulation rates of IT capital in Europe has had a counterpart in terms of lower capital deepening and productivity growth, both in the US and the EU, all sorts of inefficiencies remain hidden in the non-IT manufacturing and services industries. This may have further dragged productivity growth in Europe.

As shown in a number of studies and notably in the early attempts of computing disaggregated TFP growth rates undertaken by van Ark et al. (2002) and Timmer et al. (2003), the combination of diminished capital deepening from non-IT capital goods and the diminished TFP growth in non-IT producing industries added up to more than 1 percentage point (see the figures in Timmer et al., 2003, Tables 10, 11 and 13).

This provides first-hand evidence that only a fraction of the growth gap between the EU and the US is attributable to IT.[7] This is apparent and strongly confirmed in the results reported in European Commission (2003).

Such accounting results have been attributed to a more precise content within the OECD Growth Project, undertaken in the second half of the 1990s, which has recently given rise, among other publications, to OECD (2003a). In this study, the role of product and labour market institutions has been explored using the vast array of aggregate, industry and firm-level data that OECD scholars such as Nicoletti and Scarpetta have bravely put together. Extensive evidence that labour and product market regulation are systematically associated with lower aggregate and industry TFP growth in the OECD countries has been presented in Nicoletti and Scarpetta (2003), while OECD (2003a) had firm-level evidence that the scope for more frequent market experimentation, enabled by the market-friendly US institutions, may be associated to higher productivity growth.

The pieces of evidence provided by the OECD may be taken as lending some support to the IT-irrelevance view for one reason. The OECD studies do *not* describe delayed IT diffusion as the ultimate cause of the EU productivity slowdown, but rather as one of the manifestations of the inappropriateness of EU institutions. Such institutions, by granting excessive protection to the incumbents, may have ended up stifling incentives to both accumulating IT capital *as well as* to innovation.

A complementary explanation, consistent with the growth accounting evidence for the US and the UK, is proposed by Basu et al. (2003). Starting from an adjustment costs model, they point out that declining TFP growth outside the IT-producing industry is precisely to be expected during times of fast technical change. This is because innovation involves costly restructuring and restructuring takes time. Hence, higher IT investment only causes higher costs with no benefits upfront, and thus may result in lower TFP growth in the non-IT part of the economy.

4. A numerical rendition of the proposed explanations

4.1 The thought experiment

In what follows, the empirical relevance of each of the three hypotheses briefly described above is numerically evaluated against the yardstick of the best available cross-country productivity data, those employed in O'Mahony and van Ark (2003).[8] This is not explicitly done in their book, which instead spends considerable effort in providing an unusually rich picture of the disaggregated trends of productivity and its components in Europe.

In their data set, real GDP is computed by double-deflating nominal output and intermediate input data. The prices employed to deflate nominal variables in the high-tech industries (ISIC Code 30-33) are adjusted for quality for the US. Price deflators for European countries are harmonised as in Schreyer (2000), i.e. derived from US deflators corrected for inflation

[7] These studies do not really provide clean measures of TFP growth, however. Labour quality is not accounted for. Long enough series of the industry capital stock are not available and therefore industry TFP must be computed under some heroic assumption, such as that of equal TFP growth in Europe as in the US. Work by Inklaar, O'Mahony and Timmer (2003) is under way to construct meaningful measures of industry TFP for the EU-15. For the time being, however, disaggregated TFP measures are only available for 26 industries and four EU countries (Germany, France, the UK and the Netherlands) and the US.

[8] These data are available at www.ggdc.nl.

differentials. Given the low inflation differentials between the US and most EU countries over the 1990s, this effectively amounts to superimposing a close similarity in the price dynamics of high-tech goods between Europe and the US. To avoid such quality correction translating into an exaggeration of the computed growth rate of overall real value added, real GDP is recalculated through chained weights, i.e. using average weights at time *t* and *t*-1 (Törnqvist indices).

Altogether, these features represent definite improvements over any other data set previously employed in this stream of literature, including those made available by the Groningen Growth and Development Centre itself in the past.

The quantitative evaluation exercise in this section runs as follows. First, labour productivity growth (value added per hour worked) for the total economy is calculated for the two areas: the US and the EU-15 aggregate. The concept of the "business sector" employed here is the one borrowed from the OECD, and covers the industries featuring the ISIC Rev. 3 Codes from 1 to 74, except for "real estate activities" (ISIC Rev. 3 Code: 70) in the STAN database. Thus the business sector differs from the total economy for real estate; "non-market services" and "social and personal services" are left out. The reasons to leave such services industries out are diverse. Productivity cannot be meaningfully calculated for non-market services and the bulk of the social and personal services item, as the value added is in most cases computed super-imposing a mark-up on wages and salaries of the employees for these industries. As far as the real estate activities industry is concerned, its exclusion is motivated by the fact that "imputed rent of owner-occupied dwellings" – an item outright unrelated to the business sector – is included with the properly stated business activities in the real estate sector under SNA93 for many countries.[9]

As a second step, labour productivity growth is decomposed by industry and, in turn, by industry group, on the output side. As a result, Table 3 can be compiled, where labour productivity growth data for the EU-15 and the US are reported over three distinct periods: 1979-90 (the productivity slowdown period), 1990-95 (the period before the US boom) and 1995-2001 (the period of the US productivity revival). The list of IT-producing industries is based on the OECD classification. In the manufacturing sector, it includes "office machinery" (ISIC 30), "insulated wire" (ISIC 313), "electronic valves and tubes" (ISIC 321), "TLC equipment" (ISIC 322), "radio and TV receivers" (ISIC 323) and "scientific instruments" (ISIC 331). In the services sector, it includes "communications" (ISIC 64) and "computer and related activities" (ISIC 72).

Drafting a list of IT-using industries is more controversial, as discussed below. In van Ark et al. (2003a, 2003b), this includes "clothing" (ISIC 18), "printing and publishing" (ISIC 22), "mechanical engineering" (ISIC 29), "other electrical machinery and apparatus not elsewhere classified" (ISIC 31-313), "other instruments" (ISIC 33-331), "building and repairing of ships and boats" (ISIC 351), "aircraft and spacecraft" (ISIC 352), "railroad equipment and transport equipment not elsewhere classified" (ISIC 352+359) and "furniture and manufacturing not classified elsewhere" (ISIC 36-37) in the manufacturing sector. In the same papers, the IT-using services industries are "wholesale trade" (ISIC 51), "retail trade" (ISIC 52), "financial intermediation" (ISIC 65-67), "renting of machinery and equipment" (ISIC 71), "research and development" (ISIC 73) and "legal, technical and advertising business services" (ISIC 741-3).

Bearing the data in Table 3 in mind, one can decompose the growth rates of labour productivity of the business sector in its industry group components, draw numerical

[9] An example of the use of this definition can be found in the 2001 Edition of the OECD STI Scoreboard.

implications of the three explanations and evaluate the role of IT usage and IT production in determining productivity developments in the US and Europe. This is done in the next subsections through the end of this section.

Table 3. Labour productivity in the EU and the US: Growth rates and contributions (% points)

	EU-15			US		
	1979-90	1990-95	1995-01	1979-90	1990-95	1995-01
Labour productivity growth, total economy	2.25	2.28	1.71	1.26	1.10	2.25
Contributions to labour productivity growth from:						
IT producers	0.34	0.24	0.49	0.26	0.43	0.68
IT producers, manufacturing	0.14	0.03	0.09	0.15	0.26	0.43
IT users (broad definition)	0.71	0.63	0.58	0.44	0.22	1.23
Non-IT industries (broad definition of IT users)	1.20	1.41	0.64	0.56	0.55	0.34
IT users (narrow definition)	*0.58*	*0.52*	*0.51*	*0.23*	*0.20*	*0.84*
Non-IT industries (narrow definition of IT users)	*1.33*	*1.53*	*0.71*	*0.77*	*0.47*	*0.73*

Notes: Labour productivity is measured as value added per hour worked. The reported growth rate of labour productivity for the business sector is the sum of the various industry groups' growth contributions. In turn, each of the industry contributions is the product of the growth rate of labour productivity of each industry times its value added share at the initial time in each sub-period. Hence, the reported growth contributions only include the so-called 'pure productivity growth' effect (see Nordhaus, 2002a, 2002b). The list of the IT-using industries is as in van Ark et al. (2003a, 2003b).
Source: Own calculations from O'Mahony and van Ark (2003, pp. 111-113).

4.2 The explanatory power of the IT-production view

4.2.1 Numerical evaluation

The IT-production view is conveniently numerically evaluated first in its 'US over time' and 'EU versus US' variants. Using the data in Table 3, one can raise the Gordon question: How much of the total labour productivity gain in the US is accounted for by the change in the growth contribution of IT-producing manufacturing? And, more relevant here, how much of the EU-US growth gap is explained by gaps in the contributions from overall IT production? The figures in Table 4 provide the elements to answer both questions.

Table 4. Evaluating the IT-production hypothesis

Total economy, percentage points		
	US	**US-EU**
	(1995-01) – (1990-95)	(1995-01) – (1990-95)
Δ(Labour productivity)	+1.15 (=2.25-1.10)	+1.72 [=(2.25-1.10)-(1.71-2.28)]
Δ(Labour productivity), IT producers	+.25 (=.68-.43)	+.00 [=(.68-.43)-(.49-.24)]
Δ(Labour productivity), IT producers, manufacturing	+.17 (=.43-.26)	+.11 [=(.43-.26)-(.09-.03)]

Source: Own calculations from data in Table 3.

The US-over-time variant of the IT-production view is verified by computing what fraction of the period change in the growth rate of labour productivity between 1990-95 and 1995-2001 is attributable to IT production. The contribution of the IT-producing industries to the productivity acceleration in the US economy stemming from the pure productivity effect (see Nordhaus, 2002a, 2002b) is about *one-fifth of the total labour productivity acceleration* in the US economy. The growth contribution of IT production to labour productivity growth rose from 0.43 percentage points in 1990-95 to 0.68 in 1995-2001, hence by about 0.25 points. This is some 21% of the total increase in labour productivity growth of 1.15 percentage points experienced in the US economy in 1995-2001 with respect to 1990-95. Consistent with the Gordon hypothesis, most of this (two-thirds of it) is due to the productivity acceleration in the *manufacturing* industries producing IT durable goods.

The overall growth contribution from IT producers is instead essentially zero when one comes to explain the EU-US gap. The variables to look at here are the double-differenced ones between the period change in the US variable of interest and the same period variation for the EU-15 variable of interest. This is equal to 1.72 percentage points for the growth rate of labour productivity of the business sector, i.e. the difference between the US acceleration (+1.15 percentage points) and the same period change in the EU (-0.57 percentage points, as a result of the growth slowdown from 2.28% per year in 1990-95 to 1.71% in 1995-2001). In the face of the total of 1.72 percentage points to be explained, IT production accounts for nothing. This is because the growth contributions from IT production went up by the same amount in the US and in the EU (+0.25 percentage points). Interestingly, most of the increased productivity contribution of IT production in European countries was from the industries producing IT services (such as TLC services) and not to the manufacturing ones, as was the case in the US.

Where do such different results come from? The bulk of the result is driven by the marked changes in growth rates over time. The acceleration to double-digit growth rates of labour productivity in high-tech industries, according to the data set employed here, was a worldwide phenomenon and occurred in both the US and the EU-15. Hence this acceleration effect, although more pronounced in the United States, does not account for a sizable share of the *cross-country* US-EU growth gap, but only for a tiny part of it. At the same time, however, it was a non-negligible part of the US productivity acceleration *over time*. This closely replicates previous findings, in particular in van Ark et al. (2003a).[10]

4.2.2 Discussion

A qualifier to these conclusions is warranted here, though. As recalled above in section 4.1, the national accounting price deflators for high-tech goods are not adjusted for quality changes outside the US and a handful of other OECD countries, including France, but not Germany, the UK, Italy and Spain. Therefore, the currently available national accounting data, such as those currently embodied in the OECD STAN database, do not systematically reflect such quality matters. This has driven the GGDC researchers to construct alternative price deflators for high-tech goods from Schreyer's (2000) 'harmonisation assumption' (see section 4.1). In turn, this amounted to assuming that the dynamics of the prices of high-tech goods in Europe is essentially driven by the dynamics of US prices, except for an overall inflation correction. This correction is usually of a smaller order of magnitude compared to the quality improvement component.

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[10] For an econometric investigation leading to more optimistic conclusions about the importance of IT production as a potential cause for cross-country differences in productivity growth, see Guerrieri et al. (2003).

In their papers, the GGDC scholars repeatedly reported that such a correction does not make a big difference for the behaviour of aggregate productivity. Indeed, the aggregate price deflator, when recomputed using the quality-adjusted prices of high-tech goods, is only marginally different from the published figures. Yet this does not necessarily apply to the subset of high-tech industries, whose estimated productivity growth may be raised substantially by this correction. To learn about the order of magnitude of this possible bias, it is instructive to take a look at Table 5 where the productivity growth rates of the computer industry (ISIC Rev. 3 Code: 30 in STAN) in Germany and France are reported. Such growth rates are calculated using two data sets (the OECD STAN and the O'Mahony-van Ark data set). Not only are the computed growth rates sharply different in the two cases, but also the direction of the acceleration may not be the same across data sets (see data for France). Given a value added share of about 0.35 in both countries, the high-tech contribution to accelerating growth estimated through STAN data amounts to 0.01 percentage points for Germany and negative 0.02 percentage points for France. These are very small figures indeed. It instead adds up to much bigger figures (0.15 for Germany and about 0.07 for France) when the GGDC data are employed.

Table 5. Comparing labour productivity growth in the computer industries from different data sets

Value added per employed person, percentage points		
	O'Mahony-van Ark	**STAN**
Office machinery et al. (ISIC Rev. 3 Code: 30)		
Germany		
1991-95	31.7	11.1
1995-00	75.2	15.2
1995-00 minus 1991-95	+43.5	+4.1
France		
1991-95	29.0	28.7
1995-00	48.6	21.4
1995-00 minus 1991-95	+19.4	-7.3

Source: Own calculations from O'Mahony and van Ark (2003) and STAN.

In conclusion, it may be that at last a fraction of the worldwide common trend in high-tech industries, as documented in section 4.1, is in fact an artefact of the harmonisation assumption employed to compute price deflators for the high-tech industries. Being less conjectural is hard for the time being. The O'Mahony-van Ark (2003) data set is in fact the result of an impressive effort of data collection, also inclusive of substantial data filling, in particular for smaller sub-industries. In most cases, this prevents pair-wise data comparisons from different data sources.

4.2.3 Summing up

The IT-production view does not strike one as a promising explanation of the EU-US growth gap. This result is clearly affected by the treatment of IT goods prices, though, in a direction still hard to assess with the currently available information.

4.3 IT usage versus IT irrelevance

In this section, the explanatory power of the IT usage and the IT irrelevance hypotheses is quantified. The extent to which such explanatory power is sensitive to how industry classification issues are resolved is also discussed.

4.3.1 Recovering the Stiroh and van Ark et al. results

The quantitative importance of the IT usage view can be recovered from the data reported in Table 6. Its US-over-time variant (how much of the total productivity gain in the US over time is explained by IT usage?) is verified by computing what fraction of the period change in the growth rate of labour productivity between 1990-95 and 1995-2001 is attributable to IT usage. On the output side, the increased growth contribution from IT users is 1.01 percentage points (from 0.22% in 1990-95 to 1.23% in 1995-01), over 87% of the total productivity increase. This is clearly reminiscent of Stiroh's (2002) result.

Table 6. Evaluating the IT-usage hypothesis

Total economy, percentage points		
	US	**US-EU**
	(1995-01) – (1990-95)	(1995-01) – (1990-95)
Δ(Labour productivity)	+1.15 (=2.25-1.10)	+1.72 [=(2.25-1.10)-(1.71-2.28)]
(a) Broad definition of IT-using industries		
Δ(Labour productivity), IT users	+1.01 (=1.23-.22)	+1.06 [=(1.23-0.22)-(0.58-0.63)]
(b) Narrow definition of IT-using industries		
Δ(Labour productivity), IT users	+0.64 (=0.84-0.20)	+0.65 [=(0.84-0.20)-(0.51-0.52)]

Source: Own calculations from data in Table 3.

How about the EU-versus-US variant of the IT-usage view, according to van Ark et al. (2003a)? This is like asking: How much of the double-differenced productivity gap between the EU and the US[11] is explained by IT usage? The answer is: a lot, as reported in the rightmost part of Table 6 – the growth contribution from IT-using industries is about 1.05 percentage points, some 60% of the total.

Hence, irrespective of whether one looks at the US over time or at the EU-US change-in-growth gap, there is a strong sense that the IT-usage hypothesis first-hand accurately explains most of what it is meant to explain, respectively the US productivity revival or the relative productivity slowdown of the EU-15.

4.3.2 Discussion

As mentioned in section 3.1, the IT-usage view crucially rests on the identification of a subset of industries as IT users. Classifying industries according to their IT intensity is a contentious issue, though, for three main reasons:

1) A *criterion* must be chosen, which may be based on one or more variables. A problem manifests itself here if the industry ranking changes, depending on which variable is chosen as a criterion.
2) For any given criterion, a *threshold* must be chosen so as to separate the group of the IT users from the group of the non-IT users. The problem here is the unavoidable arbitrariness of the chosen threshold.

[11] The double-differenced growth gap between the EU and the US is given by the difference between the change in productivity growth in the EU between 1995-2001 and 1990-95 and the same change in the US.

3) For any given criterion and threshold, an industry may turn out to be IT-intensive in one country and non-IT-intensive in another country, depending on such things as *factor prices and endowments*.

In his 2002 paper, Stiroh identified as IT users those industries whose share of IT investment over total investment was in the top 50% ranking. Potentially alternative criteria may be the share of IT capital services in value added and the share of IT capital stock over value added or total capital stock. A potentially alternative threshold might be to label IT users as those industries showing values of the criterion above the average. Van Ark et al. (2003a) nicely raised question 3) above, appropriately reporting national accounting data for the shares of IT investment over total investment for the US, France, Germany, the Netherlands and the UK in one of their Appendix Tables (Table A.2), coming to the conclusion that cross-country differences are not too serious.

The extent to which the IT content classification of industries is an issue is perhaps better appreciated by looking at the implications of adopting an alternative criterion threshold, within the data set currently used here to evaluate the IT-usage hypothesis.

As recognised by Stiroh (2002), the share of IT capital services in value added is possibly a better indicator than the IT investment share, for it identifies as IT-intensive those industries tangibly spending money on IT *and* being successful in reallocating inputs towards high-tech assets. Inklaar, O'Mahony and Timmer (2003) took up Stiroh's suggestion and reported the values of IT capital services shares in value added, averaged over 1979-95 and 1995-2000, for 26 industries for the US, an EU-4 aggregate (inclusive of the UK, France, Germany and the Netherlands) and the four individual EU countries (see Tables B.15 and B.16 in their paper). The need to choose an indicator relatively exogenous to the productivity revival suggests that 1995-2000 data should perhaps be left aside. A classification method employed to draw inference about the features of the productivity revival after 1995 should in fact be based on data *before* the productivity revival has actually started. Hence one is left with the *value added shares of IT capital services over 1979-95* as the relevant classification criterion.

Based on such 1979-95 rankings, retail ranks 9th and 10th, respectively in the US and the EU-4, hence well within the 50% threshold chosen by Stiroh (2002). Yet, thinking it through, one may wonder whether such a threshold is a really sensible yardstick. In fact, it turns out that, while the Stiroh criterion classifies retail among the IT-using industries, retail is actually using less IT capital (and therefore generating less IT capital services) than the *average* industry in the whole US economy (2.79 compared to 3.37 percentage points). The same applies to the EU-4 (2.10 versus 2.49) and to three (Germany, France, the Netherlands) of the individual EU countries for which data are available. The UK is the only exception where retail trade exhibits above-average IT intensity. This is again contradicted, however, by the IT-intensity data in the careful study of Basu et al. (2003, Table 10), where the 1990 value-added shares of IT goods in the retail trade are reportedly lower than the average of the UK economy for all the IT goods, as well as for computers and software, although not so for communication equipment.

Hence, depending on the specific threshold chosen, a crucial industry such as retail – accounting for the bulk of the productivity gains for Stiroh (2002) and one of the three explaining the bulk of the EU-US productivity growth gap – may no longer be classified among the IT users and be assigned instead to the group of the non-IT industries.

Furthermore, this problem is not restricted to retail. A careful scrutiny of the list of the industries classified among the IT-intensive industries by Inklaar, O'Mahony and Timmer

(2003) gives very similar results. The manufacturing industries of clothing, paper and printing, furniture equipment not elsewhere classified and, even more markedly, transport equipment are all classified among the IT-intensive industries that feature *below-average* IT capital services share of value added in the US and the EU-4 in 1979-95.

One may thus legitimately wonder what is left of the explanatory power of the IT-usage hypothesis when, e.g., retail and transport equipment are classified among the non-IT industries.

The basic results from such a reclassification are reported in the lower panel (panel b) in Table 6. Although not totally overturned, they look somewhat different from those seen above. The remaining IT-using industries still play a crucial role. IT usage only explains 56% of the US acceleration and 38% of the total EU-US growth gap. This compares respectively with 87% and 60% in the baseline case based on Stiroh (2002) and van Ark et al (2003a). The explanatory power of the IT-usage hypothesis is therefore clearly weakened under a different, but equally (or even more) plausible than the one employed by Stiroh and van Ark et al. in their papers.

4.3.3 IT irrelevance

The explanatory power of the IT-irrelevance view strictly depends on how restrictive the criteria are for classifying industries within or outside the group of IT users. As shown in Table 7, in the baseline case where retail and transport equipment are IT-using industries, the overall contribution of non-IT industries to the understanding of the EU productivity slowdown is even negative when US data over time are considered. This is essentially because productivity growth decelerated in the non-IT part of the US economy in the second half of the 1990s. It comes close to explain 40% of the US-EU change-in-growth gap. This is because the growth slowdown of non-IT industries was more marked in Europe than in the US. In particular, as discussed in the next sections, the non-IT manufacturing part of the economy has suffered a sharp productivity shortfall in 1995-2001.

Things change quite radically, however, when the baseline case is amended and retail and production of transport equipment are classified among the non-IT industries. The contribution from non-IT industries to explain the productivity growth change is no longer negative. Even more apparently, the productivity growth gap between the US and the EU is now accounted for by non-IT industries to a major extent (1.08 percentage points, about 63% of the total 1.72 percentage points).

Table 7. Evaluating the IT-irrelevance hypothesis

Total economy, percentage points		
	US	**US-EU**
	(1995-01) – (1990-95)	(1995-01) – (1990-95)
Δ(Labour productivity)	+1.15 (=2.25-1.10)	+1.72 [=(2.07-1.07)-(1.71-2.28)]
(a) Broad definition of IT-using industries		
Δ(Labour productivity), non-IT industries	-0.22 (=0.34-0.55)	+.66 [=(0.34-0.55)-(0.64-1.41)]
(b) Narrow definition of IT-using industries		
Δ(Labour productivity), non-IT industries	+0.26 (=0.73-0.47)	+1.08 [=(0.73-0.47)-(0.71-1.53)]

Source: Own calculations from data in Table 3.

4.3.4 Summing up on IT usage versus IT irrelevance

To sum up, simple back-of-the-envelope calculations, using the latest version of the same data set employed by van Ark et al. (2003a) clearly shows the strengths and weaknesses of the IT-usage hypothesis as an explanation of the EU productivity slowdown.

If one adopts the same criterion and threshold as in Stiroh (2002) and van Ark et al. (2003a), the IT-usage hypothesis is an *iron hypothesis*: it explains – in an accounting sense – a lot of the variation in the US economy over time and a very large fraction of the growth gap between the EU and the US. If, however, labels carry a meaning, industries using IT less than the average of the whole economy may perhaps *not* be grouped among the IT-intensive users. If they are left out, the explanatory power of the IT-usage hypothesis is much smaller (only about one-third of the total EU-US growth gap). Irrespective of the precise numerical weights to be put on one explanation or another, the point remains: classification issues matter and crucially determine whether IT-using or non-IT related industries are the main underlying causes of the relative productivity performances across the two shores of the Atlantic Ocean.

4.4 Summing up on the explanations of the productivity slowdown

In this section, an accounting evaluation of three potential explanations of the productivity slowdown in the EU has been offered. Most of the attention has been centred on the controversial quantitative basis of the IT-usage hypothesis. Depending on how specific industries are assigned to one group or another, the conclusions on the relative importance and explanatory power of each explanation may change to a non-negligible extent.

Is there a policy message attached to such findings? Yes, at least one. Given that the IT-usage hypothesis is in the background of the recipes stated in the Lisbon strategy, the results reported here should be taken to imply that spreading IT around the EU will not necessarily make Europe grow faster. This holds unless such IT-friendly policies are accompanied by other accompanying policies *not* focused on IT and aimed at raising productivity in the *non-IT* part of the economy.

In this respect, the slowdown in the growth rate of labour productivity in non-durable manufacturing – the area of the economy where IT diffusion is perhaps less profound – should be considered worrisome in two respects. First, although declining as a share of value added everywhere, the manufacturing share of value added is still bigger than in the US (19% of EU's total value added against 14% in the US). It follows that the 'mature' manufacturing decline is possibly more relevant for the EU than for the US. Moreover, most EU countries still entertain their revealed comparative advantage in mature manufacturing industries, producing non-durable or medium- to high-tech manufacturing goods. Hence, declining productivity growth in such industries is a signal that some change is probably needed there, such as changes in labour or product market legislation. These issues are discussed at length in the next section.

5. The nitty-gritty of the EU productivity slowdown

So far, the attention has been on labour productivity. The economists' preferred measure of efficiency in resource allocation is TFP, however. This is usually computed as a residual after netting out the growth rate of hourly productivity of the component attributed to the growth of the stock of capital per hour worked.[12] Accordingly, when decomposing the sources of labour productivity growth, a crucial distinction is made between TFP growth, the genuine increase in efficiency for a given amount of resources and capital deepening, i.e. the labour productivity increase enabled by capital accumulation for a given technology. This section presents evidence on such a decomposition, although for a smaller number of countries owing to data limitations.

In section 5.1, a summary of the industry productivity slowdown across non-durable and durable manufacturing, market services and other business sector industries is provided for the EU-15 and the US. In section 5.2, labour productivity trends are decomposed into their TFP and capital-deepening components for a subset of the EU-15 (the EU-4, see below) and the US.

5.1 Manufacturing versus services

In this section, the evolution of the growth rates of labour productivity at the industry level for manufacturing and services industries (as well as for a residual item) is reviewed. Given that the purpose of this section is to look at efficiency, business sector data are considered instead of total economy data, for this allows one to more neatly interpret the results from the decomposition carried out here. As noted in section 4.1, the concept of business sector employed here is borrowed from the OECD, and covers the industries featuring the ISIC Rev. 3 Codes from 1 to 74, except for real estate activities (ISIC Rev. 3 Code: 70) in the STAN database. Thus the business sector differs from the total economy for real estate; non-market services and social and personal services are left out. The reasons to leave such services industries out are diverse. Productivity is not meaningfully calculated for non-market services and the bulk of the social and personal services item, as value added is in most cases computed super-imposing a constant mark-up on wages and salaries of the employees for these industries. As to real estate activities, its exclusion is motivated by the fact that imputed rent of owner-occupied dwellings – an item outright unrelated to the business sector – is included with the properly stated business activities in the real estate sector under SNA93 for many countries.

Looking at the nitty-gritty of labour productivity growth at the industry level is a potentially useful undertaking for two reasons. First, the discussion on the classification issues in the previous section is suggestive that concentrating the attention on IT usage only may be of limited guidance, given that agreeing on a definition of IT intensity is contentious. Moreover, industrial policy debates often revolve around the traditional classification of industries in manufacturing and services, with manufacturing in turn distinguished in industries producing non-durable (typically low-tech) goods and industries producing durable goods, commonly thought of as vehicles of innovation and technical change.

Hence the traditional breakdown is employed here. Using such a breakdown invites thinking of the current productivity slowdown in the EU as the combination of two distinct phenomena: a missed opportunity in the services industries and a continued slowdown in manufacturing, mostly non-durable manufacturing.

[12] The reason why it is called TFP (total factor productivity) or MFP (multifactor productivity) is perhaps more transparent when considering that, rather than as a residual, it can be equivalently computed as the average of the productivity of labour and the productivity of capital, each weighted by its respective share in value added.

Table 8. Industry labour productivity growth in the US and the EU-15: Growth contributions, growth rates and value-added shares

	US			EU-15		
	1979-90	1990-95	1995-01	1979-90	1990-95	1995-01
Business sector	1.04	1.41	2.85	2.18	2.05	1.66
Manufacturing	1.10	1.06	1.09	1.30	1.20	0.72
Growth rates	3.42	3.65	3.90	3.50	3.63	2.36
1980, 1990, 1995 value-added shares (2001 in parentheses)	0.32	0.29	0.28 (0.22)	0.37	0.33	0.31 (0.28)
Non-durable manufacturing	0.41	0.33	0.06	0.69	0.78	0.38
Growth rates	2.07	1.93	0.35	2.87	3.74	1.91
1980, 1990, 1995 value-added shares (2001 in parentheses)	0.20	0.17	0.17 (0.13)	0.24	0.21	0.20 (0.18)
Durable manufacturing	0.64	0.75	0.99	0.60	0.42	0.34
Growth rates	5.35	6.23	9.02	4.61	3.47	3.17
1980, 1990, 1995 value-added shares (2001 in parentheses)	0.12	0.12	0.11 (0.09)	0.13	0.12	0.11 (0.10)
Market services	-0.18	0.29	1.78	0.19	0.28	0.55
Growth rates	-0.38	0.53	3.12	0.46	0.58	1.05
1980, 1990, 1995 value-added shares (2001 in parentheses)	0.48	0.54	0.57 (0.63)	0.42	0.49	0.52 (0.56)
Other industries	0.39	0.21	0.11	0.73	0.59	0.36
Growth rates	1.97	1.25	0.71	3.49	3.27	2.14
1980, 1990, 1995 value-added shares (2001 in parentheses)	0.20	0.17	0.15 (0.15)	0.21	0.18	0.17 (0.15)
Total within	1.26	1.57	2.94	2.21	2.07	1.63

Notes: 'Total within' is the sum of the growth contributions from non-durable manufacturing, durable manufacturing, market services and other industries. Data refer to the business sector, not to the total economy. 'Business sector' includes all the industries in the economy except for real estate, social and personal services and non-market services. The industry codes are: ISIC Rev. 3: 1-74, excluding 70 (real estate activities).

Source: Own calculations from O'Mahony and van Ark (2003).

As emphasised in Table 8, where data for the EU-15 and the US over 1979-2001 are reported, the stagnation of labour productivity in the EU market services industries in the second half of the 1990s stands in front of a sudden and definite productivity acceleration in the same industries in the US at about the same time. This is why the current productivity trends in services should be seen as a missed opportunity for Europe. Such issues have been extensively studied in previous work, though, and indeed form the skeleton of the previously discussed IT-usage hypothesis. The productivity slowdown in manufacturing has instead been somewhat overlooked and is thus investigated here at a greater length.

As also visible in Table 8 (see the value-added shares lines), the declining share of manufacturing in business sector value-added is not a novel feature of the 1990s. All of the industrial countries have been undergoing a de-industrialisation process for a long time now. As a part of this process, the manufacturing share in business sector employment and value added has begun declining as early as in the late 1960s in the UK and the US, and a handful of years later in France, Germany, Italy and Spain as well. Table 8 documents the final bit of this long-lasting process, showing that the value-added share of manufacturing declined by about 10 percentage points for the EU-15 between 1980 and 2001, from 37% of business sector value-added in 1980, gradually declining to one-third of the total in the first half of the 1990s, and further down to 28% of the total in 2001. This decline of 10 percentage points was exactly matched by the US economy, however, where the manufacturing share of business value added fell from 32% in 1980 to 22% in 2001.

Table 8 also shows that, while de-industrialisation occurred everywhere in the so-called ‘industrial countries’, the sudden decline of almost half a percentage point per year (from 0.8 to 0.4 percentage points) in the productivity growth contribution of manufacturing was specific to Europe.

In turn, this mainly originated from the declining growth rate of labour productivity in non-durable manufacturing, which fell from values in excess of 3 percentage points per year during the 1980s through the early 1990s to less than 2% per year in the last part of the past decade. Notably, this is still much bigger than the growth rate of labour productivity of the same industries in the US, whose growth rate went down as well to 0.35% per year in 1995-2001 from about 2% in 1980-95.

As shown in Table 9, where the same data as in Table 8 are presented for the five big EU countries, the non-durable and durable manufacturing declines in labour productivity growth are a particularly serious matter in Italy and Spain. In these two countries, the growth slowdown was in excess of 3 percentage points for non-durables and 2 percentage points for durables. But the decline has been sizable (namely, above the average slowdown of the EU-15) for Germany and the UK as well in the same mature manufacturing industries. In France, the slowdown has instead been more moderate.

Examples of individual European industries in patent difficulties abound. Among the intermediate goods-producing industries, chemicals saw its labour productivity performance dramatically worsening over time in most of the big EU countries. Productivity growth rates in chemicals fell from 6-7%, the high rates of the 1980s through the first half of the 1990s, to 0-2% per year in the second half of the decade in Germany, Spain, Italy and the UK, with a moderate reduction in growth rates in France as well. Even some of the industries producing non-durable consumer goods experienced sharp declines in productivity growth: both the textiles and leather and footwear sectors underwent reductions of about 3-4%, respectively, in Spain, France and the UK and in France, Spain and Italy.

Cases of even more abrupt turnarounds in growth rates can be listed for each of the big EU countries. In the German motor vehicle industry, productivity growth fell from positive 3% in 1990-95 to negative 3% in 1995-2001. In the UK and France, another medium- to high-tech industry such as railroad and other transport equipment experienced a substantial reduction in productivity growth (from +3% per year in 1990-95 to -9% in 1995-2001 in the UK and from +9% per year to –1% per year in France). In Spain and Italy, labour productivity in the insulated wire industry – a branch of electrical equipment production – has experienced sustained growth even at double-digit rates since 1980, but then its yearly growth rate fell to negative yearly figures in the most recent years.

Taken altogether, the evidence on durable and non-durable manufacturing may lead one to conclude, as succinctly put by Blanchard (2004), that the slowdown in the growth rate of manufacturing (non-durable manufacturing, in particular) cannot possibly be important to explain diverging productivity trends between the EU and the US.

Table 9. Industry labour productivity growth in the big EU countries: Growth contributions, growth rates and value-added shares

Germany			France			UK			Italy			Spain		
1979-90	*1990-95*	*1995-2001*	*1979-90*	*1990-95*	*1995-2001*	*1979-90*	*1990-95*	*1995-2001*	*1979-90*	*1990-95*	*1995-2001*	*1979-90*	*1990-95*	*1995-2001*
Business sector (growth rates)														
2.45	2.54	2.50	3.67	2.18	1.78	2.70	3.97	2.95	2.54	3.25	1.26	3.82	2.11	0.87
Manufacturing (growth contributions, growth rates, industry value-added shares)														
1.14	1.22	0.77	0.92	1.10	0.96	1.81	1.56	0.90	1.26	1.18	0.38	1.82	0.98	0.16
2.77	3.04	2.28	2.64	3.74	3.35	5.02	4.96	2.97	3.31	3.64	1.23	5.34	3.71	0.62
0.41	0.40	0.34 (0.33)	0.35	0.30	0.29 (0.28)	0.36	0.31	0.30 (0.24)	0.38	0.32	0.31 (0.28)	0.34	0.26	0.26 (0.24)
Non-durable manufacturing (growth contributions, growth rates, industry value-added shares)														
0.53	0.80	0.36	0.22	0.60	0.38	0.89	0.81	0.34	0.84	0.83	0.22	1.25	0.70	0.01
2.21	3.74	1.90	0.97	3.08	1.99	3.71	3.97	1.72	3.37	3.78	1.04	5.00	3.69	0.06
0.24	0.22	0.19 (0.18)	0.23	0.19	0.19 (0.18)	0.24	0.20	0.20 (0.15)	0.25	0.22	0.21 (0.19)	0.25	0.19	0.19 (0.17)
Durable manufacturing (growth contributions, growth rates, industry value-added shares)														
0.58	0.43	0.39	0.69	0.52	0.57	0.91	0.76	0.55	0.42	0.36	0.15	0.57	0.28	0.14
3.39	2.32	2.65	5.77	5.06	5.90	7.58	6.86	5.28	3.20	3.38	1.62	6.29	3.77	1.95
0.17	0.19	0.15 (0.13)	0.12	0.10	0.10 (0.10)	0.12	0.11	0.10 (0.09)	0.13	0.11	0.10 (0.09)	0.09	0.07	0.07 (0.07)
Market services (growth contributions, growth rates, industry value-added shares)														
0.90	1.33	1.18	1.61	0.28	0.48	0.62	1.50	1.88	0.26	1.37	0.48	0.59	0.28	0.28
2.26	2.99	2.35	3.57	0.52	0.88	1.60	3.06	3.55	0.61	2.69	0.89	1.47	0.59	0.54
0.40	0.44	0.50 (0.54)	0.45	0.53	0.54 (0.57)	0.39	0.49	0.53 (0.51)	0.43	0.51	0.54 (0.57)	0.40	0.48	0.52 (0.55)
Other industries (growth contributions, growth rates, industry value-added shares)														
0.39	0.07	0.40	0.96	0.71	0.32	0.56	1.17	0.37	0.76	0.59	0.27	1.41	0.72	0.37
2.03	0.43	2.47	5.05	4.03	1.89	2.22	5.99	2.25	4.02	3.53	1.73	5.41	2.83	1.74
0.19	0.16	0.16 (0.12)	0.19	0.18	0.17 (0.15)	0.25	0.19	0.17 (0.15)	0.19	0.17	0.16 (0.14)	0.26	0.25	0.22 (0.21)
Total within														
2.40	2.63	2.33	3.48	2.09	1.75	2.98	4.23	3.15	2.28	3.14	1.12	3.81	1.99	0.81

Notes: 'Total within' is the sum of the growth contributions from non-durable manufacturing, durable manufacturing, market services and other industries. Data refer to the business sector, not to the total economy. "Business sector" includes all the industries in the economy except for real estate, social and personal services and non-market services. The industry codes are: ISIC Rev. 3: 1-74, excluding 70 (real estate activities).

Source: Own calculations from primary data in O'Mahony and van Ark (2003).

For one thing, this is simply the continuation of the process of cross-country convergence in productivity levels in mature industries. Both neoclassical growth theory and catching-up theories – such as the one in Acemoglu et al. (2002) – would predict a decline of productivity growth in a given industry as its productivity level gradually becomes closer to the technological frontier, namely to the productivity level of the country-industry leader. As various studies have shown (see e.g. Maddison (2001)), this process started long ago and has been at work in manufacturing for a few decades on both sides of the Atlantic. Hence, why should the decline of non-durable manufacturing be a particularly important problem for *today's* EU productivity?

It may be so for three reasons. In the US, the declining non-durable producers are being taken over by fast growing high-tech manufacturing industries and by services industries. This is seemingly not the case in the EU. Second, the share of non-durable manufacturing is still much higher in Europe than in the US. A given productivity slowdown in non-durable manufacturing is thus bound to bring about more serious growth consequences in the EU than in the US. Third, non-durable (more generally, mature) manufacturing industries represent the heart of Europe's comparative advantage in international trade. This does not apply to the US, which exhibits a pronounced and sharpening specialisation in the production of high-tech goods. While losing competitiveness in non-durable goods industries makes the EU more vulnerable in world trade, the US doesn't suffer from such a shortcoming. Let's see these arguments in turn.

The role of high-tech industries in offsetting the sharp productivity slowdown of nondurable producers in the US economy is confirmed by the rough constancy exhibited by the growth contribution of the overall manufacturing sector over time in Table 8. This could not have possibly been the case, had the decline of non-durable goods producers not been offset by improved productivity performance in durable production. The average growth rate of durable-goods producing US industries has indeed gone up from an already high of 6% per year in 1980-95 to about 9% in 1995-2001 (this is even more apparent when the attention is restricted to high-tech industries only). In Europe, instead, not only did the growth rate of labour productivity in durable manufacturing not take off, but it even suffered a mild shortfall, from 3.5% to 3% per year, over the same period of time. As in the US, if durable manufacturing is then further decomposed into IT-producing manufacturing and the producers of other capital goods, it emerges that IT producers enjoyed a productivity acceleration at least qualitatively, if not quantitatively, similar to the one experienced by the same industries in the US. The producers of other capital goods, instead, also known as 'medium- to high-tech' industries in the OECD jargon, have suffered from a productivity growth slowdown in the EU-15.

Consistent with the evidence brought forward in the previous section, the data in Table 8 eventually show that the non-IT part of the manufacturing sector (which includes most non-durable goods producers and a few medium- to high-tech durable goods producers) has contributed negatively to the productivity growth performance of the EU. Although a qualitatively similar phenomenon has occurred in the US economy, it should not be forgotten that the value added shares of such industries is much smaller in the US than in Europe. Non-durable goods industries represented about 13% of the total business sector in 2001, against 18% in the EU-15 in the same year. This is one reason why the same productivity slowdown in manufacturing may well be a, possibly temporary, but clearly more serious concern in Europe than in the US.

There is another reason to be worried about the productivity slowdown in Europe's mature manufacturing industries. This is seen in Table 10, where data about the revealed comparative advantage (RCA) of the US, the EU-15 and the five big EU countries in 1992 and 2001 are shown for four manufacturing industry groups classified according to technological intensity (high, medium-high, medium-low, low) for the European Union countries of interest. The most common indicator of RCA of a country in a given industry is the contribution to the trade balance of that industry. Such contributions are the difference between the observed trade balance (exports minus imports) for each industry and the hypothetical trade balance that would arise if the overall trade balance was uniformly spread across industries according to their shares over total trade. Hence, a positive value of the contribution indicates the presence of a comparative advantage in that industry. In this analysis it is computed for manufacturing industries only, given that services are usually non-traded internationally.

Table 10. Patterns of revealed comparative advantage, 1992 and 2001, the US, the EU and the five big countries in the EU-15

	High-tech industries (aircraft, pharmaceuticals, computers, TLC equipment, medical & optical instruments)		**Medium- to high-tech industries** (chemicals, automotive, transport equipment, machinery n.e.c., electrical machinery n.e.c.)		**Medium- to low-tech industries** (oil, plastics, other mineral products, basic metals, ship building, other metal products)		**Low-tech industries** (manufacturing n.e.c., wood products, paper & publishing, food, textiles and wearing)	
	1992	**2001**	**1992**	**2001**	**1992**	**2001**	**1992**	**2001**
US	**3.8**	**5.4**	1.9	0.6	-1.2	-1.5	-4.5	-4.4
EU-15	-1.2	-1.0	**2.2**	**1.9**	0.0	0.0	-1.1	-1.0
Germany	-2.0	-2.7	**9.0**	**7.1**	-1.0	-0.6	-6.0	-3.9
France	0.1	0.8	**2.1**	**1.7**	-0.5	-0.7	-1.6	-2.0
UK	**2.0**	**3.6**	2.1	0.4	-0.1	0.3	-4.5	-4.6
Italy	-3.5	-3.7	-0.5	-0.1	0.0	0.4	**4.0**	**3.5**
Spain	-3.7	-3.7	1.6	1.1	**3.5**	**1.5**	-1.4	1.1

Notes: The index of revealed comparative advantage (RCA) is computed as the observed trade balance of industry *i* minus the 'theoretical' trade balance, expressed in hundreds of manufacturing trade.

Source: OECD (2003c), pp.196-197.

The data clearly indicate the areas where the comparative advantages of the EU and the five big EU countries lie. The UK, like the US, is specialised (i.e. has a comparative advantage) in high-tech industries (namely, aircraft and spacecraft, as well as pharmaceuticals). Germany and France entertain their comparative advantage in medium- to high-tech industries, in the automotive industries in particular, but also machinery and equipment not elsewhere classified at least for Germany. Going further down along the technological ladder, Spain's specialisation in medium- to low-tech industries (such as other non-metallic mineral products) comes next, while Italy has its comparative advantage in low-tech industries (essentially, textiles and wearing).[13]

Comparing a big entity relatively close to international trade such as the US with individual, small, open economies, such as each of the big EU countries is probably not fully satisfactory for drawing implications about the patterns of international specialisation. A more proper yardstick might thus be the EU-15 as a whole. The RCA (revealed comparative advantage) data in Table 10 shows that the competitiveness of the EU-15 in high-tech industries is weak. These are just the industries where the comparative advantage of the US lies. The EU-15 is instead specialised in the production of medium- to high-tech industries. The EU-15 and the US are also both weak in low-tech industries, those at the bottom end of the technological spectrum. Germany is the only big EU countries whose trade structure has some similarities with the overall EU trade structure.

[13] This is clearly just a broad picture, which omits a variety of details. For example, France is not specialised in high-tech industries as a whole, but does have a comparative advantage in aircraft and spacecraft, whereby France's RCA comes second in the OECD right after the US. Italy, in spite of its technologically backward trade structure, entertains a comparative advantage in a medium- to high-tech industries such as machinery not elsewhere classified. And the US, although unambiguously the most technologically advanced country, has a slight comparative advantage in food, beverages and tobacco, where Italy is instead at a comparative disadvantage.

How does this compare with productivity data? Available evidence indicates that productivity growth has declined more often in non-durable manufacturing for Italy and Spain and for traditional (non-IT) durable goods production for Germany and the UK. Interestingly (but worrisome), the industry localisation of the productivity slowdown often coincides with the industry localisation of comparative advantage. In the US economy, instead, the slowdown in non-durable goods manufacturing has occurred in those industries where the US is at a comparative disadvantage already. In parallel, the productivity boom occurred just in those industries where the US has had a comparative advantage at least since 1992.

While this may still be too farfetched to be taken as solid evidence that the productivity slowdown has had a competitiveness counterpart, collecting more detailed evidence on these issues should be of concern in the near future.

5.2 The EU productivity slowdown: Capital or TFP?

In this section, the labour productivity trends described in section 5.1 are dissected further by decomposing them in two components, one owing to TFP and the other to capital deepening.

5.2.1 Data

This is done through a data set, complementary to the main one employed above, put together by the Groningen Growth and Development Center and the British National Institute of Economic and Social Research (NIESR). Within this project of data collection, 'meaningful' industry TFP growth rates are computed for 26 industries of four European countries (Germany, France, the UK and the Netherlands) and the US. By 'meaningful' it is meant that, in addition to the quality adjustment of the output side discussed above, such industry TFP measures also net out labour and capital quality improvements, added up to the respective factor contributions à la Jorgenson and Griliches (1967). An aggregate EU-4 is also computed for comparison purposes with the US. This EU-4 aggregate represents about two-thirds of the overall EU-15 GDP. These data have been used in O'Mahony and van Ark (2003) and Inklaar, O'Mahony and Timmer (2003).

Unlike the productivity data previously analysed, such TFP data only span to 2000. For each variable of interest, two sub-periods will be considered: 1979-95 and 1995-2000. This serves the purpose of addressing the concern that, by comparing the first and the second half of the 1990s, the constructed productivity measures would be affected by different cyclical circumstances. By taking 1979-95 rather than 1990-95 as a benchmark, the probability that recent trends are contrasted with genuinely long-term averages is much higher.[14]

5.2.2 Results

Table 11 reports the outcome of decomposing the growth rates of value added per hour worked into their capital deepening, TFP growth and labour quality growth contributions for the US and the aggregate EU-4. In turn, the capital deepening component is usefully further split into an IT capital component and a non-IT capital component. This same decomposition is carried out for non-durables, durables and market services in Tables 12, 13 and 14 as well.[15]

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[14] This does not eliminate the possibility that recent data are affected by the business cycle, however. A useful discussion of business cycle issues is in Inklaar and McGuckin (2003).

[15] According to the growth accounting methodology, the growth rate of GDP can be routinely decomposed into its labour, capital and TFP components. As shown in the early growth accounting exercises, if labour and capital are treated as monolythic homogeneous entities, this translates into a very high contribution attributed to TFP in

Although some cross-country heterogeneity is unavoidable, two main results can be drawn for the European business sector as a whole. First, *the European productivity slowdown is mostly the result of diminished capital deepening of non-IT goods only*. Second, there is a *substantial constancy of European TFP growth* at the respectable rate of about 1 percentage point reached in the past. These pieces of evidence are apparent in Table 11. The slowdown in the growth rate of labour productivity in the business sector for the EU aggregate – milder for the four countries considered here than for the EU-15 – is more than accounted for by the diminished contribution of non-IT capital (-0.45 percentage points) and the worsening in labour quality, which has contributed another negative 0.15 percentage points. On the positive side, instead, business sector productivity has benefited from an increase in the already positive contribution from IT capital (up from 0.3 to 0.5 percentage points) and from the slight increase in TFP growth (from 0.9 to 1.05 percentage points). Hence, at least for the overall business sector, one has to concur with Jorgenson (2003) who argues that *TFP as well as accumulation of IT capital are unrelated to the growth slowdown of European productivity*. This marks a sharp contrast with the US, where TFP growth markedly accelerated, moving from a contribution of 0.25 to more than 1 percentage point per year and the contribution of IT capital jumped up by almost half a percentage point (from 0.4 to 0.8 percentage points).

So far, the discussion has focussed on the *aggregate* decomposition of labour productivity. The GGDC-NIESR data set, however, provides detailed industry information, and the decomposition can be repeated at various levels of disaggregation. Here manufacturing and services are looked at, in line with the description of labour productivity trends given above. The key question here is to understand which factors account for the two distinct phenomena – the lack of productivity acceleration in the services sector and the sheer decline in productivity growth in non-durable and mature durable manufacturing – that have seemingly driven the EU productivity slowdown.

Table 11. Decomposing aggregate labour productivity growth, business sector

	US		**EU-4**	
Business sector	1979-95	1995-00	1979-95	1995-00
Labour productivity growth	1.21	2.46	2.30	2.02
Contributions to labour productivity growth from				
IT capital	0.46	0.86	0.33	0.53
Non-IT capital	0.35	0.43	0.70	0.25
TFP growth	0.26	1.05	0.94	1.07
Labour quality	0.13	0.13	0.33	0.18

Source: Own calculations from O'Mahony and van Ark (2003).

Table 12 concerns non-durable manufacturing. It shows that the lessened growth contribution of non-durable manufacturing is owing to everything but IT capital: the diminished contribution of non-IT capital, the reduced contribution from TFP growth and the worsening of labour quality. It is thus the outcome of a relatively balanced implosion of the growth potential of these industries.

explaining GDP growth. If, instead, labour and capital are adjusted for quality, as they perhaps should given that workers and machines are not all the same, the computed TFP shrinks and, in parallel, the contribution from labour and capital becomes more sizable. The capital deepening contribution to labour productivity growth alluded to in the main text includes such quality adjustments. See Inklaar et al. (2003) for a detailed discussion of how labour and capital quality are captured in the estimates by Inklaar, O'Mahony and Timmer (2003).

Table 12. Decomposing the contribution of non-durable manufacturing to the aggregate growth of labour productivity

	US		EU-4	
Non-durable manufacturing	1979-95	1995-00	1979-95	1995-00
Total contribution to aggregate growth of labour productivity	0.26	0.04	0.39	0.23
Contributions from				
IT capital	0.03	0.06	0.03	0.04
Non-IT capital	0.06	0.09	0.13	0.07
TFP growth	0.13	-0.11	0.18	0.11
Labour quality	0.04	0.00	0.05	0.01

Source: Own calculations from O'Mahony and van Ark (2003).

As to durable manufacturing (Table 13), the lack of an acceleration of TFP growth in the EU-4 is indeed there, but at the same time the reduced growth contribution of non-IT capital, which practically zeroed in 1995-2000, is also visible.

Table 13. Decomposing the contribution of durable manufacturing to the aggregate growth of labour productivity

	US		EU-4	
Durable manufacturing	1979-95	1995-00	1979-95	1995-00
Total contribution to aggregate growth of labour productivity	0.50	0.79	0.47	0.36
Contributions from				
IT capital	0.06	0.07	0.03	0.03
Non-IT capital	0.05	0.05	0.10	0.02
TFP growth	0.34	0.64	0.28	0.28
Labour quality	0.05	0.03	0.06	0.03

Source: Own calculations from O'Mahony and van Ark (2003).

The positive trend of TFP growth in market services (see Table 14) is even more surprising. TFP growth contributed a positive half a percentage point in 1995-2000, up from about a quarter of a percentage point. This is clearly much less than the sharp acceleration experienced in the US (up from slightly negative contributions in 1979-95 to about 0.8 per year in 1995-2000). The culprit for the lack of acceleration is again the decline to slightly negative figures of the growth contribution from non-IT capital. The contribution of IT capital was instead positive and growing from 0.2 to about 0.4 percentage points per year.

Table 14. Decomposing the contribution of market services to the aggregate growth of labour productivity

	US		EU-4	
Market services	1979-95	1995-00	1979-95	1995-00
Total contribution to aggregate growth of labour productivity	0.47	1.74	0.75	0.92
Contributions from				
IT capital	0.30	0.71	0.22	0.38
Non-IT capital	0.12	0.13	0.18	-0.02
TFP growth	-0.06	0.82	0.27	0.48
Labour quality	0.11	0.08	0.08	0.08

Notes: The growth contributions of manufacturing and services do not add up to the total business sector. The gap is made up by the contribution of other industries.

Source: Own calculations from O'Mahony and van Ark (2003).

5.2.3 Summing up on capital versus TFP as causes of the EU productivity slowdown

A definite answer to the question whether capital or TFP was behind the EU productivity slowdown of the 1990s cannot be given yet. Any answer is still tentative, based on data only referred to as a subset of EU countries. The limited available information suggests, however, that capital deepening is not as large as in the past and this – rather than diminished TFP growth – is the main culprit for the European slowdown. In turn, available data also show that the diminished growth contribution from capital comes from non-IT capital rather than IT capital. Hence, the evidence, based on the better data available today, comes very close to confirm the findings in Daveri (2000, 2002) and Gros (2001, 2002), where rough measures of IT capital and TFP were employed. Such results have then been restated in a number of studies by the OECD, the European Commission and lately by Jorgenson (2003) and Inklaar, O'Mahony and Timmer (2003) with more refined data sets. The bottom line is still the same, though: *IT as such was not the only cause behind the EU productivity slowdown of the 1990s*.

6. The future prospects of productivity growth in the EU

In the previous section, the diminished contribution from non-IT capital and the lack of an acceleration of TFP growth have been pinpointed as the main sources of the growth gap currently suffered by Europe as a whole with respect to the US. This holds, in spite of the continued positive trend of TFP growth in high-tech manufacturing industries in the EU-4 – an indication that something positive is anyway in the making in the most dynamic part of the EU economies.[16]

The crucial policy question nowadays in the EU is thus whether and how the declining growth contribution from capital may eventually come to a stop and whether TFP growth may be speeded up. This section is a discussion of such issues.

In section 6.1, the likely forces affecting capital deepening are investigated. In section 6.2, TFP developments are discussed, with special emphasis on one of its main determinants, i.e. R&D spending. The main conclusions from this discussion will be put in a broader perspective in the conclusions, against the twofold benchmark of the contents of the Sapir Report of July 2003 and the EC Growth Initiative of November 2003.

6.1 Diminished capital deepening: Temporary or permanent?

The European productivity slowdown is too recent for observers to be able to evaluate whether its nature is long or short term. When decomposing TFP and capital components starting from a production-function framework, one is naturally driven to think in terms of the long run. Yet the time series length involved here is so short that distinguishing what is long term and what is short term is conjectural, to say the least.

It is thus a possibility that the declining growth contribution from capital deepening may not last. This may be the case if they are the result of the labour market reforms enacted in many European countries in the 1990s. Evidence not reproduced here (see, e.g., Garibaldi and Mauro, 2002) in fact shows that Europe's labour market reforms in the second part of the

[16] This conclusion is subject, however, to the same caveat raised before on the potential bias induced by the adoption of US quality-adjusted price deflators to compute real GDP in the high-tech industries. This is problematic for Europe is still in the *vacuum* caused by the absence of independent information on whether the implied assumption that the law of one (in its weak rate-of-change formulation) really holds for high-tech goods.

1990s, although introduced in bits and pieces and often affecting the hiring and firing of temporary workers only, effectively encouraged the hiring of such, often unskilled, part-time workers. The aggregate and industry evidence, respectively in Figure 1 and Table 15, is startling on this respect.

Table 15. Growth of total hours worked, the US and the EU-15 (business sector, manufacturing and services)

Compounded average growth rates						
	US			**EU-15**		
	1979-90	1990-95	1995-2001	1979-90	1990-95	1995-2001
Business	1.29	0.95	1.47	-0.44	-1.40	0.97
Manufacturing	-0.69	-0.31	-1.12	-1.56	-2.77	-0.34
Non-durable manufacturing	-0.75	-0.03	-1.37	-1.69	-2.60	-0.70
Durable manufacturing	-0.60	-0.73	-0.72	-1.33	-3.10	0.30
Mkt services	2.53	1.67	2.19	1.31	0.12	2.34

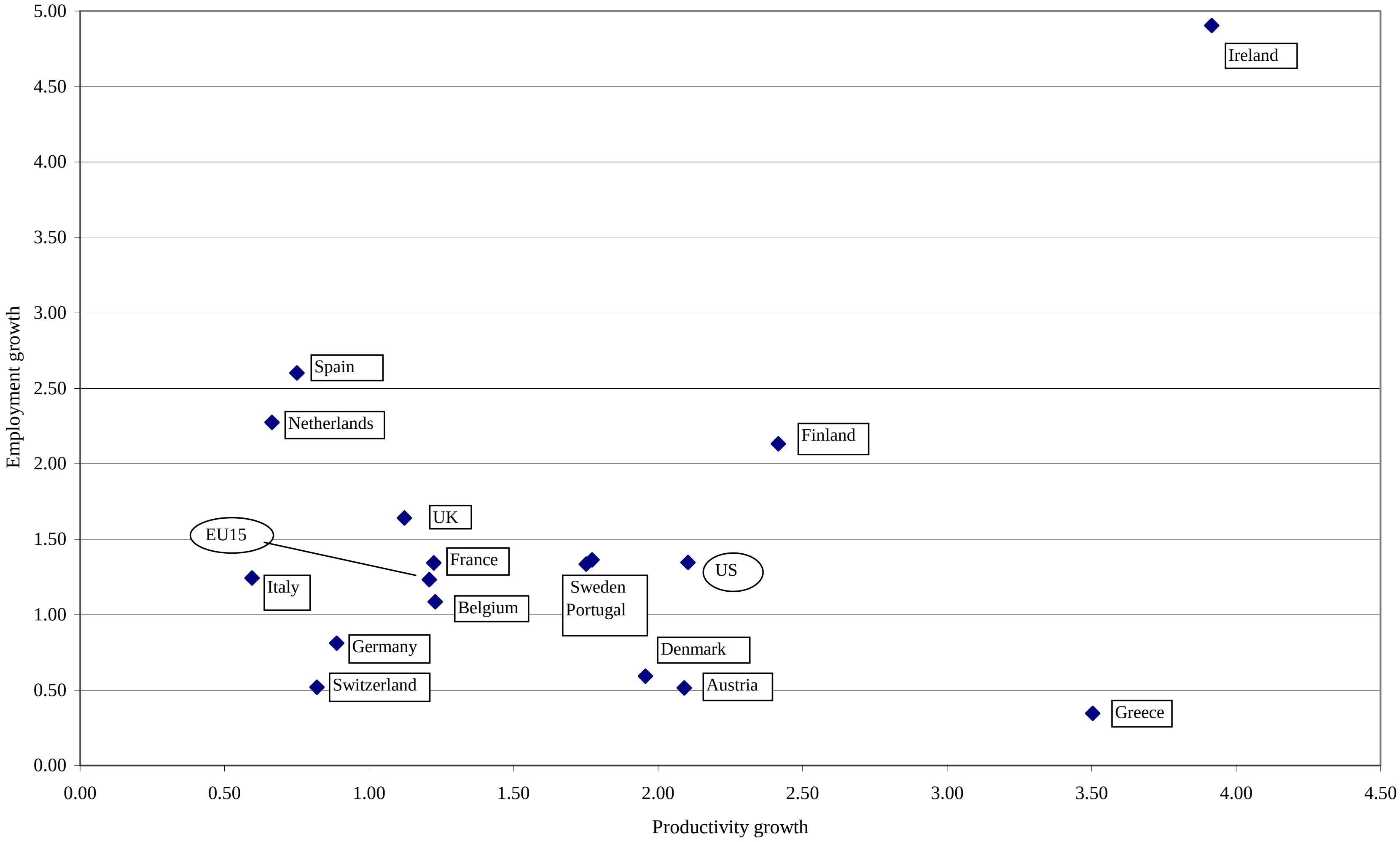
Source: Own calculations from O'Mahony and van Ark (2003).

Figure 1 presents employment and productivity growth rates in the 15 EU countries and the US in 1995-2002. As is well known, in the EU-15 employment and productivity grew at lower rates than in the US. Most European countries appear to have suffered from an employment-productivity trade-off over this period of time, however. In countries often taken as success stories in the EU labour markets, such as Spain and the Netherlands, employment grew at more than 2% per year, but labour productivity stagnated. In a country such as Greece, with buoyant productivity growth, employment stagnated instead. The only exceptions on the positive side are Ireland and Finland, with Italy and Germany being the exceptions on the negative side.

Table 15 clearly documents the sharp turnaround in the pace of job creation in Europe since 1995. The growth rate of hours worked has gone from persistently negative growth rates of hours worked of about half a percentage point per year in the 1980s and almost 1.5 percentage points per year in the early 1990s to persistently positive figures leading to an increase in the number of hours worked by 1% per year in the last few years. This is still slightly lower than in the US (where the growth rate of hours worked remained around 1.5% per year even in the productivity revival years before the current recession), but clearly indicates that the 1980s chronic inability of the European economies to create jobs has been partly overcome.

Table 15 also shows that the new entrants in the labour market, given their low human capital endowment, likely found themselves more easily employed in traditional industries. Hours increased by 2.3% per year in the market services industries in Europe (about the same as in the US). In the manufacturing industries, Europe's employment performance was less striking, for negative figures were still recorded in 1995-2001, at least for the growth of hours worked in non-durable goods manufacturing. Yet this compares with a negative rate of 2.6% per year in 1990-95 and a negative rate of 1.6% in the 1980s, and should thus be regarded, if anything, as a marked improvement. The same applies to durable manufacturing where the roughly zero-growth in the number of hours worked definitely improves upon negative rates of growth of 3% or so in the first half of the 1990s and about a negative rate of 1.5% per year throughout the 1980s. Europe's employment outlook indeed dramatically changed in the last bit of the 1990s.

Figure 1. Productivity growth and employment growth in Europe and the US, 1995-2002



Notes: Employment growth is the growth rate of total employment; productivity growth is the growth rate of GDP per employed person.
Source: OECD Economic Outlook.

One interpretation of these figures is that, altogether, productivity growth has been somehow hampered by the entry of the unskilled workers in the labour market. This has possibly driven down the equilibrium of the capital-labour ratio. As long as this is simply the other side of the coin of the increased employment rate of the last five years (and possibly of the mismatch induced by the introduction of IT capital goods), the diminished capital deepening might just be transitional. If this is the case, governments should perhaps not be overly pessimistic about Europe's prospects of reviving labour productivity growth.

This is not the only possible view of the facts, though. A simpler but pessimistic view would instead stress that the declining productivity growth in non-durable (and mature) manufacturing industries signals the *insufficient reallocation of workers* away from that declining sector into newer, more dynamic, industries. This suggests that governments have to do something, namely continue along the undertaken path of market reform in the goods and labour markets, perhaps broadening their scope and enlarging their extent, in order to ease reallocation and raise efficiency (see section 6.2 for a discussion of how to raise TFP growth).

It is hard to judge which view is more plausible. The back-of-the-envelope calculations in Box 1 indicate, however, that reversing the negative trend in capital deepening is unlikely if the goal of reaching the 70% employment rate in the EU-15 in 2010 – one of the stated Lisbon goals – is taken seriously.

Box 1. The capital-deepening counterpart of reaching the Lisbon employment goal

One of the policy goals stated in Lisbon for the European Union to reach by 2010 is raising the EU employment rate – the ratio of total employment over total working age population – to 70%. Given that the current employment rate in the EU is about 63%, this implies an increment of about 1 percentage point per year in the next seven years or so. In turn, if the working age population keeps growing at the past rates of about 0.5 percentage points per year – an average of 0.3 percentage points for the native population and 1.2 percentage points. for the immigrants – total employment has to go up by 1.5% per year until 2010 to meet the Lisbon employment goal. This is a bit higher than 1.25%, the growth rate of total employment averaged in the EU in 1995-2002 (see Figure 1). But it is not unfeasible, at least in principle. If coupled with a continuation of the long-term trend towards a reduction of average hours worked (about half a percentage point per year), this translates into an expected increase of the labour input of about 1% per year from now to 2010.

What does this imply in terms of capital deepening, i.e. the growth contribution of capital to productivity growth? To come up with an educated guess of such implications, the past growth rates of the capital stock for the whole economy (e.g. for 1996-2000) have to be projected into the future. Based on the data Inklaar, O'Mahony and Timmer (2003) employed in the main text, one can obtain estimates ranging between 0.8% per year for France and 4.2% per year for the UK, with Germany and the Netherlands in between (but much closer to Germany). Hence, a simple continuation of past accumulation rates would imply a growth rate of the capital stock of about 3% per year for the EU-4. In turn, the corresponding growth rate of the capital stock per hour worked would be 2% per year and the growth contribution from capital deepening would be equal to *two-thirds of a percentage point* per year (at least as long as the value-added share of capital stays unchanged at one-third). This compares with 0.78 percentage points computed for the EU-4 in 1995-2000.

In the end, the increased capital stock per hour worked would add to labour productivity growth about the same as (or slightly less than) in the years of the European productivity slowdown. This amounts to saying that, if the Lisbon employment goal is taken seriously, one can hardly expect capital deepening to take off again and contribute much to productivity growth in the next few years through 2010.

6.2 R&D and productivity growth

As productivity growth is unlikely to accelerate as a result of a revived contribution from capital, TFP growth is the only remaining possible engine of such acceleration. The question discussed here is whether this acceleration in TFP growth is likely to materialise.

Higher TFP growth (the economists' proxy for technical change) may be induced by a host of elements, the main and perhaps least controversial of which is spending in research and development. R&D may be performed and/or funded on the business as well as on the government side. The government may directly fund R&D or grant R&D tax credits to the business sector. Private and public R&D may also originate domestically or abroad. All such different aspects of R&D may (and do) have different productivity effects, which have been extensively studied. This body of applied research represents the most natural yardstick against which one can evaluate whether increasing R&D to 3% of the EU GDP – as envisaged by the Lisbon strategy – will produce sizable productivity-enhancing effects.

A few basic facts about R&D and patents in the US and Europe are presented first (section 6.2.1). Then a short recollection of why there may be a positive relationship between R&D and productivity is in section 6.2.2. Finally, a selective review of the available evidence on R&D and productivity is reported in section 6.2.3, with a special emphasis on cross-industry and cross-country studies.

6.2.1 A few facts about R&D and patents: The US versus the EU

Here are a few data to document whether and to what extent the EU lags behind the US in terms of R&D spending. OECD data show five main facts as to the R&D basics. These are shown in Table 16.

Table 16. Basic indicators of R&D and patents, the EU and the US

% points		**EU**	**US**
R&D spending/GDP	2001	1.9	2.8
Growth rate of PPP-adjusted R&D spending	1995-2001	3.5	5.1
Business R&D/total R&D	2001	58	70
% High tech R&D/manufacturing R&D	2001	47	59
% Health R&D/GDP	2001	8	25
% Defence R&D/GDP	US: 2003; EU: 2001	15	54

Source: OECD (2003c).

First, total R&D in the US makes up a much higher *GDP share* than in the EU. As reported by OECD (2003c), in 2001 – the latest year for which comparable R&D data are available – the US spent about 2.8% of their GDP in R&D, while the EU GDP share of total (public and private) R&D did not reach 2%. This is 1 percentage point below the Lisbon target of 3%.

Second, in the last few years, the *growth rate* of R&D has been higher in the US than in Europe. During 1995-2001, PPP-adjusted R&D spending increased by more than 5% per year in the US and by some 3.5% in the EU. This rapid growth has produced a slight increase in the GDP share of R&D, which is anyway impressive, given the very fast GDP growth that occurred in the US economy. The 2001 EU share was the highest since 1991, though, with the R&D spending of Finland and Sweden exceeding 3% of their GDP.

Third, the bulk of US R&D stems from *business R&D*, while this share is much lower for Europe. Business R&D was 1.92% of the US GDP in 2001 – equivalent to 70% of total R&D in the United States. In the EU-15, business R&D represents about 1.1% of GDP, some 58%

of total R&D in the European Union countries. Fourth, the US allocated a high share of their manufacturing R&D – a large chunk of business R&D – to high-tech industries, about 60% of business R&D in manufacturing. In the EU-15, this share was much lower (47%). Although the reasons for the patently lower R&D investment of Europe may be many, it probably mainly reflects the higher share of small-sized enterprises and the lower value-added share of high-tech industries in the EU vis-à-vis the United States.

Yet the EU-US differences as to R&D efforts are not constrained to the business sector: government priorities as to *R&D policy* differ as well. The US government devotes a much larger share of its budget to health-related, defence and space programme R&D than the EU governments added up together. Health-related budget appropriations for public R&D reach 0.2% of the US GDP (one-fourth of the government R&D budget), and are instead a bare 0.05% of the EU-15 GDP (8% of the total government budget appropriations for R&D purposes). As of 2003, budget appropriations for defence R&D in the US boomed to 0.5% of their GDP (or 54% of the total budget appropriation for R&D). In the EU, this figure stopped at a bare 0.1% (or 15% of the total budget appropriation for R&D) in 2001.

OECD (2003c) also provides data about patent families – a set of patents filed in various countries to protect a single invention.[19] It relates to 'triadic' families, i.e. patents *applied for* at the European Patent Office (EPO) and the Japanese Patent Office (JPO) and patents *granted* by the US Patent Office (USPTO). The patents from these offices are linked by priority dates to form 'families'. In 1998, there were more than 40,000 patent families in the OECD area, a 32% increase since 1991. The US accounted for 36% of the total (roughly constant since 1991) and the EU for 33% (up from 30.5% in 1991). Hence, over the 1990s, the EU share of patent families converged somewhat towards the share held by the US.

Perhaps, the most important piece of evidence on patents in OECD (2003c) is the picture that shows a tight cross-sectional parallel between business R&D and patent families (both in logs) in the OECD in 1991-98. This is a stark indicator of a tight link between R&D and patenting activity. The number of patent families are usually well-determined by interpolating a straight line based on the amount of business R&D. The only exceptions are the poorer OECD countries, such as Mexico, Poland, the Czech Republic, Slovakia, Turkey and Portugal, which slightly under perform in terms of patents for a given amount of R&D with respect to the other OECD countries. [20]

In the end, it appears that:

- The EU does lag behind under practically all R&D items with respect to the US.
- The link between R&D spending and patenting activity is a tight one across the OECD.

6.2.2 Why is there a relationship between R&D and productivity growth?[21]

R&D activity affects productivity growth through various channels. Business-performed R&D spending results in new goods and services, improved output quality as well as new methods of production. It does so adding the firm's capital stock of knowledge, which may be patented or not. It is thus contributing to capital deepening, as long as the investment in R&D

[19] This indicator improves upon the counting of patent application issued by a single patent office, which unavoidably suffers from the 'home bias advantage' granted by national patent office to domestic innovators.

[20] A very similar picture obtains as well even when contrasting business R&D spending with the number of patent applications at the EPO (both in logs).

[21] This section draws on Guellec and van Pottelsbergh de la Potterie (2001).

can be accumulated and an internal rate of return earned on it as on any other type of capital. One question often discussed here is whether the rate of return earned on R&D investment is higher than the rate of return on physical capital, i.e. if there is a supernormal return on R&D.

Particularly related to the main topic of interest here, business R&D adds to TFP growth, easing innovation, directly if patented and indirectly by facilitating technology adoption. Part of these effects may not accrue to the firm undertaking the R&D investment and instead spill over onto other firms in the same or another industry, within the country or outside the country.

Government and university research have an effect on the accumulation of basic scientific knowledge. Such productivity effects may go unmeasured, however. Examples are many: the effects of defence or health-related R&D, if resulting in enhanced security and lengthened life, are not recorded in the GDP statistics. The same applies to the basic-knowledge-augmenting effect of university research. If basic research creates new profit opportunities for business, including business research, this will instead be eventually included in productivity measures.

Foreign-originated R&D finds its ways into national borders in many ways. Domestic firms may buy patents, licenses and know-how from foreign firms, but may also try reverse engineering, hire foreign scientists and engineers. Otherwise, a country may also gain access to foreign knowledge through the operation of multinational firms within its borders. The extent to which a country can benefit from foreign knowledge may also depend on the amount of R&D performed within the country, which affects the absorptive capacity of the country.

All such effects have been quantified in various empirical studies surveyed in section 6.2.3.

6.2.3 The evidence on R&D and productivity growth

As mentioned above, business R&D has an internal effect on capital deepening, owing to the same components as any other capital good, its accumulation rate and its rate of return on the accumulated capital. But it also has external effects, both in its private and public components. They manifest themselves onto the industry, across industries and within industries across countries. Basic R&D has a likely productivity effect as well. The same applies to the R&D undertaken internationally.

There are estimates of all such effects, which wander around quite a bit in terms of size. Dowrick (2003) provides a useful survey of previous microeconomic, industry and economy-wide studies. The bulk of such studies refer to the US economy, but country studies on European countries are available, as well as cross-country studies. As surveyed in Lichtenberg and Siegel (1991), the private rate of return on R&D in the US economy is about 25-30% (plus an additional 7% owing to federally-funded business R&D). This is high already, being between two and three times as much as the normal rate of return earned on investment in physical capital. Moreover, internal rates of return do not exhaust the return to R&D investment. Nadiri (1993) reports that even more (between 20% and 100%, with an average of 50%) may be earned when cross-industry spillovers are added. In his cross-country study on 74 countries, Lichtenberg (1992) found rates of return close to twice as much as the return on fixed investment – a result in the low end of the findings of microeconomic studies for the US economy.

More recently, Frantzen (2000) jointly estimated the extent of national and international returns from R&D, extending the Coe and Helpman (1995) approach, through the following equation:

$$\text{growth(TFP)}_{jt} = \alpha \text{ (business R\&D intensity)}_{jt} + \beta \, \Sigma_i \text{ [(total R\&D intensity)}_i\text{*(import share from country } i)]_{jt}$$

i = 1,.., 21 (number of OECD countries included in the regression), 1961-1991

The estimated α (a measure of the national social rate of return on R&D) in this equation is about 0.6 and the estimated β (a measure of the international spillovers) is (a huge) 1.5. All of these results are likely plagued by serious econometric problems of endogeneity and measurement error.

The estimated size of such coefficients ought therefore to be taken with care, if it were not that some recent, econometrically very careful studies tend to confirm the big picture arising from the previous studies. In their study on 12 OECD countries, Griffith et al. (2001) found a high estimate (43%) of the social rate of return from innovation-producing R&D. Using German and British micro-data, Bond et al. (2002) raise a word of caution, however, on the potential heterogeneity of rates of return across countries, which they find much higher in Germany (45%) than in the UK (a rather low 16%).

In the end, irrespective of the precise, possibly questionable, numerical determination of the estimated coefficients, the existing literature on the productivity effect of R&D suggests two definite conclusions:

- The social rate of return from R&D is probably much higher than its private rate of return.
- Such discrepancy is the outcome of substantial spillovers both across industries and across countries

Before going on, two remarks are important with regard to how to interpret such findings. First, theory (see Jones and Williams, 1998) says that there may be reasons for the amount of private R&D to even exceed its social optimum. One reason for having excess private R&D is that the R&D races, originating from decentralised R&D, drive to *ex-post* wasteful duplication of research efforts. Another reason for excess R&D is that, when R&D output (patent) benefits an innovator at the expense of the incumbents, this causes creative destruction. Obviously, there are also reasons why private R&D may be sub-optimally low. This may be the case *as social returns (total R&D surplus) are only imperfectly appropriated when a monopoly is granted to an innovator*. It may also be the case as R&D assumes a public good nature in that it *decreases the cost of future innovations*. The empirical studies mentioned above suggest that the positive externalities are seemingly bigger than the negative externalities. If social rates of return are higher than private returns, this is a reason for the public sector to actively engage in R&D programmes, perhaps by a substantial amount.

Second, the results suggesting potentially high rates of return on R&D also suggest why R&D, being such a small share (about one-tenth) of total investment, may be an important determinant of productivity: it is because its rate of return is unusually high compared with other types of capital accumulation.

6.2.4 Summing up on the promise of R&D as a vehicle of higher productivity growth

The evidence presented in this section conveys a simple and important policy message. Given the tight link between R&D and patents, along with the high rate of return on R&D

investment, raising R&D spending towards the Lisbon goal of 3% of GDP looks like a promising route to raising the European Union's innovation potential and productivity growth.

7. Conclusions: The Sapir Report, the European Growth Initiative and the future of growth in the EU

Rather than recalling the main themes touched upon in this paper (already summarised in the introduction), these concluding remarks are devoted to drawing some policy implications from the findings of the paper, within the broader perspective offered by the Sapir Report and the Growth Initiative currently underway in the EU.

Indeed, the most obvious benchmark against which to evaluate whether enough innovation and growth is being generated in the European Union is the policy goal(s) set forth by the EU for itself. This is the so-called Lisbon strategy, formulated in Lisbon in 2000, which would prescribe the EU to become the most dynamic and competitive knowledge-based economy in the world, with sustainable growth and social cohesion by 2010. This was before the war on terrorism and the current recession came about. Since then, however, the focus on long-term strategic issues has been significantly revived by the Sapir Report, completed by a High-Level Study Group on behalf of the European Commission in July 2003. The Sapir Group, headed by André Sapir, included, among other outstanding economists, prominent growth scholars such as Philippe Aghion and Giuseppe Bertola.

What's nice and what's new in the Sapir Report? At least two things, among a few others. On the methodological side, it should be regarded as highly commendable that the report does not have the flavour of the usual reports drawn up by or under the auspices of international organisations. Such reports usually tend to be self-referential (within the organisation that produces the report) and have overly long lists of actions 'to do'. The Sapir Report was instead written by academic economists, who took a (more or less) temporary policy detour from their main professional activities. This probably encouraged them to give policy trade-offs an unusually large space – a good idea indeed.[22]

The other nice feature of the Sapir Report is that it starts from a well-specified and sensible conceptual framework, borrowed from Acemoglu et al. (2002). The bottom line of Acemoglu et al. is that the best growth strategy for a country depends on how far the country is from the available technological frontier. This means that taking advantage of and adopting the US technology was best for Europe after the end of WWII. At that time, Europe was distant enough from the technological frontier and thus large enough gains from learning-by-doing, imitating and buying technological advances generated elsewhere, notably in the US, could be achieved.

Yet 25 or 30 years of convergence have made such mechanisms no longer apt to further feed growth in the now-advanced Europe. This makes producing innovations in Europe today all the more necessary.

This is why, among other proposals on how to perfect the functioning of the Union, the Sapir Report devotes a fair amount of space to the importance of boosting investment in knowledge.

[22] This feature of the Sapir Report may have not been welcomed by politicians who often prefer to be endowed with one-sided experts' opinions to trash or recover from the waste bin when needed depending on circumstances. Yet pointing out that choices have costs and benefits is useful to the public opinion and therefore this is a definite success of the Sapir Report.

In particular, the goal of producing more innovation is presumably well served by raising more funds for research and development and improving their efficiency of allocation. This is advocated to occur in three ways:

- creating an independent European agency for science and research;
- encouraging private sector R&D through tax credits;
- re-focusing the structure of the (slim) EU budget away from agriculture into separate growth and restructuring funds. The growth fund would be the appropriate pool to fund supranational R&D, training and educational projects.

As of today, it is uncertain whether the Sapir Report has been buried already or if it will be given the chance of being as influential as its predecessor, the 1986 Padoa-Schioppa Report.

To be sure, under the European Growth Initiative, launched by the Commission on 11 November 2003, infrastructure investment will be speeded up. This programme includes a list of 56 ‘Quick Start’ projects (31 in transport, 17 in energy and 8 in high-speed communication networks, R&D and innovation). The overall investment from now to 2010 amounts to approximately €38 billion for cross-border sections of the Trans-European Network (TEN) in transport, €10 billion for the TEN energy projects and about €14 billion for a high-speed communication network, R&D and innovation). Hence, this is about €62 billion, 60% of which is supposed to come from public sources and the remaining part from private funding. The European Investment Bank is supposed to be in charge of putting together the financing for the plan from the various sources.

Leaving aside a number of implementation issues of such an initiative (including how likely is the chance of getting the private sector involved in delayed and uncertain investment plans, such as building the Messina Bridge between Sicily and Calabria? How rapid can spending be with such huge investment projects?), just one question is raised here for its relevance for future growth in the EU.

How does the European Growth Initiative underway relate to innovation and growth (and to the approach suggested by the Sapir Report)? The answer is: very tangentially, at first sight. First of all, the size of the cake itself is small anyway – €10 billion per year, or one-tenth of a decimal point of the EU GDP. It’s not much to propel growth. Yet, were funds invested in high rate-of-return projects, this would not be a major concern. Nevertheless, and this the real source of concern, the majority of these projects are likely to be slow to deliver, with the high-return part of the cake (R&D and innovation) being very small.

For the time being, therefore, it looks as though EU institutions and governments have not taken the modern and growth-enhancing approach implicit in the Sapir Report very seriously. If it has not been buried yet, but it certainly has not contributed to reshaping the EU approach to innovation policy in any fundamental way.

Thus, as far as its future growth prospects are concerned, the EU is seemingly left in between the rhetoric of the official documents, sequentially produced by the national governments and the Commission, and the practice of growth promotion, which, for many reasons, is far from single-handedly embracing a much-needed growth plan for the EU.

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