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Cambios estructurales y discriminación de la productividad laboral en la zona del euro

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El bajo crecimiento de la productividad ha estado presente en la zona del euro desde mediados de la década de los noventa. Esto es particularmente llamativo al contractual con las importantes ganancias en productividad observadas en los Estados Unidos durante el mismo período. En el presente trabajo se muestra que la desaceleración de la productividad laboral en la zona del euro fue causada por cambios estructurales en la formación de salarios, que afectaron el precio relativo del trabajo, incrementaron la intensidad del trabajo en el cercimiento y redujeron la profundización del capital. Los choques tecnológicos jugaron un papel menor explorando esta desaceleración. Este puede ser un efecto económico general que puede estar presente en otros países que han tratado de reducción sus tasas de desempleo. Los cambios tecnológicos desempeñaron un papel menor en la explicación de dicha desaceleración.

Clasificación JEL: D24, E22, E24, J23.

Palabras clave: crecimiento de la productividad, cambio estructural, formación de salarios, generación de empleo.

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Structural Changes and Labor Productivity Slowdown in the Euro Area

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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 this deceleration. This is a general economic effect that may surface in other countries as they fight to lower unemployment rates.

JEL Classification: D24, E22, E24, J23.

Keywords: productivity growth, structural change, wage bargaining, employment creation.

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I. INTRODUCTION

Labor productivity in the euro area briefly surpassed that in the United States in the mid-1990s, but has been falling behind since then. Identifying the reasons for the sluggish growth of labor productivity in the euro area is crucial to guide an effective policy response. In particular, if it reflects relatively weak growth in total factor productivity (TFP), as suggested by several analysts (European Comission, 2003), would point to problems with technology adoption and managerial efficiency. 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. The productivity surge in key high-tech sectors in the United States may also be crucial to explain the performance gap (for instance, see O'Mahony and van Ark, 2003).

This paper improves our understanding of the ultimate causes for the recent productivity slowdown in the euro area, by arguing 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 is associated mainly with the use of production inputs, rather than 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 changes in wage-setting behavior. 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 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 paper shows, in passing, that the gap between labor productivity growth in the euro area and in the United States in the second half of the 1990s can be explained by slower capital deepening in the euro area (as argued above) and a surge in productivity growth in intensive ICT-using sectors (mainly wholesale and retail trade and financial intermediation) in the United States. These results mirror the evidence for the European Union as a whole provided by O'Mahony and van Ark (2003).

Looking ahead, policies to improve labor utilization in Europe should continue in the medium term, 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. This general pattern would be present in any economy fighting high unemployment by changing relative input prices. In addition, the labor market reforms needed for continued reductions in unemployment should improve economic efficiency and ultimately affect TFP growth positively. Turning to the TFP growth differential with respect to the United States, product market deregulation would promote efficiency gains, and help to close the productivity growth gap in key sectors with respect to the United States.[1]

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

1 For a theoretical discussion and empirical evidence on the positive interaction between labor and product market reforms in OECD countries see Blanchard and Giavazzi (2003) and Estevão (2005).

of convergence in GDP per capita between the two regions. Section III performs a more rigorous breakdown of labor productivity growth for a subset of the euro area (France, Germany, the Netherlands) with good information on changes in ICT and non-ICT capital, labor quality, and TFP. The data come from the Groningen Growth and Development Center (GGDC) and account for severe measurement errors in national accounts data. The results point to an increase in TFP growth in those countries while capital deepening declined substantially in the second half of the 1990s. 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.

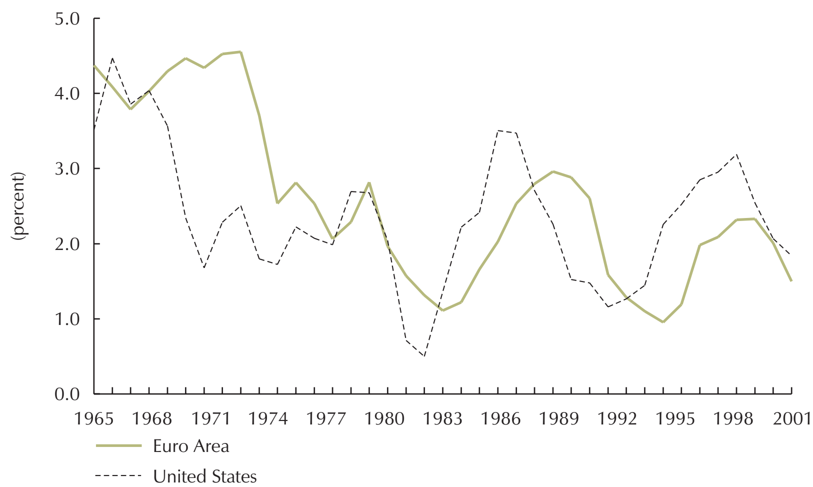
II. GDP PER CAPITA AND PRODUCTIVITY GROWTH

As a starting point, it is useful to examine the broad trends in labor productivity and GDP per capita growth according to readily available national accounts information. In fact, part of the policy and academic debate has focused on the messages from these data. The long-run pattern of declining GDP per capita growth (evaluated at purchasing power parity prices) 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 (graphs 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 Graphs for the first time (Graph 3 and Table 1).[2] Increasing employment rates in both economies (Graph 4 and Table 1) maintained 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.

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

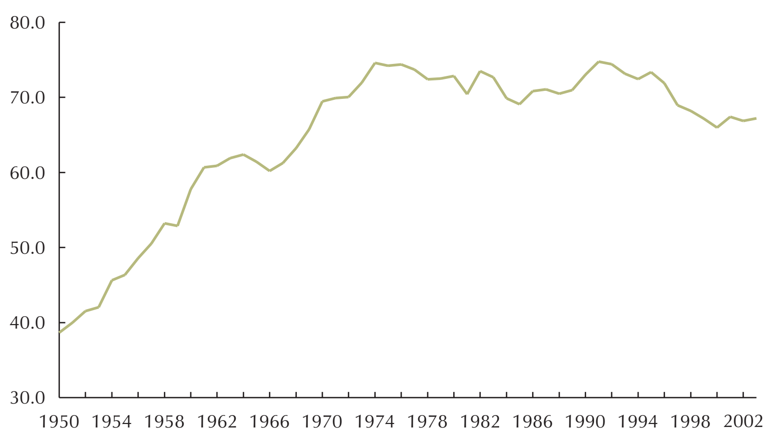
2 Basic identity: Growth in GDP per capita = Growth in GDP per hours of work + Growth in employment as a ratio of total population + Growth in average hours of work per person. Data used in this section come primarily from the AMECO database, produced by the European Commission. Data on economywide average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

Graph 1
GDP per Capita Trend Growth
(five-year moving average)



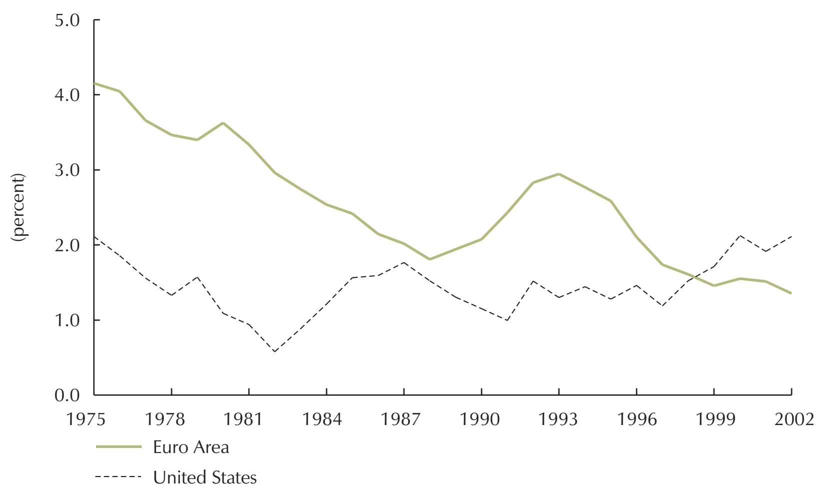
Sources: EC-AMECO database; OECD Productivity database, and author´s calculations.

Graph 2
PPP GDP per capita in the Euro Area
as Percentage of U. S. Value



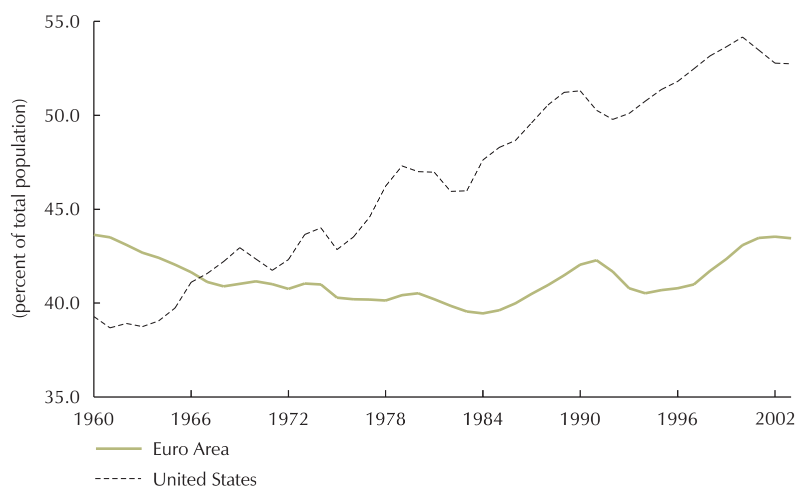
Sources: EC-AMECO database; OECD Productivity database, and author´s calculations.

Graph 3
Labor Productivity Growth
(five-year moving average)



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

Graph 4
Employment Rates



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

Table 1
GDP per capita Growth
(annual rates, in percent)

Euro Area

	GDP per capita	Labor productivity	Employment rate	Average hours worked
1960-1970	4.4	---	-0.6	---
1970-1980	2.7	3.9	-0.2	-1.0
1980-1990	2.1	2.2	0.4	-0.5
1990-1995	1.1	2.6	-0.7	-0.8
1995-2000	2.3	1.6	1.2	-0.4
1995-2003	1.7	1.2	0.8	-0.4

United States

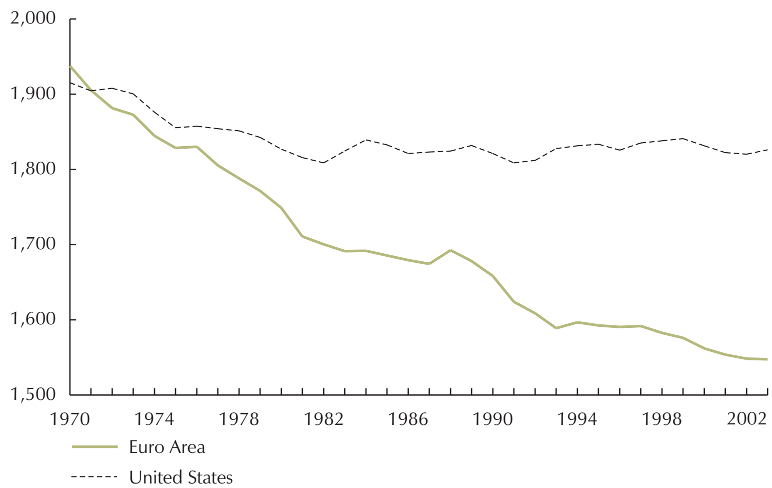
	GDP per capita	Labor productivity	Employment rate	Average hours worked
1960-1970	2.9	---	0.8	---
1970-1980	2.2	1.6	1.1	-0.5
1980-1990	2.2	1.4	0.9	0.0
1990-1995	1.4	1.3	0.0	0.1
1995-2000	3.2	2.1	1.1	0.0
1995-2003	2.4	2.1	0.3	0.0

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

(graphs 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 United States 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)

Graph 5
Annual Hours per Worker



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

explains a large part of the productivity deceleration in the euro area (Table 2).[3] 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 1970-1995. The cyclical decline in TFP growth during 2001-2003 was about the same in the two countries.

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.

3 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.

Table 2
Labor Productivity Growth
(annual rates, in percent)

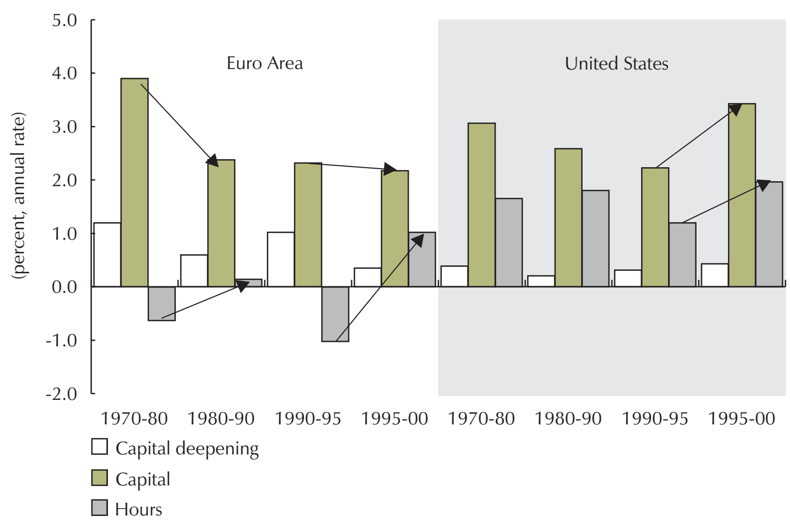
	Euro Area			United States		
	Labor productivity	Capital deepening	TFP	Labor productivity	Capital deepening	TFP
1970-1980	3.9	1.2	2.7	1.6	0.4	1.2
1980-1990	2.2	0.6	1.6	1.4	0.2	1.2
1990-1995	2.6	1.0	1.6	1.3	0.3	1.0
1995-2000	1.6	0.4	1.2	2.1	0.4	1.7
1995-2003	1.2	0.4	0.8	2.1	0.6	1.4

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

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 (Graph 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 (Graph 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 in unit labor cost growth (total labor compensation divided by output, as in Graph 8).

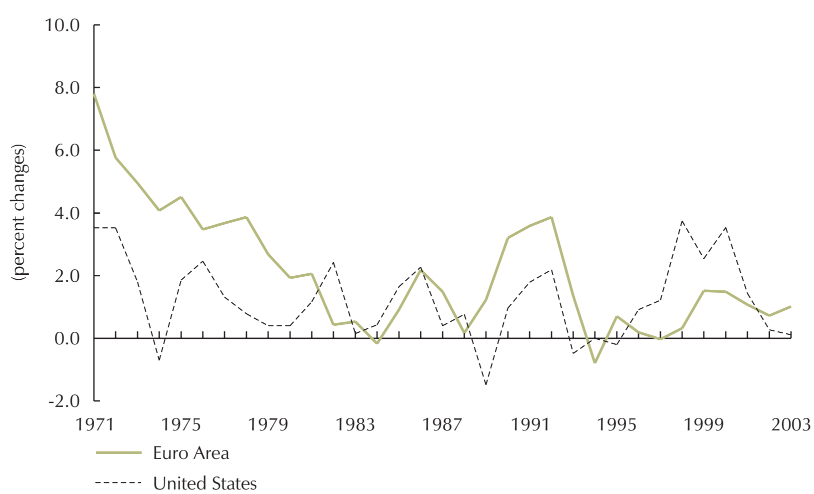
The story going from a downward trend in labor costs in the euro area to slower capital deepening, and, thus, slower labor productivity growth seems plausible at first glance. Aggregate data also suggest a slowdown in TFP growth. The next sections will delve deeper into these issues.

Graph 6
Breaking Down Changes in the Capital-Labor Ratio



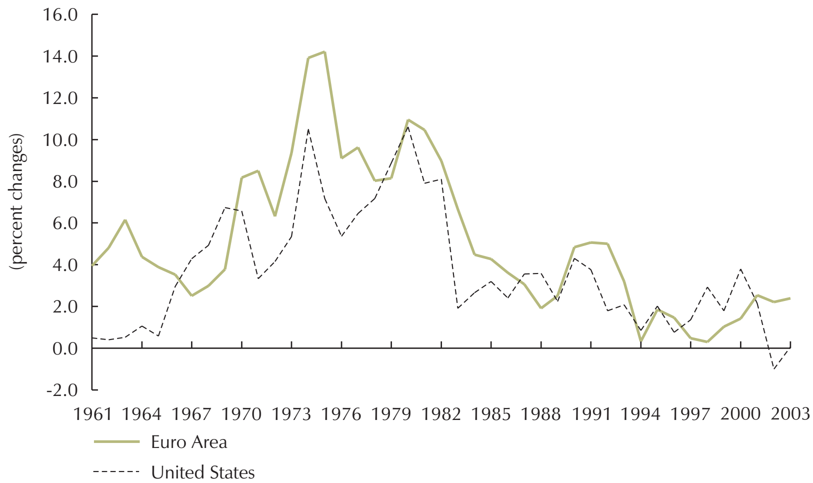
Sources: EC-AMECO database for capital stock and employment; OECD for average hours of work, and author's calculations.

Graph 7
Real Hourly Compensation



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

Graph 8
Unit Labor Costs



Sources: EC-AMECO database; OECD Productivity database, and staff calculations.

III. LABOR PRODUCTIVITY GROWTH USING DETAILED INPUT 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 has shed some light on differences between the United States and European productivity developments, (Jorgenson, 2003, and the more comprehensive work of O'Mahony and Van Ark, 2003).

This section examines the role of these issues in explaining differences in productivity trends in Europe and in the United States. It focuses on three countries —France, Germany and the Netherlands— comprising 65 percent of euro-area GDP, and with good information on growth in real value added, hours of work, ICT capital, non-ICT capital, labor quality, and TFP. The Groningen Growth and Development Center (GGDC) constructed the database departing from the OECD STAN database and national sources.[4] 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 the other countries. All sector and country aggregations performed here use value-added weights at the industry level. 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), and laid out in equation (A1.2) of Appendix 1. 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.

Calculations with the more precise database reveal that the TFP growth shown in Table 2 is misleading: German TFP accelerates continuously when carefully measured according to the GGDC in contrast to aggregate national accounts data, which point to a decline (Table 3). Given the weight of Germany in the euro area's aggregate (about 30 percent of total value added in the area) TFP growth in the area based on the detailed industry database was actually 0.35 percentage point higher than shown in Table 2 —about the size of the deceleration in TFP shown in that table—. The general profile of TFP growth in France and in the Netherlands is similar in both calculations.

The contribution of ICT capital deepening to productivity growth increased significantly for all countries between the first and the second halves of the 1990s (Table 4, row 2). In contrast, the contribution of non-ICT capital deepening declined, becoming negative in France and zero in the Netherlands (Table 4, row 3). Labor quality growth contributed less to productivity growth in the Netherlands and in Germany, but not in France (Table 4, row 4). Table 4 (rows 6 to 20) also provides a breakdown of aggregate labor productivity into three large sectors: ICT-producing, ICT-using, and Non-ICT industries.[5] The contribution of non-ICT capital deepening declined in

4 For more information on the data, see Appendix 1.

5 Appendix 2 presents the composition of each of these industries, which depends on the type of goods and services produced, and the intensity of use of ICT equipment.

Table 3
Productivity Growth in Two Different Databases [a/]
(percent, at an annual rate)

	Growth Accounting Database			AMECO and OECD data		
	1979-1990	1990-1995	1995-2000	1979-1990	1990-1995	1995-2000
France: total economy						
labor productivity	2.95	1.47	1.54	2.91	1.86	2.13
of which TFP [b/]	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 [b/]	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 [b/]	1.21	0.44	0.72	1.28	0.97	1.44

a/ Productivity is defined as real value added per hours worked.
b/ 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.
Sources: Growth Accounting Database (EC and GGDC); EC-AMECO and OECD, and staff calculations.

the three 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, and shows that it was not a sector-specific development. 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 5). 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 (Table 5, row 2). 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 (Table 5, row 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 (Table 5, row 5). The TFP growth differential in favor of the euro-3 aggregate contrasts with the message for

Table 4
Decomposition of Labor Productivity Growth in Three Euro Area Countries [a]
(percent, at an annual rate)

		1979-1990		
		France	Germany	Netherlands
Total economy	Labor productivity	2.95	1.96	2.33
	Contribution of:			
	ICT capital deepening [b]	0.18	0.48	0.33
	Non-ICT capital deepening [b]	0.56	0.60	0.69
	Labor quality [c]	0.37	0.33	0.10
	TFP [d]	1.85	0.55	1.21
ICT-producing industries [e]	Labor productivity	7.71	5.80	6.80
	Contribution of:			
	ICT capital deepening [b]	0.47	0.72	0.50
	Non-ICT capital deepening [b]	1.43	0.97	0.77
	Labor quality [c]	-0.27	0.53	-0.10
	TFP [d]	6.08	3.58	5.64
ICT-using industries [f]	Labor productivity	4.41	1.75	2.86
	Contribution of:			
	ICT capital deepening [b]	0.32	0.45	0.78
	Non-ICT capital deepening [b]	0.70	0.27	0.50
	Labor quality [c]	0.19	0.33	0.04
	TFP [d]	3.20	0.70	1.54
Non-ICT industries [g]	Labor productivity	1.78	1.29	1.51
	Contribution of:			
	ICT capital deepening [b]	0.09	0.31	0.19
	Non-ICT capital deepening [b]	0.17	0.54	0.39
	Labor quality [c]	0.20	0.47	-0.02
	TFP [d]	1.33	-0.03	0.94

a/ Productivity is defined as real value added per hours worked. Detailed breakdown by ICT type listed in Appendix III.
b/ Capital deepening defined as changes in the capital to hours worked ratio.
c/ Labor quality changes calculated by the ratio of hours weighted by wages of individuals with different educational backgrounds.
d/ Total factor productivity (TFP) calculated as a residual.
e/ Includes office machinery, telecommunications equipment, scientific instruments, communications, and computer and related activities.
f/ Includes most transportation equipment, mechanical engineering, printing and publishing, wholesale and retail trade, and financial services.
g/ Includes agriculture, construction, mining, motor vehicles, chemicals, basic and fabricated metals, real estate activities and public services.
Sources: Growth Accounting Database (EC and GGDC); and staff calculations.

	1990-1995			1995-2000		
	France	Germany	Netherlands	France	Germany	Netherlands
	1.47	2.26	1.42	1.54	2.08	1.52
	0.13	0.38	0.29	0.27	0.55	0.59
	0.48	1.01	0.46	-0.24	0.51	0.10
	0.26	0.07	0.23	0.47	0.01	0.10
	0.59	0.80	0.44	1.05	1.01	0.72
	4.17	4.65	3.87	9.20	12.55	4.26
	0.14	0.80	0.62	0.39	1.09	1.35
	0.74	1.62	1.16	-0.23	0.53	0.90
	0.12	0.88	0.05	0.36	0.56	0.31
	3.16	1.35	2.03	8.67	10.38	1.70
	1.75	2.60	1.08	1.55	1.54	2.75
	0.26	0.54	0.57	0.55	0.60	1.18
	0.81	0.67	0.54	0.01	0.16	0.19
	0.05	0.30	0.22	0.42	0.23	0.15
	0.62	1.08	-0.26	0.58	0.56	1.23
	0.90	1.66	1.40	0.85	0.84	1.35
	0.09	0.17	0.21	0.15	0.39	0.39
	0.21	0.72	0.40	-0.48	0.29	0.18
	0.19	0.28	0.26	0.43	0.01	0.28
	0.41	0.49	0.53	0.74	0.16	0.50

Table 5
Decomposition of Labor Productivity Growth in Euro-3 and in the U.S. [a/]
(percent, at an annual rate)

		1979-1990		1990-1995		1995-2000	
		Euro-3 [b/]	United States	Euro-3 [b/]	United States	Euro-3 [b/]	United States
Total economy	Labor productivity	2.35	1.26	0.00	1.00	0.00	2.17
	Contribution of:						
	ICT capital deepening [c/]	0.36	0.48	0.00	0.41	0.00	0.80
	Non-ICT capital deepening [c/]	0.59	0.24	0.00	0.23	0.00	0.25
	Labor quality [d/]	0.32	0.26	0.00	0.23	0.00	0.25
	TFP [e/]	1.08	0.28	0.00	0.13	0.00	0.87
ICT producing industries [f/]	Labor productivity	6.59	7.72	0.00	8.41	0.00	14.31
	Contribution of:						
	ICT capital deepening [c/]	0.61	1.30	0.00	1.27	0.00	1.84
	Non-ICT capital deepening [c/]	1.12	0.92	0.00	0.84	0.00	0.95
	Labor quality [d/]	0.18	0.24	0.00	0.41	0.00	0.03
	TFP [e/]	4.69	5.25	0.00	5.89	0.00	11.48
ICT using industries [g/]	Labor productivity	2.82	1.44	0.00	1.64	0.00	4.71
	Contribution of:						
	ICT capital deepening [c/]	0.44	1.05	0.00	0.74	0.00	1.45
	Non-ICT capital deepening [c/]	0.45	0.61	0.00	0.59	0.00	0.57
	Labor quality [d/]	0.25	0.23	0.00	0.30	0.00	0.34
	TFP [e/]	1.68	-0.44	0.00	0.00	0.00	2.34
Non-ICT industries [h/]	Labor productivity	1.49	0.63	0.00	0.22	0.00	0.02
	Contribution of:						
	ICT capital deepening [c/]	0.22	0.28	0.00	0.30	0.00	0.45
	Non-ICT capital deepening [c/]	0.39	-0.04	0.00	0.09	0.00	0.09
	Labor quality [d/]	0.32	0.37	0.00	0.19	0.00	0.29
	TFP [e/]	0.56	0.03	0.00	-0.37	0.00	-0.81

a/ Productivity is defined as real value added per hours worked. Detailed breakdown by ICT type listed in Appendix II.
b/ Industry value-added weights used to aggregate data underlying Table 4.
c/ Capital deepening defined as changes in the capital to hours worked ratio.
d/ Labor quality changes calculated by the ratio of hours weighted by wages of individuals with different educational backgrounds.
e/ Total factor productivity (TFP) calculated as a residual.
f/ Includes office machinery, telecommunications equipment, scientific instruments, communications, and computer and related activities.
g/ Includes most transportation equipment, mechanical engineering, printing and publishing, wholesale and retail trade, and financial services.
h/ Includes agriculture, construction, mining, motor vehicles, chemicals, basic and fabricated metals, real estate activities and public services.
Source: Growth Accounting Database (EC and GGDC); and staff calculations.

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, which, as discussed in Estevão (2004), has shown a large deceleration in labor productivity growth during the period) 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. TFP growth in these industries went from 0 percent to 2.34 percent in the United States while in the euro area it went from 0.79 percent to 0.63 percent.

In summary, a 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-3 aggregate in the second half of the 1990s. Labor productivity acceleration in ICT-producing industries in the second half of the 1990s was as fast in the euro-3 aggregate as in the United States. Dissecting the aggregate labor productivity growth, the difference in performance vis-à-vis the United States can be accounted for by a decline in capital deepening, a slower labor quality improvement, and a smaller increase in TFP growth in the euro-3 aggregate. The difference in TFP acceleration in favor of the United States can be traced to a surge in ICT-using industries. If these results are generalized for the remaining 40 percent of the euro-area 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). Technological progress seem to have actually increased in the period, albeit not nearly as much as in the United States. Slower capital deepening seem to have been the most important factor behind the deceleration in labor productivity in the euro area.

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-3 group has not posted a productivity surge in ICT-using industries), this section focuses on explaining the roots of the slower capital deepening in the euro-3 aggregate in the second half of the 1990s.

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.[6] Other studies claim that workers actually learned from the mistakes of the past after observing the consequences of excessive wage demands (Blanchard and Philippon, 2003), or that a set of factors could have conspired to generate lower wage growth in the 1990s.[7] Among many factors, declines in unions' bargaining power (maybe related to globalization), implicit contracts with governments (who provided services to workers in exchange for moderation in 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 (Estevão, 2007). Finally, labor market reforms allowing a better use of temporary

6 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.

7 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.

and part-time work in many euro-area countries could also have strengthened labor market competition and held wage growth down.

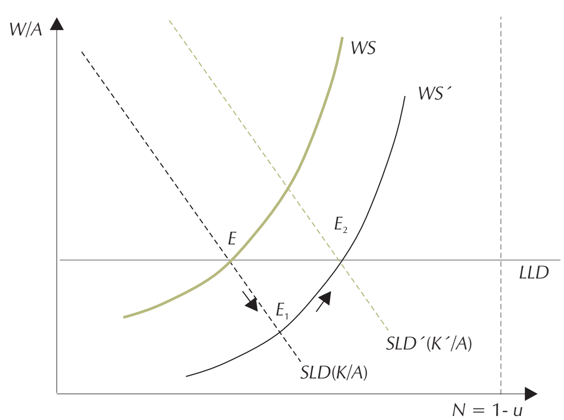
A. BENCHMARK MODEL

A simple model captures the basic argument relating structural labor market changes and the productivity developments discussed in the previous section.

A short-run labor demand curve (SLD in Figure 1) 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 1).

Figure 1
Structural Labor Market Changes and Long-Run Adjustment



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. The model generates

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

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.

Equation (1) represents a contract curve relating wages in efficiency units to the unemployment rate (the wage-setting curve, *WS*, in Figure 1). 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 1 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 wage-setting curve, 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 is assumed to remain unchanged, as, in this simple model, composition changes in the labor force do not affect total factor productivity. However, 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:

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

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

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units ($\ln(W_t / (CP_t * A_t))$) are modeled as changes in ξ_t. 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.[8]

Calculations based on equation (2) show major structural changes in wage-setting in the 1970s that were then reversed in the 1980s and in the second half of the 1990s. This path is presented in Graph 9, 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:

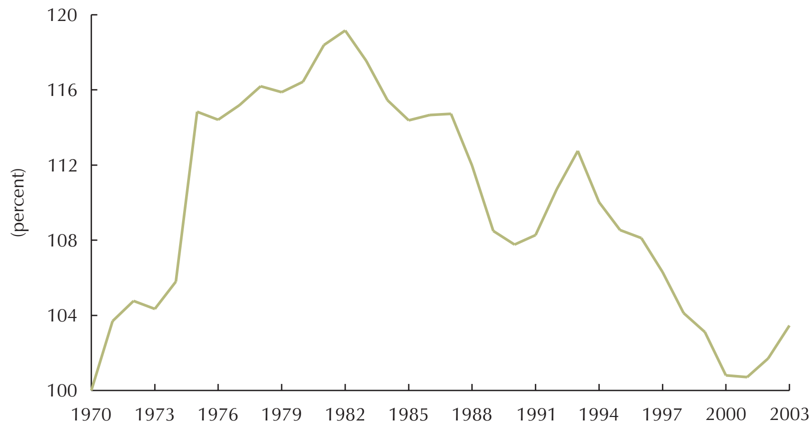
$$\xi_{ijt} * \gamma_{ij} = \ln\left(\frac{W_{ijt}}{CP_{jt} * A_{ijt}}\right) + 0.1 * \ln\left(u_{jt}\right), \tag{3}$$

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 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.

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

8 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. Recently, Sanz de Galdeano and Turunen (2005) report elasticities between -0.1 and -0.3 for different euro-area countries. Estevão (2007) estimates a -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.

Graph 9
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.

demand equation used in the model sketched above.[9] 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}):

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

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 (the term $\alpha * \Delta\eta_{ijt}$), which are

9 Note that in the model described above, changes in bargaining power occur exogenously and do not depend on the relative use of capital and labor during the transition to a new steady-state equilibrium. Endogeneizing changes in wage-setting parameters is an interesting area for further research.

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.

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 6). The result is consistent with the simple model described in the previous section, in which wage moderation lowers capital deepening in a first moment. The short-run elasticity of capital deepening to wage-setting shocks 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 Graph 9, 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 (not directly observed, but relevant to determine the rate of capital deepening in each industry, as in equation 4) because of

Table 6
Elasticity of Capital Deepening to Wage-Setting Shocks [a/]

Dependent variable: $\Delta ln(K_{ijt}/L_{ijt})$	
WS shock [b/]	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
Nobs	1,690
Number of industries	26
Sample period	1980-2000

a/ Estimation uses industry-level data for France, Germany and the Netherlands. Standard error is shown in parentheses and is corrected for AR(1) residuals.
b/ Wage-setting shocks measured as shown in equation (3). Consumer prices are measured by the implicit deflator for private consumption expenditures.
* Stands for significant at the 5 percent level.
Sources: GGDC; AMECO database; and staff estimates.

declining interest rates and ICT equipment prices, offset the strong push from these wage shocks for firms to substitute away from capital toward labor.

The results are indicative that the wage-setting changes observed since the 1980s would significantly depress capital deepening in the euro area. However, a more elaborate empirical work is needed to determine the full dynamic effects of these structural labor market changes. In particular, changed wage-setting conditions have raised profit rates in the period, which should raise investment rates, capital deepening and potential economic growth in the second phase of adjustment discussed in the theoretical model.

V. CONCLUSIONS

The paper argues that slower capital deepening resulting from structural labor market changes is behind the labor productivity slowdown in the euro area in the second half of the 1990s. That is, labor productivity decelerated for good reasons: it was the by-product of improved labor market functioning, which has reduced unemployment rates. Looking ahead, 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. The temporary link between labor market reforms and slower labor productivity growth is an important economic factor that needs to be kept in mind when Latin American governments seek to reduce unemployment rates (now fluctuating at around 10 percent).

However, this is not to say that structural policies cannot raise productivity growth while labor market reforms help the absorption of the unemployed into jobs. As discussed here and in other papers, a large part of the labor productivity growth gap between the euro area and the United States after the mid-1990s can be explained by the surge in TFP growth in ICT-using sectors in the United States. This differential has been attributed to better product market regulations and higher incentives to process innovation in North America. In this sense, labor and product market reforms could complement themselves: besides intensifying the adoption of technologies in the marketplace, stronger product market competition in Europe and elsewhere would also curb higher economic rents from reduced wages at a given rate of unemployment —a common result of labor market reforms—in favor of larger output gains—. In addition, assuring higher returns from labor market reforms by raising product market competition is a way to increase popular support for a reform agenda.

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APPENDIX 1
The Growth Accounting Database[1]

The Growth Accounting Database from the Groningen Growth and Development Center (GGDC) provides information for three euro-area countries (France, Germany and the Netherlands), the United Kingdom (not used here), and the United States. The database uses primarily information from 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 extra information from annual production surveys, and service statistics. In addition, where necessary, more detailed national accounts data 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, working hours, stock of ICT and non-ICT capital, and changes in labor quality.

Most important for this paper, the GGDC 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. All the tables and results shown in the previous sections use value-added weights to get to (ICT-based) sectoral breakdowns.

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

The database goes from 1980 to 2000 and includes information for 26 industries. The aggregations by the ICT taxonomy are based on a mapping between the listing in Appendix II 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.

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 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 (college 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 (not available to the outside researcher) and not its acquisition cost.

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

$$\Delta y = \alpha_l * \Delta l + \alpha_l * \Delta q + \alpha_{ict} * \Delta k_{ict} + \alpha_{nict} * \Delta k_{nict} + \Delta tfp, \qquad \text{(A1.1)}$$

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:

$$\Delta p = \alpha_l * \Delta q + \alpha_{ict} * \left(\Delta k_{ict} - \Delta l\right) + \alpha_{nict} * \left(\Delta k_{nict} - \Delta l\right) + \Delta tfp, \qquad \text{(A1.2)}$$

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

APPENDIX 2
ICT Taxonomy[2]

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 (741-743).

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

2 Original list can be found in O'Mahony and Van Ark (2003).

(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).