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Why Is Productivity Growth in the Euro Area So Sluggish?

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Why Is Productivity Growth in the Euro Area So Sluggish?

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Abstract

Slow productivity growth has plagued the euro area since the mid-1990s. That is particularly striking in view of the large productivity gains in the United States during the same period. This paper shows that the deceleration in labor productivity in the euro area was caused by structural changes in wage formation that have affected the relative price of labor, increased the labor intensity of growth and, thus, reduced the rate of capital deepening. Technological shocks seem to have played a minor role in explaining slower productivity growth in the euro area. In addition, a surge in capital deepening and, mainly, TFP growth in key service industries in the United States explain a large part of the productivity growth gap between the two regions in the second half of the 1990s.

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I. INTRODUCTION

Labor productivity in the euro area seems to have risen a bit above U.S. levels in the mid-1990s, hinting at a full technological catch-up, but has lost some ground since then. Several analysts have pointed to a decline in total factor productivity (TFP) growth in the euro area as an important cause for the sluggish labor productivity since 1995.[2] Others have highlighted the productivity surge in key high-tech sectors in the United States as crucial to the performance gap.[3]

In fact, identifying the ultimate reasons for the changed path of labor productivity growth in the euro area is crucial to determine effective policy actions, as relatively weak TFP growth would point to problems with technology adoption and managerial efficiency, while slower capital deepening (growth in the capital-labor ratio) would signal a change in the relative benefits of investing in capital vis-à-vis hiring labor. Several new studies have recently produced some stylized facts and corrected important data mismeasurements. However, we are still grappling to find the reason for sluggish productivity growth in the euro area.

This paper improves our understanding of the ultimate causes for the recent productivity slowdown in the euro area, while at the same time incorporating new and much improved cross-country databases on the utilization and production of information and communications technology. The focus on the euro area, the second-largest economy in the world, is also an important difference with respect to previous work. This paper agues that:

- The bulk of the labor productivity deceleration in the euro area in the second half of the 1990s can be explained by slower capital deepening (slower growth in the capital-labor ratio), as opposed to slower TFP growth**.** The apparent slowdown in TFP growth obtained from productivity calculations using national accounts data for the euro area disappears once better, industry-level data for Germany are considered in the analysis. Therefore, the sluggishness in euro-area labor productivity in the second half of the 1990s should be more associated with the use of production inputs and not with negative technological or efficiency shocks.

- The slower capital deepening in the euro area in the second half of the 1990s can be explained by structural wage-setting changes. These changes made labor cheaper, inducing firms to slow the process of capital accumulation and to hire more workers. To quantify the effect of these structural labor market changes on capital deepening, the paper develops a simple model for evaluating how structural changes in wage setting affect labor productivity growth. Calculations based on econometric estimates using industry-level data for a subset of euro-area countries (France, Germany and the

[2] European Commission (2003).

[3] O'Mahony and van Ark (2003), for instance.

Netherlands) show that wage-setting shocks would have forced capital-labor ratios to decline in the second half of the 1990s. In the event, capital-labor ratios grew at a slower rate but did not decline, as other factors, including cheaper information and communication technology (ICT) equipment, partly offset the wage shock.

- The productivity growth differential with respect to the United States since the mid-1990s can be explained by a faster labor productivity deceleration in traditional industries (i.e. industries that are neither producers nor intensive users of ICT) in the euro area and, even more importantly, by a surge in productivity growth in intensive ICT-using sectors (mainly wholesale and retail trade and financial intermediation) in the United States**.** Productivity behavior in ICT-producing sectors (e.g. computers, semiconductors, and communication services) was similar in the two areas.

Looking ahead, policies to improve labor utilization in Europe should continue in the medium term as the Lisbon targets are pursued, which might dampen labor productivity growth through slower capital deepening. However, lower labor productivity growth is a temporary phenomenon that will fade away when the economy reaches a new equilibrium unemployment rate. In addition, the labor market reforms needed for the continuation of low wage growth and reductions in the unemployment rate should improve economic efficiency. Besides labor market reforms, further product market deregulation (particularly in wholesale and retail trade) would promote efficiency gains, and help to close the productivity growth gap with respect to the United States. Higher TFP growth could also be attained by letting markets better reward individual effort, which would raise risk-taking activities, spending on research and development, and human capital accumulation.

The next section discusses labor productivity developments in the euro area and in the United States using aggregate national accounts data within a larger context of convergence in GDP per capita between the two regions. It serves as a motivation for the paper and presents a decomposition of labor productivity growth in the euro area and in the United States into the contributions of capital deepening and TFP growth. Section III presents calculations using the industry-level database from the Groningen Growth and Development Center (GGDC) for the 12 euro-area countries and the United States. These calculations document productivity developments among intensive users of ICT equipment, producers of ICT equipment, and more traditional industries. Then, the GGDC growth accounting database for France, Germany, the Netherlands, and the United States is used to provide a breakdown of labor productivity growth into the contributions of changes in ICT and non-ICT capital, labor quality, and TFP. The bias in growth decompositions based on national accounts data (as in section II) is discussed. Section IV proposes a simple wage-bargaining model to illustrate how structural labor market changes would affect the adjustment path of labor productivity growth through changes in capital deepening. An econometric estimate for the effect of structural wage-setting changes on capital deepening and, therefore, labor productivity is provided. Section V concludes the paper by briefly discussing key results from the literature to highlight the effect of structural changes, including deregulation of product markets, on TFP growth—a topic that is left for future research.

II. GDP Per Capita and Productivity Growth in the Euro Area and in the United States

Readily available aggregate national accounts data (evaluated at purchasing power parity prices) are frequently used to describe relative movements in labor productivity and GDP per capita growth. The message from these data has served to frame the policy and academic debates. They show that the long-run pattern of declining GDP per capita growth in the euro area has a mirror image in declining trend rates of labor productivity growth. Trend GDP per capita growth in the euro area has been declining since the 1950s, finally bringing to a halt the convergence to U.S. levels in the 1970s (Figures 1 and 2). In the United States, labor productivity growth oscillated around 1½ percent a year for many years until it trended up in the second half of the 1990s, surpassing the euro-area figures for the first time (Figure 3 and Table 1).[4] Increasing employment rates in the United States (Figure 4 and Table 1) widened this gap and GDP per capita growth in the second half of the 1990s was about 1 percentage point a year higher than in the euro area.

Figure 1. GDP per Capita Trend Growth (5-year moving average, in percent)

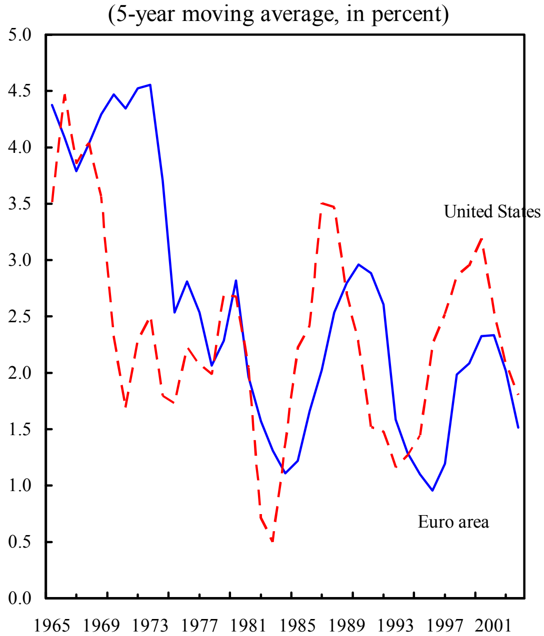
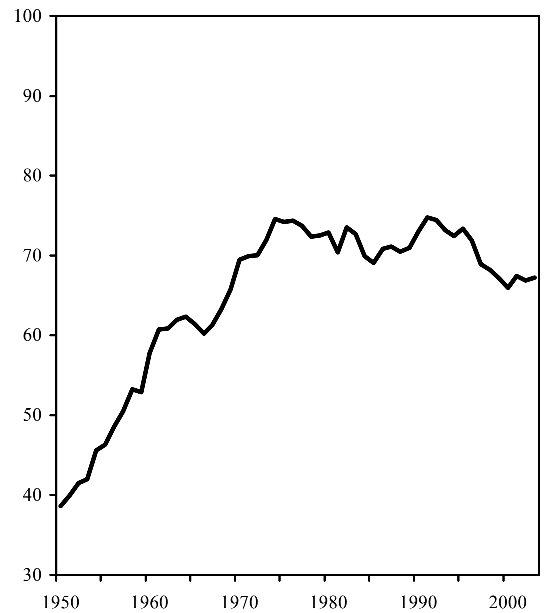


Figure 2. PPP GDP per Capita in the Euro Area as Percentage of U.S. Value



Sources: EC - AMECO database; OECD Productivity database; and author's calculations.

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[4] Basic identity: Growth in GDP per capita = Growth in GDP per hours of work + Growth in employment as a ratio of total population + Growth in average hours of work per person. Data used in this section come primarily from the AMECO database, produced by the European Commission. Data on economywide average hours of work come from the new OECD productivity database.

Figure 3. Labor Productivity Growth
(5-year moving average, in percent)

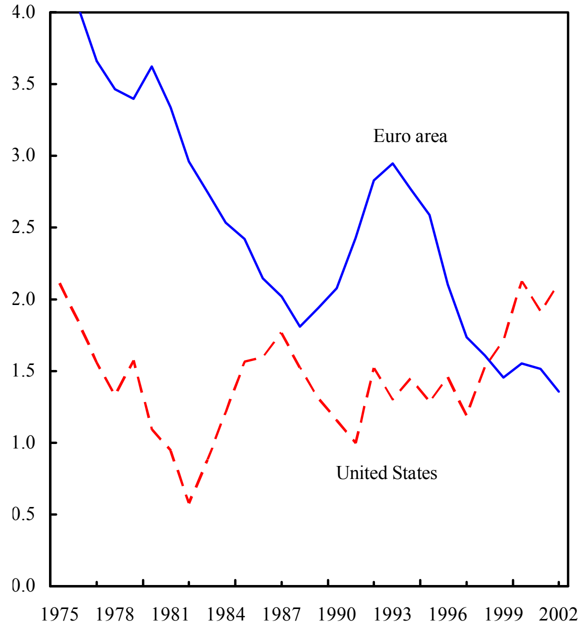
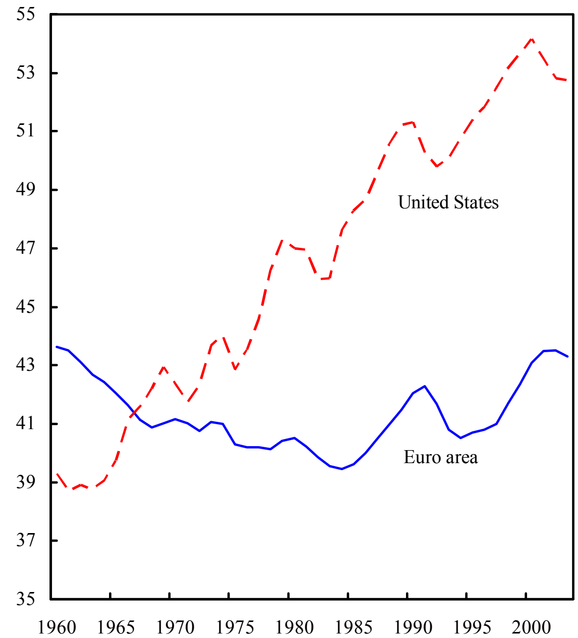
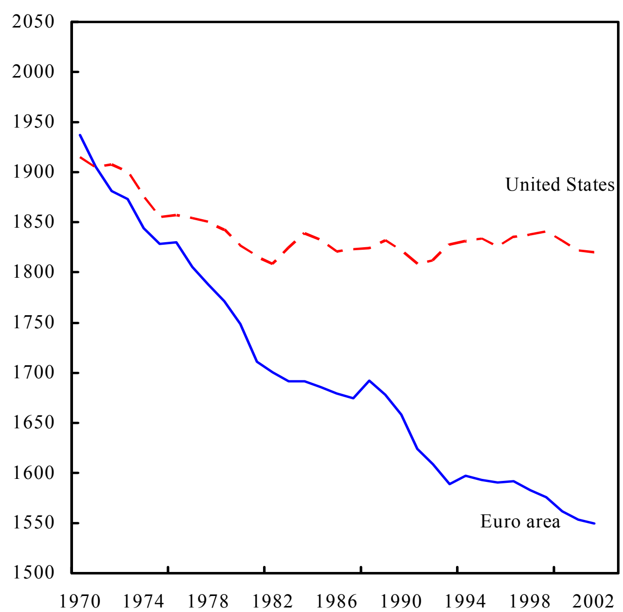


Figure 4. Employment Rates
(In percent of total population)



Sources: EC - AMECO database; OECD Productivity database; and author's calculations.

Figure 5. Annual Hours Per Worker



Sources: Author's calculations based on total hours from OECD and employment from EC - AMECO.

Table 1. GDP Per Capita Growth
(Annual rates, in percent)

	Euro area				United States			
	GDP per capita	Labor Productivity	Employment rate	Average hours worked	GDP per capita	Labor Productivity	Employment rate	Average hours worked
1960-70	4.4	---	-0.6	---	2.9	---	0.8	---
1970-80	2.7	3.9	-0.2	-1.0	2.2	1.6	1.1	-0.5
1980-90	2.1	2.2	0.4	-0.5	2.2	1.4	0.9	0.0
1990-95	1.1	2.6	-0.7	-0.8	1.4	1.3	0.0	0.1
1995-2000	2.3	1.6	1.2	-0.4	3.2	2.1	1.1	0.0
1995-2003	1.7	1.2	0.8	-0.4	2.4	2.1	0.3	0.0

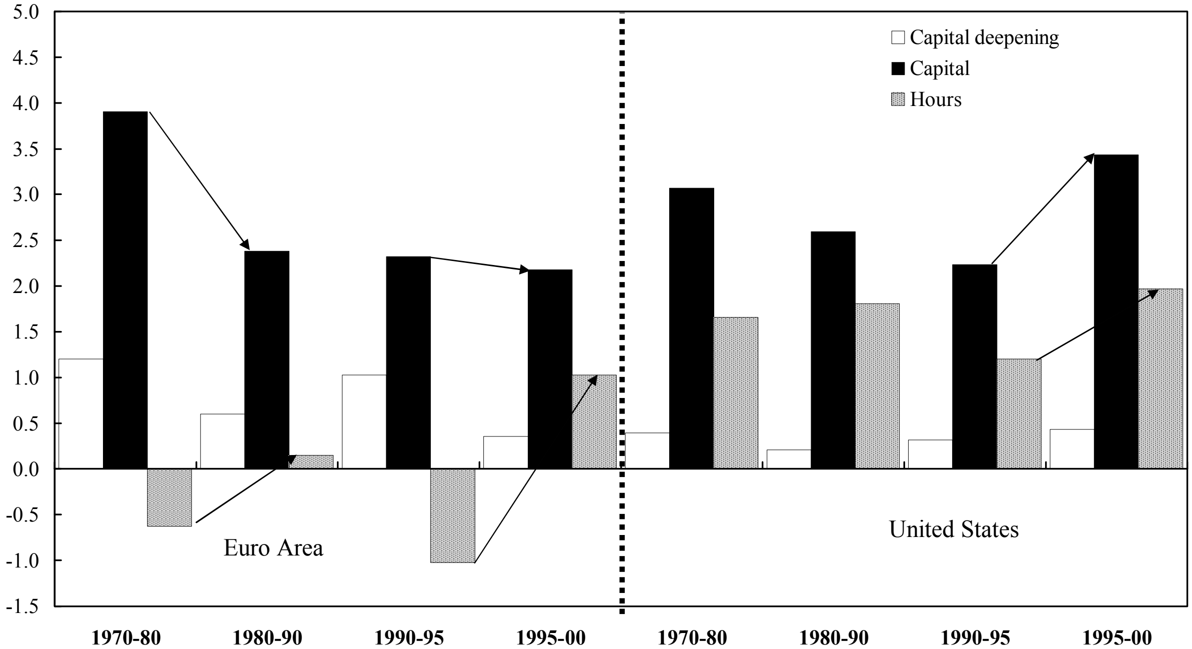
Sources: EC-AMECO database; OECD productivity database; and author's calculations.

GDP per capita growth in the euro area, even if lower than in the United States, did increase in the second half of the 1990s, when a surge in employment rates offset a deceleration in labor productivity and continued declines in average hours of work (Figures 4 and 5, and Table 1). The opposite movements of employment rates and labor productivity during this period suggest that lower labor productivity growth in the euro area could be related to the reinsertion of unemployed individuals into jobs. On the other hand, the positive correlation between accelerating productivity and employment rates in the U.S. during the same period is consistent with increased technological growth and economic activity in an economy near its natural rate of unemployment.

Breaking down labor productivity growth into its determinants reveals that a significant decline in capital deepening (a slower increase in the capital-labor ratio) explains a large part of the productivity deceleration in the euro area (Table 2).[5] However, the aggregate national accounts-based data used here also show that TFP growth declined in the euro area while sharply increasing in the United States in the second half of the 1990s. In fact, euro-area TFP seems to have converged to U.S. rates for 1970-95. The cyclical decline in TFP growth during 2001-2003 was about the same in the two countries.

[5] Basic identity: $\hat{TFP} = \left(\hat{Y} - \hat{L}\right) - (1-\alpha)\left(\hat{K} - \hat{L}\right)$, where ^ denotes percent changes, Y is real value added, L is total hours of work (employment*average hours of work), K is the capital stock and α is the share of labor compensation in total domestic income.

Figure 6. Breaking Down Changes in the Capital-Labor Ratio
(Percent, annual rate)



Sources: EC-AMECO database for capital stock and employment; OECD for average hours of work; and author's calculations.

Figure 7. Real Hourly Compensation
(Percent changes)

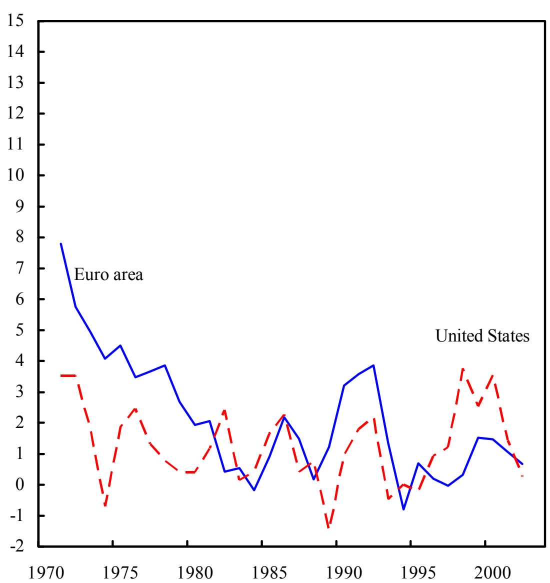
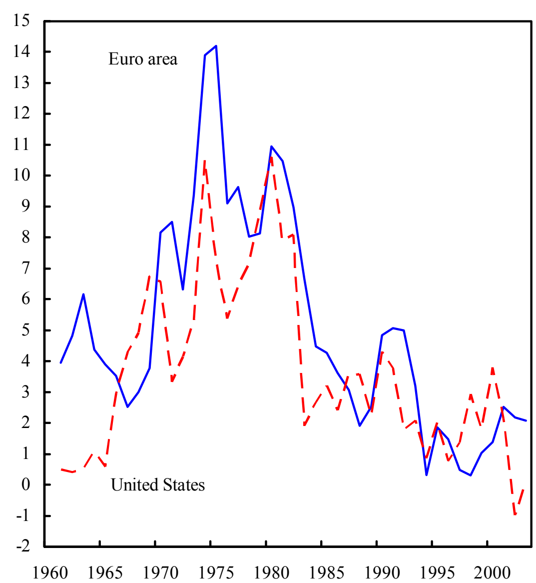


Figure 8. Unit Labor Costs
(Percent changes)



Sources: EC - AMECO database; OECD Productivity database; and author's calculations.

Table 2. Labor Productivity Growth
(Annual rates, in percent)

	Euro area			United States		
	Labor Productivity	Capital deepening	TFP	Labor Productivity	Capital deepening	TFP
1970-80	3.9	1.2	2.7	1.6	0.4	1.2
1980-90	2.2	0.6	1.6	1.4	0.2	1.2
1990-95	2.6	1.0	1.6	1.3	0.3	1.0
1995-2000	1.6	0.4	1.2	2.1	0.4	1.7
1995-2003	1.2	0.4	0.8	2.1	0.6	1.4

Sources: EC-AMECO database; OECD productivity database; and author's calculations.

A note of caution should be introduced at this point: Cross-country comparisons using national accounts data could be compromised by different national methodologies in the calculation of investment flows, deflators (including the treatment of quality improvements in high-tech equipment), aggregation methods, and so on. In addition, changes in labor quality could bias the TFP measures shown in Table 2. While these are crucial issues, I assume them away for now but will return to them later.

The reduced rate of capital deepening in the euro area in the second half of the 1990s can be associated with the reinsertion of unemployed workers into jobs because of reduced wage demands. That is consistent with the rate of capital growth declining only slightly while work hours growth surged in the euro area in the second half of the 1990s (Figure 6). In addition, real hourly compensation in the euro area in the second half of the 1990s grew significantly more slowly than in the United States for the first time since the series has been available (Figure 7). Overall, euro-area hourly compensation growth follows a “boom-bust” pattern, but the downward trend is probably associated with labor market reforms and moderate wage agreements beginning in the 1980s and continuing through the 1990s. These developments were translated into a negative trend unit labor cost growth (total labor compensation divided by output, as in Figure 8).

The story going from a downward trend in labor costs in the euro area to slower capital deepening, and, thus, slower labor productivity growth seems plausible at first glance. Aggregate data also suggest a slowdown in TFP growth. The next sections will delve deeper into these issues.

III. LABOR PRODUCTIVITY GROWTH IN THE EURO AREA AND IN THE UNITED STATES USING INDUSTRY-LEVEL DATA

Observers have attributed the productivity acceleration in the United States in the 1990s to what has been dubbed the "new economy"—an acceleration in technical change in which rapid investment and use of ICT transformed business practices leading to new breakthroughs and the wider adoption and use of ICT. Oliner and Sichel (2000) and Jorgenson and Stiroh (1999 and 2000) first documented the surge in U.S. productivity growth using traditional growth accounting techniques. They show that the accumulation of ICT capital plus the growth in TFP in the computer and semiconductor industries accounted for over three-fourths of the labor productivity acceleration in the U.S. nonfarm business sector. Still, about one-third of the acceleration is accounted for by TFP growth in non-ICT sectors.

More recent work sheds light on differences between the United States and European productivity developments, focusing on either a small sample of European countries (Jorgenson, 2003, who also provides evidence for Japan) or on the European Union as a whole (O'Mahony and van Ark (2003)). O'Mahony and van Ark (2003) also present country-specific calculations for labor productivity (output per worker) growth and document some of the cross-country disparities within the European Union. In this section, the focus is shifted to the euro area as a whole, to comparisons with the United States, and to measures of output per hour.

A. Labor Productivity Growth by ICT Classification and Countries

The first industry database used provides information for 15 EU countries and the United States. The database was constructed by the GGDC departing from the OECD STAN database and national sources. It contains information on value added (real and nominal), employment, and hours of work for 56 industries in each of these countries. The database corrects several problems with the aggregate data used in the previous section. Most important, the GGDC used information on quality changes in ICT equipment from the U.S. statistical agencies to correct data for all the other countries. All sector and country aggregations performed here use value-added weights at the industry level. For more information on the Industry Productivity Database, see Appendix I.

The industry data broadly confirm the developments described in the previous section, with one important difference: labor productivity growth does not decline as much in the second half of the 1990s as shown in Tables 1 and 2. According to the results in Table 3, labor productivity decelerated by 0.7 percentage point in the euro area in the second half of the 1990s, as opposed to the 1 percentage point indicated in the first two tables. Again, one could claim that labor productivity growth in the euro area converged to U.S. rates up to the mid-1990s (about 1.5 percent at an annual rate) but missed the technological shock observed in the United States thereafter.

Table 3. Labor Productivity Growth by ICT Classification[1]
(In percent, at an annual rate)

	1979-90		1990-95		1995-2001		GDP shares (%) 2001	
	Euro area	U.S.	Euro area	U.S.	Euro area	U.S.	Euro area	U.S.
Total economy	2.6	1.4	2.2	1.2	1.5	2.3	100.0	100.0
ICT-producing industries	7.7	8.5	5.0	7.4	7.3	8.0	5.5	7.0
ICT-producing manufacturing2	12.4	16.0	6.2	14.2	8.6	18.1	1.4	2.4
ICT-producing services3	4.7	2.4	4.5	2.5	6.6	1.9	4.0	4.5
ICT-using industries	2.5	1.2	1.9	1.2	1.7	4.8	27.6	31.6
ICT-using manufacturing4	2.3	0.3	2.2	-0.7	2.3	0.3	6.0	4.4
ICT-using services5	2.5	1.5	1.7	1.6	1.4	5.5	21.6	27.2
Non-ICT industries	2.1	0.4	2.1	0.4	0.9	0.0	66.9	61.4
Non-ICT manufacturing[6]	2.5	1.9	3.5	2.7	1.6	0.0	12.6	8.9
Non-ICT services[7]	1.0	0.1	1.2	-0.3	0.4	0.0	44.0	42.8
Non-ICT other[8]	3.4	1.0	2.9	1.1	1.7	0.4	10.3	9.7

Sources: Industry Labor Productivity Database - EC and GGDC; and author's calculations.

[1] Productivity is defined as real value added per hours worked. Detailed breakdown by ICT type listed in Appendix I.

[2] Includes office machinery, telecommunications equipment, and scientific instruments.

[3] Comprises communications, and computer and related activities.

[4] Includes most transportation equipment (excludes motor vehicles), mechanical engineering, and printing and publishing.

[5] Includes wholesale and retail trade, and financial intermediation.

[6] Includes motor vehicles, chemicals, basic and fabricated metals.

[7] Includes real estate activities and public services.

[8] Includes agriculture, construction, and mining and quarrying.

When compared to the United States, the faster productivity deceleration in non-ICT industries in the euro area accounts for 30 percent of the gap between the two regions since the mid-1990s, while the surge in productivity growth in ICT-using industries in the United States accounts for the remaining difference (Table 4).[6] Overall labor productivity decelerated from 2.2 percent per year in the euro area in the first half of the 1990s to 1.5 percent in the second half (acceleration of -0.7 percentage point). In the United States, labor productivity growth increased from 1.2 percent to 2.3 percent over the same periods (acceleration of 1.1 percentage point). Table 4 shows that the 1.7 percentage points relative swing in these growth rates in favor of the United States (1.1 percentage points minus -0.7 percentage point, adjusted for rounding) can be explained by the larger deceleration in non-ICT industries in the euro area (0.5 percentage point or 30 percent of the gap) and the

[6] Appendix III provides a listing of industries by ICT classification according to work presented in O'Mahony and Van Ark (2003).

surge in labor productivity growth in ICT-using industries in the United States (1.2 percentage points or 70 percent of the gap.) The large difference between the two regions in this category was caused by a productivity surge in service industries (mainly wholesale and retail trade, and financial services) in the United States (Table 4, line 7). Lagging deregulation in product and labor markets is likely to have dampened efficiency gains in ICT-using service industries in the euro area. Productivity growth among intensive-ICT users in manufacturing in the euro area remained unchanged and much above U.S. rates (Table 4, line 6).

Table 4. Contributions to Aggregate Labor Productivity Acceleration[1]

(In percentage points, at an annual rate)

	Acceleration 1995-2001		**Contributions** 1995-2001		GDP shares (%) 2001	
	Euro area	U.S.	Euro area	U.S.	Euro area	U.S.
Total economy	-0.7	1.1	-0.7	1.1	100.0	100.0
ICT-producing industries	2.3	0.5	0.1	0.1	5.5	7.0
ICT-producing manufacturing[2]	2.5	3.9	0.0	0.1	1.4	2.4
ICT-producing services[3]	2.2	-0.6	0.1	0.0	4.0	4.5
ICT-using industries	-0.3	3.6	-0.1	1.1	27.6	31.6
ICT-using manufacturing[4]	0.1	1.0	0.0	0.1	6.0	4.4
ICT-using services[5]	-0.3	3.9	-0.1	1.1	21.6	27.2
Non-ICT industries	-1.2	-0.4	-0.7	-0.2	66.9	61.4
Non-ICT manufacturing[6]	-1.9	-2.6	-0.2	-0.2	12.6	8.9
Non-ICT services[7]	-0.8	0.3	-0.4	0.1	44.0	42.8
Non-ICT other[8]	-1.2	-0.7	-0.1	-0.1	10.3	9.7

Sources: Industry Labor Productivity Database - EC and GGDC; and author's calculations.

[1] Productivity is defined as real value added per hours worked. Detailed breakdown by ICT type listed in Appendix III.

[2] Includes office machinery, telecommunications equipment, and scientific instruments.

[3] Comprises communications, and computer and related activities.

[4] Includes most transportation equipment (excludes motor vehicles), mechanical engineering, and printing and publishing.

[5] Includes wholesale and retail trade, and financial intermediation.

[6] Includes motor vehicles, chemicals, basic and fabricated metals.

[7] Includes real estate activities and public services.

[8] Includes agriculture, construction, and mining and quarrying.

Notwithstanding the wedge that has opened in ICT-using industries, the euro area has seen large productivity increases in several high-tech industries. It is true that ICT-producing industries in the euro area have, on average, lagged behind the United States, but the differences have been small (Table 3, row 2). In addition, labor productivity growth in this category increased in the second half of the 1990s in both regions. Within ICT producers, the euro area lags in manufacturing but is an outstanding performer in services, where productivity growth jumped significantly in the second half of the 1990s while declining in the United States.

The much faster acceleration in work hours in the euro area than in the United States account for a large part of the gap in labor productivity acceleration in the second half of the 1990s (Table 5). In fact, all of the deceleration in labor productivity growth in non-ICT sectors in the euro area can be explained by the acceleration in work hours. Half of the differential in ICT-using sectors also comes from faster growth in hours. A more detailed analysis for the contribution of input accumulation and TFP growth to labor productivity developments will be left to the next subsection.

Table 5. Acceleration in Total Work Hours[1]
(In percent, at an annual rate)

	1990-95 (1)		1995-2001 (2)		**Acceleration (2)-(1)**	
	Euro area	U.S.	Euro area	U.S.	**Euro area**	**U.S.**
Total economy	-0.6	1.0	1.0	1.6	**1.6**	**0.6**
ICT-producing industries	-1.2	0.9	2.5	3.6	**3.7**	**2.7**
ICT-producing manufacturing[2]	-3.0	-1.5	0.5	-0.5	**3.6**	**1.0**
ICT-producing services[3]	-0.1	2.8	3.5	5.9	**3.6**	**3.1**
ICT-using industries	-0.6	0.4	1.1	0.8	**1.8**	**0.3**
ICT-using manufacturing[4]	-3.2	-1.2	-0.4	-1.7	**2.8**	**-0.5**
ICT-using services[5]	0.3	0.8	1.7	1.2	**1.4**	**0.4**
Non-ICT industries	-0.6	1.4	0.9	1.9	**1.5**	**0.5**
Non-ICT manufacturing[6]	-2.4	0.5	0.0	-0.8	**2.4**	**-1.3**
Non-ICT services[7]	0.8	1.9	1.7	2.2	**0.9**	**0.3**
Non-ICT other[8]	-2.4	0.1	-0.9	2.2	**1.5**	**2.1**

Sources: Industry Labor Productivity Database - EC and GGDC; and author's calculations.
[1] Detailed listing of all industries in each ICT category in Appendix III.
[2] Includes office machinery, telecommunications equipment, and scientific instruments.
[3] Comprises communications, and computer and related activities.
[4] Includes most transportation equipment (excludes motor vehicles), mechanical engineering, and printing and publishing.
[5] Includes wholesale and retail trade, and financial intermediation.
[6] Includes motor vehicles, chemicals, basic and fabricated metals.
[7] Includes real estate activities and public services.
[8] Includes agriculture, construction, and mining and quarrying.

The aggregate euro-area pattern masks important cross-country differences (Table 6). In ICT-using sectors, labor productivity growth increased between the first and the second half of the 1990s in several countries (Ireland, Netherlands, Portugal and Spain, although only Ireland had larger growth than the United States). However, the weight of the three largest euro-area countries (with some help from other smaller countries) forced down productivity growth in this category. The largest countries also imposed most of the productivity deceleration on the large non-ICT sector. Among them, Italy experienced the largest declines in productivity growth after 1995. Overall, Italy contributed with about 40 percent of the 0.7 percentage point deceleration in labor productivity growth in the euro area in the second half of the 1990s (Table 7).

Table 6. Labor Productivity Growth Across Countries
(In percent, at an annual rate)

	ICT-producing			**ICT-using**			**Non-ICT**			**Total**		
	1979-90	1990-95	1995-2001	1979-90	1990-95	1995-2001	1979-90	1990-95	1995-2001	1979-90	1990-95	1995-2001
Austria	9.4	6.8	3.3	3.3	3.9	2.7	2.2	3.6	1.9	2.9	4.0	2.3
Belgium	7.7	3.0	6.8	2.9	3.4	0.4	2.6	2.0	2.0	3.0	2.5	1.7
France	8.0	3.1	5.2	4.3	1.3	1.1	2.1	1.5	1.1	3.1	1.6	1.5
Finland	8.3	6.2	9.8	3.9	1.4	0.4	2.9	3.0	1.1	3.5	3.2	2.3
Germany	7.8	6.2	10.5	2.1	2.6	2.1	1.7	2.1	1.1	2.2	2.5	2.0
Greece	5.4	4.2	6.7	0.2	-1.0	4.1	1.3	1.3	2.4	1.3	0.9	3.1
Ireland	9.9	15.7	17.6	2.9	1.5	5.7	4.1	3.7	5.3	4.7	4.3	7.8
Italy	6.9	5.3	5.4	1.0	2.7	1.6	2.1	2.0	0.1	2.2	2.4	0.8
Luxembourg	7.1	8.2	4.0	3.0	0.9	-0.3	3.6	2.5	0.5	3.8	3.1	1.0
Netherlands	6.4	3.3	2.0	2.8	1.0	1.9	1.9	1.5	0.5	2.3	1.3	1.2
Portugal	12.7	10.7	5.6	3.0	0.8	1.9	3.2	2.1	3.0	3.8	2.3	3.0
Spain	8.1	3.3	3.8	2.2	-0.3	0.9	3.0	2.2	0.5	3.1	1.8	0.8
Euro area	**7.7**	**5.0**	**7.3**	**2.5**	**1.9**	**1.7**	**2.1**	**2.1**	**0.9**	**2.6**	**2.2**	**1.5**
Denmark	6.8	7.4	4.0	1.8	0.8	2.9	1.7	1.8	0.5	1.9	1.9	1.6
Sweden	8.7	6.5	-0.5	2.2	2.8	1.9	1.2	1.4	1.8	1.8	2.1	1.9
UK	8.9	9.5	8.0	2.0	2.1	3.3	1.3	2.9	1.0	2.1	3.2	2.2
EU-15	**7.5**	**5.8**	**6.8**	**2.4**	**2.0**	**1.9**	**2.0**	**2.2**	**1.0**	**2.4**	**2.4**	**1.7**
U.S.	**8.5**	**7.4**	**8.0**	**1.2**	**1.2**	**4.8**	**0.4**	**0.4**	**0.0**	**1.4**	**1.2**	**2.3**

Sources: Industry Labor Productivity Database - EC and GGDC; and author's calculations.

Notes: Productivity is defined as real value added per hours worked. Detailed breakdown by ICT type listed in Appendix III.

Table 7. Labor Productivity Deceleration in the 1990s

	Percentage points	Contribution
Austria	-1.6	0.0
Belgium	-0.8	0.0
Finland	-0.9	0.0
France	-0.1	0.0
Germany	-0.5	-0.2
Greece	2.2	0.0
Ireland	3.5	0.0
Italy	**-1.6**	**-0.3**
Luxembourg	-2.1	0.0
Netherlands	-0.1	0.0
Portugal	0.7	0.0
Spain	-1.0	-0.1
Euro area	-0.7	-0.7

Source: Author's calculations based on aggregation shown in Table 5.

B. Demonstrating the Importance of Capital Deepening and Correct TFP Calculation

The previous analysis of labor productivity developments is hampered by the lack of information on capital formation and changes in labor quality, as the productivity database has data only on hours of work and real value added. The Growth Accounting Database put together by the GGDC closes this gap. It provides information on growth in real value added, hours of work, ICT capital, non-ICT capital, labor quality, and TFP. Data availability determined its coverage—the database contains information for three euro-area countries (France, Germany and the Netherlands), the U.K. (not used here), and the United States—the end-point for the analysis (2000), and a somewhat more aggregated industry classification (26 industries) than provided by the Industry Productivity Database. All the methodological improvements introduced in the Industry Productivity Database, including the homogenization of treatment of quality changes in ICT equipment, are also present in the Growth Accounting Database. The method used to break down labor productivity growth into its main components corresponds to the traditional methodology discussed, for instance, in Oliner and Sichel (2000). The database is described in more detail in Appendix II and the breakdown of labor productivity growth follows equation (A.2). When comparing to the breakdown shown in Table 2, capital deepening has two components, ICT and non-ICT capital deepening, and changes in labor quality are measured separately instead of being included in TFP growth.

Turning to the components of labor productivity growth, the TFP growth shown in Table 2 is misleading: while German TFP accelerates continuously when carefully measured according to the GGDC, it declines sharply when using aggregate data (Table 8). Given the weight of Germany in the euro area's aggregate (about 30 percent of total value added in the area) and considering the TFP calculations based on the detailed industry database as superior, TFP growth in the area would actually have been 0.35 percentage point higher than shown in Table 2—about the size of the deceleration in TFP shown in that table. If labor productivity growth in Table 2 were augmented by this amount, the deceleration in euro-area labor productivity would conform to the measurement based on the industry data shown in Table 3 (about 0.7 percentage point). The general profile of TFP growth in France and in the Netherlands is similar in both calculations.

Table 8. Productivity Growth in Two Different Databases[1]

(In percent, at an annual rate)

	Growth Accounting Database			**AMECO and OECD data**		
	1979-90	1990-95	1995-2000	1979-90	1990-95	1995-2000
France - Total economy						
Labor productivity	2.95	1.47	1.54	2.91	1.86	2.13
of which: TFP[2]	1.85	0.59	1.05	2.16	1.00	1.70
Germany - Total economy						
Labor productivity	1.96	2.26	2.08	1.96	3.09	1.76
of which: TFP[2]	0.55	0.80	1.01	1.45	1.98	1.07
Netherlands - Total economy						
Labor productivity	2.33	1.42	1.52	1.85	1.26	1.59
of which: TFP[2]	1.21	0.44	0.72	1.28	0.97	1.44

Sources: Growth Accounting Database - EC and GGDC; EC-AMECO and OECD; and author's calculations.

[1] Productivity is defined as real value added per hours worked.

[2] Total factor productivity (TFP) from the Growth Accounting Database calculated as a residual after taking into account the contribution of different types of capital deepening and labor quality changes. Calculations using AMECO and OECD data do not correct for quality changes in ICT equipment, changes in labor quality, and aggregation issues.

The contribution of ICT capital deepening to productivity growth increased significantly for all countries while the contribution of non-ICT capital deepening declined, becoming negative in France and zero in the Netherlands (Table 9). Labor quality growth contributed less to productivity growth in the Netherlands and in Germany, but not in France. Looking at the ICT-based breakdown, the contribution of non-ICT capital deepening declined in all groupings for all countries between the first and the second halves of the 1990s, while the contribution of ICT capital deepening increased. That is consistent with the widespread use of ICT equipment in these countries even in the face of large increases in labor usage. TFP grew differently depending on the country and the sector being analyzed.

A deceleration of capital deepening is the key factor behind gaps in labor productivity growth between the United States and an aggregate of France, Germany, and the Netherlands (called euro-3 in Table 10). The contribution of non-ICT capital deepening to labor productivity growth remained unchanged in the United States in the second half of the 1990s but declined markedly in the euro-3 aggregate. In addition, the contribution of ICT capital deepening to labor productivity growth increased by twice as much in the United States as in euro-3.

TFP growth rose by ¾ percentage point in the United States in the second half of the 1990s but remained lower than the rates posted in euro-3, which, nevertheless, increased by only 1/3 percentage point during this period. The TFP growth differential in favor of the euro-3 aggregate contrasts with the message for the euro area as a whole shown in Table 2. Again, methodological problems with the aggregate data used in Table 2 likely overestimate the decline in TFP growth for the euro area, but the partial coverage of the euro-3 aggregate (in particular, the exclusion of Italy) may help to explain the more upbeat productivity scenario.

Looking at the ICT groupings, labor productivity in non-ICT industries decelerated much less in the United States than in the euro-3 aggregate. In addition, the productivity deceleration in the U.S. non-ICT sector was caused by a large decline in TFP growth that was partly offset by more capital deepening and faster improvements in labor quality. In contrast, in the euro-3 aggregate, TFP growth in the non-ICT sector remained nearly unchanged while declines in non-ICT capital deepening and labor quality growth accounted for the deceleration in labor productivity. These stylized facts are consistent with an increased use of previously unemployed or out-of-the-labor force individuals, who should be less qualified than the average employed worker, in the euro area. Unlike the non-ICT grouping, labor quality growth in the euro-3 grouping increased in the ICT sectors in the second half of the 1990s. The United States posted larger increases in both TFP growth and capital deepening in ICT-producing and, more important, ICT-using industries than the euro-3 aggregate. In fact, all of the differential acceleration in TFP in the second half of the 1990s in favor of the United States (from 0.13 percent, at an annual rate, to 0.87 percent in the United States while in the euro area went from 0.69 percent to 1 percent) originates in ICT-using industries (from 0 percent to 2.34 percent in the United States while in the euro area went from 0.79 percent to 0.63 percent).

Table 9. Decomposition of Labor Productivity Growth in Three Euro Area Countries[1]
(In percent, at an annual rate)

	1979-1990			1990-1995			1995-2000		
	France	Germany	Netherlands	France	Germany	Netherlands	France	Germany	Netherlands
Total economy									
Labor productivity	2.95	1.96	2.33	1.47	2.26	1.42	1.54	2.08	1.52
Contribution of:									
ICT capital deepening[2]	0.18	0.48	0.33	0.13	0.38	0.29	0.27	0.55	0.59
Non-ICT capital deepening[2]	0.56	0.60	0.69	0.48	1.01	0.46	-0.24	0.51	0.10
Labor quality[3]	0.37	0.33	0.10	0.26	0.07	0.23	0.47	0.01	0.10
TFP[4]	1.85	0.55	1.21	0.59	0.80	0.44	1.05	1.01	0.72
ICT-producing industries[5]									
Labor productivity	7.71	5.80	6.80	4.17	4.65	3.87	9.20	12.55	4.26
Contribution of:									
ICT capital deepening[2]	0.47	0.72	0.50	0.14	0.80	0.62	0.39	1.09	1.35
Non-ICT capital deepening[2]	1.43	0.97	0.77	0.74	1.62	1.16	-0.23	0.53	0.90
Labor quality[3]	-0.27	0.53	-0.10	0.12	0.88	0.05	0.36	0.56	0.31
TFP[4]	6.08	3.58	5.64	3.16	1.35	2.03	8.67	10.38	1.70
ICT-using industries[6]									
Labor productivity	4.41	1.75	2.86	1.75	2.60	1.08	1.55	1.54	2.75
Contribution of:									
ICT capital deepening[2]	0.32	0.45	0.78	0.26	0.54	0.57	0.55	0.60	1.18
Non-ICT capital deepening[2]	0.70	0.27	0.50	0.81	0.67	0.54	0.01	0.16	0.19
Labor quality[3]	0.19	0.33	0.04	0.05	0.30	0.22	0.42	0.23	0.15
TFP[4]	3.20	0.70	1.54	0.62	1.08	-0.26	0.58	0.56	1.23
Non-ICT industries[7]									
Labor productivity	1.78	1.29	1.51	0.90	1.66	1.40	0.85	0.84	1.35
Contribution of:									
ICT capital deepening[2]	0.09	0.31	0.19	0.09	0.17	0.21	0.15	0.39	0.39
Non-ICT capital deepening[2]	0.17	0.54	0.39	0.21	0.72	0.40	-0.48	0.29	0.18
Labor quality[3]	0.20	0.47	-0.02	0.19	0.28	0.26	0.43	0.01	0.28
TFP[4]	1.33	-0.03	0.94	0.41	0.49	0.53	0.74	0.16	0.50

Sources: Growth Accounting Database - EC and GGDC; and author's calculations.

[1] Productivity is defined as real value added per hours worked. Detailed breakdown by ICT type listed in Appendix III.

[2] Capital deepening defined as changes in the capital to hours worked ratio.

[3] Labor quality changes calculated by the ratio of hours weighted by wages of individuals with different educational backgrounds.

[4] Total factor productivity (TFP) calculated as a residual.

[5] Includes office machinery, telecommunications equipment, scientific instruments, communications, and computer and related activities.

[6] Includes most transportation equipment, mechanical engineering, printing and publishing, wholesale and retail trade, and financial services.

[7] Includes agriculture, construction, mining, motor vehicles, chemicals, basic and fabricated metals, real estate activities and public services.

Table 10. Decomposition of Labor Productivity Growth in Euro-3 and in the United States[1]
(In percent, at an annual rate)

	1979-1990		1990-1995		1995-2000	
	Euro-3[2]	US	Euro-3[2]	US	Euro-3[2]	US
Total economy						
Labor productivity	2.35	1.26	1.89	1.00	1.83	2.17
Contribution of:						
ICT capital deepening[3]	0.36	0.48	0.28	0.41	0.45	0.80
Non-ICT capital deepening[3]	0.59	0.24	0.77	0.23	0.20	0.25
Labor quality[4]	0.32	0.26	0.15	0.23	0.19	0.25
TFP[5]	1.08	0.28	0.69	0.13	1.00	0.87
ICT producing industries[6]						
Labor productivity	6.59	7.72	4.40	8.41	10.53	14.31
Contribution of:						
ICT capital deepening[3]	0.61	1.30	0.54	1.27	0.86	1.84
Non-ICT capital deepening[3]	1.12	0.92	1.26	0.84	0.29	0.95
Labor quality[4]	0.18	0.24	0.53	0.41	0.46	0.03
TFP[5]	4.69	5.25	2.07	5.89	8.91	11.48
ICT using industries[7]						
Labor productivity	2.82	1.44	2.15	1.64	1.67	4.71
Contribution of:						
ICT capital deepening[3]	0.44	1.05	0.44	0.74	0.64	1.45
Non-ICT capital deepening[3]	0.45	0.61	0.71	0.59	0.11	0.57
Labor quality[4]	0.25	0.23	0.20	0.30	0.29	0.34
TFP[5]	1.68	-0.44	0.79	0.00	0.63	2.34
Non-ICT industries[8]						
Labor productivity	1.49	0.63	1.36	0.22	0.89	0.02
Contribution of:						
ICT capital deepening[3]	0.22	0.28	0.14	0.30	0.30	0.45
Non-ICT capital deepening[3]	0.39	-0.04	0.51	0.09	0.00	0.09
Labor quality[4]	0.32	0.37	0.25	0.19	0.19	0.29
TFP[5]	0.56	0.03	0.46	-0.37	0.40	-0.81

Source: Growth Accounting Database - EC and GGDC; and author's calculations.

[1] Productivity is defined as real value added per hours worked. Detailed breakdown by ICT type listed in Appendix III.

[2] Industry value-added weights used to aggregate data underlying Table 8.

[3] Capital deepening defined as changes in the capital to hours worked ratio.

[4] Labor quality changes calculated by the ratio of hours weighted by wages of individuals with different educational backgrounds.

[5] Total factor productivity (TFP) calculated as a residual.

[6] Includes office machinery, telecommunications equipment, scientific instruments, communications, and computer and related activities.

[7] Includes most transportation equipment, mechanical engineering, printing and publishing, wholesale and retail trade, and financial services.

[8] Includes agriculture, construction, mining, motor vehicles, chemicals, basic and fabricated metals, real estate activities and public services.

C. Summary of Results from the Sectoral Productivity Analysis

A much slower deceleration in labor productivity in non-ICT industries and a faster acceleration in ICT-using sectors accounted for the U.S. productivity growth lead over the euro area in the second half of the 1990s. Labor productivity acceleration in ICT-producing industries in the second half of the 1990s was faster in the euro area than in the United States but that had little effect on aggregate developments because of the small share of this sector in total value added. Setting aside the comparison with the United States, the decline in labor productivity growth in the euro area is fully accounted for by the decline in labor productivity growth in non-ICT sectors.

Turning to the contribution of input accumulation and total factor productivity to aggregate labor productivity growth, the difference in performance vis-à-vis the United States can be accounted for by a decline in capital deepening and slower labor quality improvements observed in an aggregate of France, Germany and the Netherlands. These variables grew at a faster rate in the United States after 1995. TFP growth increased in the euro-3 aggregate in the second half of the 1990s but more slowly than in the United States. In fact, the difference in TFP acceleration in favor of the United States can be traced to a surge in ICT-using industries. These variables are not readily available for the euro area as a whole but if generalized for the remaining 40 percent of the economy, they suggest that the decline in labor productivity growth in the second half of the 1990s discussed in Section II was not caused by slower technological growth (or at least not as much as suggested by the aggregate data used in Table 2). Slower capital deepening was the most important culprit.

IV. Structural Labor Market Changes and Capital Deepening

While the sectoral performance of the two economies raise a set of interesting issues (i.e. why the euro area has not posted a productivity surge in ICT-using industries), this section focus on explaining the roots for the slower capital deepening in the euro area in the second half of the 1990s. That is important because taking the results for the euro-3 aggregate as representative for the euro area as a whole, the actual reduction in labor productivity growth in the second half of the 1990s was rooted in the sharp declines in non-ICT capital deepening, which were the counterpart of the large increase in work hours in the period.

Some studies suggest that this job-rich growth was caused in part by changes in the basic parameters of the wage-setting mechanism that shifted rightward a "labor-supply-like" relationship between real wages and the unemployment rate.[7] Other studies claim that workers actually learned from the mistakes of the past after observing the consequences of

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[7] Decressin and others (2001) analyze macroeconomic data for the largest four euro-area countries and claim that wage moderation by unions was likely behind job-rich growth. Estevão and Nargis (2002) make the same claim for France after a detailed analysis.

excessive wage demands[8], or that a set of factors could have conspired to generate lower wage growth in the 1990s.[9] Among many factors, declines in unions' bargaining power (maybe related to globalization), implicit contracts with governments (who provided services to workers in exchange for less wage demands), and targeted reductions in labor cost taxation are worth listing. Increased use of active labor market policies (mainly the policies directed toward increasing labor demand by private corporations) were also shown to have lowered wages for a given rate of unemployment and increased employment rates in a sample of OECD countries, including most euro-area economies.[10] Finally, labor market reforms allowing a better use of temporary and part-time work in many euro-area countries could also have strengthened labor market competition and held wage growth down.

A. Benchmark Model

Structural labor market changes such as the ones described in the previous paragraph are quite consistent with the stylized facts unearthed so far, and a simple model captures the basic idea and provides a framework for the econometric analysis.

A short-run labor demand curve, as SLD in Figure 9, can be obtained under standard neoclassical assumptions. Following Blanchard (1997), assume the economy grows along a balanced path determined by the rate of labor-augmenting (Harrod-neutral) technological growth, g_a. The curve SLD is derived by assuming that the production function combines labor and capital according to a constant-returns-to-scale technology, that capital is fixed in the short run and that firms maximize profits. The labor force is normalized to 1 and employment is $N = 1-u$ (u is the unemployment rate). Wages are defined in efficiency units, i.e. as a ratio of the technology level, A.

In the long run, capital varies and, assuming interest rates are determined abroad, the user cost of capital is exogenously given. In this case, labor cost in efficiency units is set to equalize the profit rate to the user cost of capital independently of the unemployment rate (LLD in Figure 9).

A "labor-supply-like" relationship can be modeled according to the *right-to-manage* model, in which firms and unions bargain over wages, given the short-run labor demand. A version of such a model, developed in Estevão and Nargis (2002), generates

[8] Blanchard and Phillipon (2003).

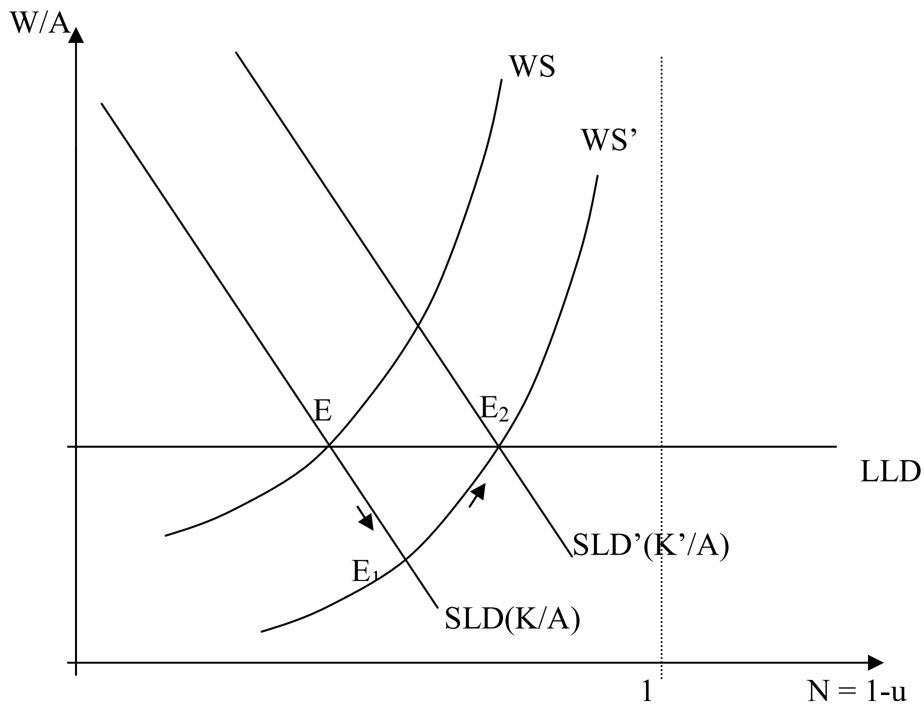
[9] Estevão and Nargis (2002) use household-level data for France to show that the trade-off between unemployment and real wages did improve in the 1990s. However, they caution that other factors beyond wage moderation could be behind the clear structural improvement in French labor markets.

[10] Estevão (2003a).

$$\frac{W}{A*B}*\tau = f(m,u), \quad f_m>0 \text{ and } f_u<0 \quad , \qquad (1)$$

where B stands for the income a worker would receive if unemployed, and τ stands for the ratio of the fiscal wedge on unemployment income to the fiscal wedge on labor income; m is a structural parameter determining the position of the wage curve and its steepness.

Figure 9. Structural Labor Market Changes and Long-Run Adjustment



Equation (1) represents a contract curve relating wages in efficiency units to the unemployment rate (the wage-setting curve, WS, in Figure 9). For a given rate of unemployment, wages depend on unemployment income (net of the relative tax wedge) and on the position of the wage curve, a function of m. Ceteris paribus, wage demands are higher the higher is unemployment income (which depends, among other things, on unemployment benefits replacement rates), as the outcome in case of disagreement (and the worker is unemployed) is less unattractive. On the other hand, when the unemployment rate increases, the probability of not finding a job also rises and wage demands are more subdued.

Whenever workers' bargaining power becomes weaker, or whenever workers value employment more, the parameter *m* decreases and wages are lower for a given rate of unemployment. Changes in the degree of labor market competition (e.g. because of reforms that allow better allocation of labor, like the deregulation of part-time and "temp" work in Spain and France in the 1990s), will also affect the position of the wage-setting relationship.

Wage-setting changes trigger an adjustment path where labor productivity growth declines at first, but then surges before returning to its original steady state. Point E in Figure 9 represents the long-run equilibrium in the labor market, where wages are such that the profit rate equals the worldwide user cost of capital. In this steady state, output, capital, and employment in efficiency units (*AN*) grow at g_a percent. Under the hypothesis of a significant downward shift in the wage-setting curve—due, for instance, either to a general agreement for wage moderation, as in the Wassenaar agreement in the Netherlands in the 1980s, or to some labor market deregulation—wages will grow more slowly than technological progress and the unemployment rate will decline as the economy moves along a negatively sloped short-run labor demand curve and reaches the short-run equilibrium point E_1. In this transition path, the rate of growth of the capital-labor ratio declines as labor grows faster than capital in efficiency units, K/A.

However, wage-setting changes in favor of cheaper labor for a given rate of unemployment will ultimately raise investment, as low wages raise profit rates to a level above the user cost of capital. In the longer run, the short-run labor demand will then shift outward, moving along the labor supply relationship, until the profit rate and the unit cost of capital are equal at point E_2. Structural unemployment is lower than in *E* but wages in efficiency units are unchanged. While labor demand shifts, capital deepening speeds up as capital in efficiency units grows at a faster rate than labor.

During the transition path, technological growth remains unchanged, but the capital-labor ratio first decelerates and, then, accelerates, causing labor productivity growth to change as well. This adjustment pattern does not account for other possible effects from structural labor market changes on labor productivity growth. In particular, TFP growth is likely to benefit in the long run from labor market reforms as labor is allocated more efficiently. TFP growth may also suffer in the short run if labor quality is mismeasured and the newly hired unemployed are less efficient than currently employed workers. Changes in the sector composition of the labor force may also affect TFP growth, although that seems to be a minor factor in explaining the disparities in productivity growth between the United States and the euro area.

B. Estimating the Impact of Wage Moderation on Capital Deepening

The wage-setting relationship has been estimated in different ways, but, in general, empirical work has tended to prefer regressing the logarithm of wages on the logarithm of the unemployment rate. Therefore, empirical versions of equation (1) are in general written as

$$\ln\left[\frac{W_t}{CP_t * A_t}\right] = \xi_t * \gamma - \theta * \ln(u_t) \quad , \qquad (2)$$

where CP_t represents consumer prices, ln(.) stands for the natural logarithm of a variable, and deviations from equilibrium levels of real hourly wages in efficiency units ($\ln(W_t/(CP_t*A_t))$) are modeled as $\xi_t \neq 1$. Therefore, in equilibrium at time 0, the wage-setting curve intercept is determined by γ, and structural shocks move the curve away from this value. Estimates of these changes can be obtained by assuming $\theta = 0.1$, as has been estimated by Blanchflower and Oswald (1994) for many different countries.[11]

The large, negative wage-setting shocks of the 1970s were reversed in the 1980s and in the second half of the 1990s. This path is shown in Figure 10, which plots the accumulated wage-setting shocks for the euro area using aggregate data from the AMECO database and the OECD. By the end of the sample period, the wage-setting curve is roughly back at its position at the beginning of the 1970s, although there is some evidence of a small upward shift during the recent slowdown. In order to know the impact of wage-setting changes on capital deepening an elasticity estimate is needed. This estimate may be obtained by using the industry data presented in the previous section. This is a superior alternative to using the aggregate cross-country data because of the greater degrees of freedom, and the quality of TFP estimates and capital deepening obtained from the growth accounting database. Using these data, industry-specific measures of wage-setting shocks can be built as

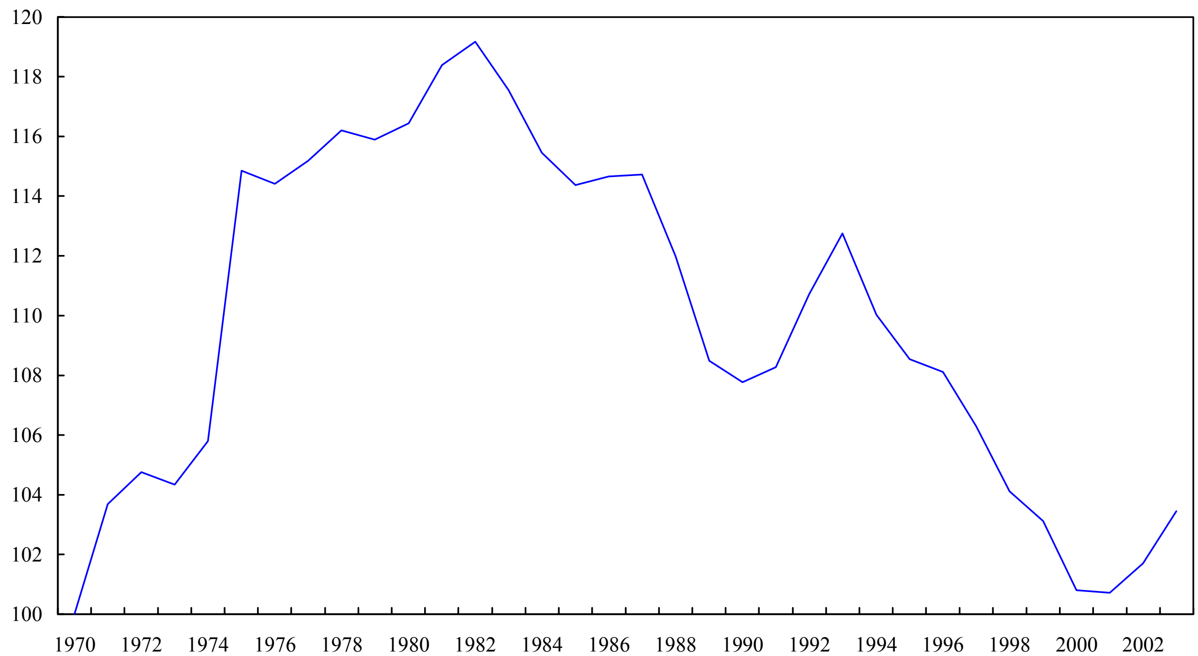
$$\xi_{ijt} * \gamma_{ij} = \ln\left(\frac{W_{ijt}}{CP_{jt} * A_{ijt}}\right) + 0.1 * \ln(u_{jt}) \quad , \qquad (3)$$

where *i* stands for country, *j* for industry, and *t* for the time period. Consumer prices and the unemployment rate are measured at the country level. Industry-level technology, A_{ijt}, gives

[11] Several papers since Blanchflower and Oswald (1994) show that there may be some variation around the -0.1 estimate. Card (1995), in particular, raises doubts about their basic specification and notices that elasticities for the United States could be smaller than their estimate. More recently, Estevão and Nigar (2002) use micro data from the French labor force survey and estimate a wage-setting elasticity of -0.1. This general result does not seem to be unique to more developed industrial economies: Estevão (2003b) estimates, also using micro data and different methods, an elasticity of about the same size (but a bit smaller) for Poland. Finally, Estevão (2003a) has estimated the same -0.1 elasticity using aggregate information for a panel of 15 OECD countries, suggesting that the results are not dependent on the use of household-level data.

the right norm for the wage increases industries could afford without weakening profit rates. Because wages are not available in the growth accounting database, hourly labor compensation is used instead.

Figure 10. Accumulating Wage-Setting Shocks in the Euro Area
(Variable as defined in equation (3), 1970 = 100)



Sources: EC-AMECO database and author's calculations. Labor cost data refer to hourly labor compensation.

The estimated equation is consistent with a simple relationship between the capital-labor ratio and the relative price of labor and capital, as implied by the neoclassical labor demand equation used in the model sketched above. Empirically, percent changes in the capital-labor ratio are modeled as a function of industry/country/year-specific dummies and their interactions, represented by the linear function F(.), shocks in wage-setting ($\Delta\xi_{ijt}$) and in the user cost of capital ($\Delta\eta_{ijt}$), and residuals that are identically and independently distributed (ε_{ijt}):

$$\Delta \ln\left(\frac{K_{ijt}}{L_{ijt}}\right) = F(country_i, industry_j, time_t) + \beta * \Delta\xi_{ijt} - \alpha * \Delta\eta_{ijt} + \varepsilon_{ijt} \quad . \qquad (4)$$

β is the parameter of interest here. The function F(.) captures a significant amount of variation in the data, including common industry shocks within a country (e.g. variations in central bank interest rate policy), common country shocks within an industry (e.g. industry-specific technological shocks), and time shocks in industry characteristics (e.g. changes in the composition of the labor force), among others. Because of a lack of information, the residual of the estimated regression includes industry-specific shocks in the user cost of capital, which are assumed to follow an AR(1) process but to be uncorrelated to wage-setting shocks. Information on total capital deepening was obtained by averaging the accumulation of ICT and of non-ICT capital, using the shares of ICT and non-ICT capital income in total capital income as weights.

Table 11. Elasticity of Capital Deepening to Wage-Setting Shocks[1]

Dependent variable: $\Delta \ln(K_{ijt}/L_{ijt})$	
WS shock[2]	0.64* (0.31)
country dummies	yes
industry dummies	yes
time dummies	yes
industry*time dummies	yes
country*time dummies	yes
country*industry	yes
Adj. R^2	0.40
Number of observations	1,690
Number of industries	26
Sample period	1980-2000

Sources: GGDC; AMECO database; and author's estimates.

[1] Estimation uses industry-level data for France, Germany and the Netherlands.

Standard errors are shown in parentheses and are corrected for AR(1) residuals.

* stands for significant at the 5 percent level.

[2] Wage-setting shocks measured as shown in equation (7). Consumer prices are measured by the implicit deflator for private consumption expenditures.

Wage-setting shocks are estimated to affect capital deepening significantly in the panel data formed by France, Germany and the Netherlands, with an elasticity of 0.64 (Table 11). This elasticity can be used as representative of the euro area, since the estimation takes care of country-specific effects. Based on the evolution of wage-setting shocks as displayed in Figure 10, capital-labor ratios would have declined in the euro area in the absence of further shocks. The contribution of capital deepening to annual labor productivity growth would have been about -0.3 percentage point as opposed to the 0.4 percentage point shown in Table 2. Other factors, such as drops in the user cost of capital because of declining interest rates and ICT equipment prices, offset the strong push from these wage shocks for firms to substitute away from capital toward labor.

V. Final Remarks

The empirical work in the previous sections points to slower capital deepening—resulting from structural labor market changes—as the main culprit behind the labor productivity slowdown in the euro area since the mid-1990s. Given the commitment of euro-area countries to increasing employment rates to fulfill the ambitious targets set out by the Lisbon Summit in 2000, labor productivity growth might be dampened for many more years. However, a large part of the labor productivity growth gap with respect to the United States can be explained by the surge in TFP growth in ICT-using sectors in that country. Even if slower capital deepening in the euro area seems to be the by-product of "good" changes that increased labor utilization in the area, flat TFP growth rates in sectors that are particularly dynamic in the United States are worrisome. There are several angles to this problem.

The same labor market reforms necessary to continuing reabsorbing people into jobs will probably ultimately increase TFP growth. These reforms should aim at increasing the incentives to work vis-à-vis receiving social benefits and correct incentives for human capital formation, with labor income better reflecting individual abilities and efforts. The increase in human capital accumulation and the better allocation of labor across alternative uses should boost TFP growth in the long term.

However, recent research has shown that other direct measures could be helpful in addressing the relatively weak TFP growth in Europe. The European Commission (2003) shows some evidence that the recent labor productivity differential between the United States and the European Union can be related to some fundamental structural differences at the individual country level. They single out five areas of significant quantitative importance: the level of product market regulation, the structure of financial markets, the degree of product market integration, the size of "knowledge" investment, and the aging of the labor force.

Turning to product market reforms, the analysis provided in this paper points to the need for reforms in specific sectors. Notwithstanding considerable progress in product and financial market reforms (see, for instance, Debrun and Annett (2004) and Blanchard (2004) for a recent positive evaluation) the gap in productivity growth in ICT-using services, which includes wholesale trade, retail trade, and financial intermediation, might be a sign that further reforms are needed. However, evidence from the McKinsey Global Institute research on productivity growth in France, Germany and the United States, does not clearly indicate which reforms should be implemented. Take the case of the retail food sector, for instance. McKinsey finds that labor productivity in that sector was actually 7 percent higher in France than in the United States in 2000. In addition, the degree of IT use in that sector was about the same in France, Germany and the United States in 1999, with the United States holding only a small lead. Blanchard (2004) suggests that barriers to firms' entry and exit in the retail sector in Europe could be behind the productivity differentials. In fact, Foster, Haltiwanger and Krizan (2002) show that productivity growth in the U.S. retail trade sector in the 1990s can be attributed to the replacement of less productive by more productive establishments. In this sense, lowering barriers to and easing the regulatory burden on the creation of enterprises in Europe seem to be necessary.

The European Commission (2003) argues that, although it is important to address static efficiency problems, product market deregulation would not actually increase TFP growth in the long term. The document provides some simulations showing that even relatively rapid deregulation toward the U.S. levels would not lead to sufficiently large productivity gains over the next seven years to close the efficiency gap with the United States. The document stresses that any gains from deregulation in terms of technological catching-up or from privatizations of state monopolies should be interpreted more as static efficiency gains and not as the dynamic efficiency gains needed to expand the technological frontier.

However, product market reforms could positively affect those risk-taking activities that are the engine of technological progress. Furthermore, Debrun and Annett (2004) find some evidence linking product market reforms to future labor market reforms, which would not only improve labor market functioning, but also, depending on the type of labor market reforms, increase human capital accumulation—an engine of TFP growth.

The Commission's work also suggests that long-run productivity gains from investments in both education and R&D would have a direct positive impact in TFP growth. With respect to R&D, the paper argues that the focus should not be on boosting R&D spending directly, but on creating the necessary conditions for promoting an endogenous increase in research spending. These could be obtained through two main channels: higher product market integration (e.g. through the completion of the single market program), and an investment environment that ensures the development of a more active market for risk capital.

Given the pattern of TFP growth in the three euro area countries studied in detail in Section III, it is equally possible to argue that the euro area is only lagging the United States in terms of adoption of ICT technologies in some service sector industries. Although product market reforms and other structural changes would speed the diffusion of technology in the euro area, the diffusion will, nonetheless, happen. Evaluating such a hypothesis is outside the scope of this paper and will be left to future research.

The Industry Labor Productivity Database[12]

The Industry Labor Productivity Database, put together by the Groninger Center for Development and Growth (GCDG), contains information on value added, employment, and hours worked in the 15 EU member states and the United States for 56 separate industries between 1979 and 2001. The point of departure for most countries was the new OECD STAN Database of national accounts. The STAN Database contains information on the most important national accounts variables from 1970 onward based on a common industrial classification. However, for a number of industries STAN does not contain sufficient detail. To obtain a sufficiently detailed perspective on industry performance, the GGDC supplemented STAN with additional detail from annual production surveys, and service statistics. In addition, where necessary, more detailed national accounts were used from individual countries. The available data series are value added in current and constant prices (at basic prices), numbers of persons engaged (including self-employed), number of employees, total labor compensation, and working hours.

Most important for this paper, the Industry Labor Productivity Database homogenized the treatment of quality changes in computer and semiconductor prices across all countries. Following the work of Schreyer (2000 and 2002), the GGDC achieved international comparability in this area by using harmonized U.S. deflators for six ICT producing industries encompassing the production of computers, semiconductors , communications equipment and others, to correct value-added data for other countries. In the process, U.S. value-added deflators are corrected for differences in overall inflation between each country and the United States. In addition, the GGDC minimized the substitution bias in fixed-weight indices (like the Laspeyres) when calculating value-added at constant prices for higher levels of aggregation.

The GGDC used the Törnqvist method of aggregation to approximate an ideal Fisher price index, a procedure also followed here when calculating industry aggregates for the euro area and the United States. All the tables and results shown in the previous sections for the euro area, the United States or the euro-3 aggregate use value-added weights to get to (ICT-based) sectoral breakdowns.

[12] All the data described here are explained in detail in "Data Sources and Methodology" by R. Inklaar and others, published as Chapter 7 in O'Mahony and Van Ark (2003).

The Growth Accounting Database

The Growth Accounting Database from the GGDC provides information for three euro-area countries (France, Germany and the Netherlands), the United Kingdom (not used here), and the United States. The sample goes from 1980 to 2000, and it uses a somewhat more aggregated industry classification (26 industries) than provided by the Industry Productivity Database. The aggregations by the ICT taxonomy are based on a mapping between the listing in Appendix III and the 26 industries in the database. This was also the procedure used by O'Mahony and van Ark (2003) but it is possible that the mapping used here differs slightly from theirs, mainly in cataloguing some service industries as non-ICT users, as opposed to ICT users. All the methodological improvements presented by the Industry Productivity Database, including the homogenization of treatment of quality changes in ICT equipment, apply to this database. For more details, see the reference in footnote 11.[13]

The method used to break down labor productivity growth into several components assumes perfect markets and constant returns to scale so that the share of total capital is one minus the share of labor compensation in total value added—the same procedure used to break down the aggregate data in Section II. The database provides information on the labor share and the share of ICT capital income in total capital income. The assumption of constant returns to scale allows the share of each type of capital stock on value added to be recovered with this information.

The database also provides information on changes in labor quality calculated by first dividing total hours by skill level (education attainment), weighting the growth in each type by its wage share and subtracting total hours. The researchers divided, for each country, total hours worked into a number of different skill types. These types vary across country, but all include a high-skill category (degree and above) and a low-skill category (broadly equivalent to no high school graduation in the United States). Therefore, variations across countries in skill types are confined to intermediate categories. Second, capital input is measured using a Törnqvist capital service index, which comprises three assets for ICT—software, computers, and communications equipment—and three for non-ICT—non-ICT equipment, structures, and vehicles. Capital inputs are measured as service flows, and the share of each type in the value of capital is based on its user cost and not its acquisition cost.

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[13] The results for labor productivity growth using information from this database will differ from the ones using the Industry Productivity Database for many reasons. First, the tables using the Growth Accounting Database will stop with averages up to 2000. The addition of 2001 in the tables based on the Industry Productivity Database lowers productivity growth slightly in the last sample period. Second, the aggregation by ICT grouping will differ because there is not a perfect match between the classification put together for the 56 industries in the Industry Productivity Database and the 26 industries included in the Growth Accounting Database. Third, small differences can be attributed to approximations made in the aggregation process.

To derive the productivity growth accounting equation, the GGDC assumed percent changes in output can be written as

$$\Delta y = \alpha_l * \Delta l + \alpha_l * \Delta q + \alpha_{ict} * \Delta k_{ict} + \alpha_{nict} * \Delta k_{nict} + \Delta tfp \quad , \qquad \text{(A.1)}$$

where α_i represents the share of input i's income in value added, Δ represents first differences, lower-case letters refer to the natural logarithm of each variable, y is real value added in a particular industry at time t (subscripts are omitted for simplicity), l is total hours of work, q is labor quality, k_{ict} and k_{nict} represent capital services of ICT and non-ICT equipment, respectively, and tfp is total factor productivity. Subtracting total hours from both sides of the above equation, and rearranging and employing constant returns to scale so that $\alpha_l + \alpha_{ict} + \alpha_{nict} = 1$, gives a decomposition of average labor productivity growth as

$$\Delta p = \alpha_l * \Delta q + \alpha_{ict} * (\Delta k_{ict} - \Delta l) + \alpha_{nict} * (\Delta k_{nict} - \Delta l) + \Delta tfp \quad , \qquad \text{(A.2)}$$

where p is labor productivity, and the terms in parentheses are ICT and non-ICT capital-hours ratios.

ICT Taxonomy[14]

1. *ICT Producing - Manufacturing (ICTPM):* Office machinery (30); Insulated wire (313); Electronic valves and tubes (321); Telecommunication equipment (322); Radio and television receivers (323); Scientific instruments (331).

2. *ICT Producing – Services (ICTPS)*: Communications (64); Computer & related activities (72).

3. *ICT Using – Manufacturing* (ICTUM): Clothing (18); Printing & publishing (22); Mechanical engineering (29); Other electrical machinery & apparatus (31-313); Other instruments (33-331); Building and repairing of ships and boats (351); Aircraft and spacecraft (353); Railroad equipment and transport equipment not elsewhere classified (352+359); Furniture, miscellaneous manufacturing; recycling (36-37).

4. *ICT Using – Services* (ICTUS): Wholesale trade and commission trade, except for motor vehicles and motorcycles (51); Retail trade, except for motor vehicles and motorcycles; repair of personal and household goods (52); Financial intermediation, except insurance and pension funding (65); Insurance and pension funding, except compulsory social security (66); Activities auxiliary to financial intermediation (67); Renting of machinery & equipment (71); Research & development (73); Legal, technical & advertising (741-3).

5. *Non-ICT Manufacturing* (NICTM): Food, drink & tobacco (15-16); Textiles (17); Leather and footwear (19); Wood & products of wood and cork (20); Pulp, paper & paper products (21); Mineral oil refining, coke & nuclear fuel (23); Chemicals (24); Rubber & plastics (25); Nonmetallic mineral products (26); Basic metals (27); Fabricated metal products (28); Motor vehicles (34).

6. *Non-ICT Services* (NICTS): Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel (50); Hotels & catering (55); Inland transport (60); Water transport (61); Air transport (62); Supporting and auxiliary transport activities; activities of travel agencies (63); Real estate activities (70); Other business activities, not elsewhere classified (749); Public administration and defense; compulsory social security (75); Education (80); Health and social work (85); Other community, social, and personal services (90-93); Private households with employed persons (95); Extraterritorial organizations and bodies (99).

7. *Non-ICT Other* (NICTO): Agriculture (01); Forestry (02); Fishing (05); Mining and quarrying (10-14); Electricity, gas, and water supply (40-41); Construction (45).

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[14] Original list can be found in O'Mahony and van Ark (2003).

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