V. RECENT GROWTH TRENDS IN OECD COUNTRIES

Introduction

This chapter assesses trends in growth rates in the OECD countries over the past decade

Recent growth trends in some OECD countries have attracted widespread attention. In particular, the conjunction of a number of developments in the United States has contributed to an impression that something fundamental may have changed. These include: strong non-inflationary growth, coupled with high labour utilisation; the spread of information and communication technology (ICT); and microeconomic evidence of continued restructuring of production processes. A sustained pick-up in economic growth is also evident in a few other OECD countries and raises the question as to whether (and how) more rapid growth could spread more widely in the near future. This chapter sheds some light on these issues by examining output and productivity growth over the 1990-98 period, and attempts to identify the role played by traditional growth determinants as well as new forces largely related to ICT.[1]

It should be stressed at the outset that international comparisons of growth patterns are constrained by a number of measurement issues. First, despite major efforts by national statistical offices and international organisations, data problems still limit the possibility of comparing growth performance across countries and over time.[2] Second, output is notoriously difficult to measure in the service sector, which is a heavy user of ICT and where quality aspects of output are important. Finally, changes in trends are difficult to disentangle from cyclical developments at the best of times but particularly so when the focus is on the most recent observations. Moreover, countries differed a lot in business cycle conditions over the 1990s. To control for these problems, frequent use is made in this chapter of cyclically-adjusted series.[3]

The first section of the chapter examines cross-country patterns of trend GDP and GDP per capita growth and their main determinants across the OECD area over the

1. The chapter draws on the more comprehensive analysis of recent growth trends in Scarpetta *et al.* (2000) and on material produced by the Directorate for Science, Technology and Industry (DSTI).
2. Comparability problems have always affected international analyses of growth performances but are particularly relevant at present because of the different pace and comprehensiveness with which different countries have adopted new measurement techniques in their national accounts (see Box I.3 in OECD, 1999*a*).
3. Trend series of output, employment and labour productivity have been estimated using an extended version of the Hodrick-Prescott filter (Hodrick and Prescott, 1997). The extended version of the H-P filter tries to overcome the well-known in-sample phase shift problem by extending actual data out of the sample using the observed average growth rate over the 1980-98 period. However, if past growth rates are not reasonable proxies for future growth patterns, this extension may lead to a bias at the end of the filtered series. For the majority of countries, the bias does not appear to be serious: the use of an alternative method of extending the data – using the projections in the OECD Medium Term Reference Scenario, (MTRS) – provided broadly similar results. There are, however, a few exceptions. In the case of Germany, France and Canada the use of OECD MTRS projections yields a somewhat higher trend growth rate over the 1990s; by contrast, they lead to a lower trend growth rate in output in Japan.

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past two decades. The second section focuses on labour productivity, labour utilisation and the evolution of human capital. The third section takes a preliminary look at the role that ICT has played as a driver of growth in OECD countries over the past decade both directly, reflecting growth in the ICT-producing industry, and indirectly *via* the use of ICT as an input to production in other sectors. The fourth section examines multi-factor productivity growth in an attempt to identify significant shifts in the rate of technological progress and, thus, in growth potential. The final section offers some concluding remarks and outlines policy issues arising from observed growth trends.

Growth rates in GDP and GDP per capita

In a few countries, the long-run slowdown in growth performance appears to have been reversed in the 1990s

For the OECD area as a whole, both actual and trend GDP growth were lower in the 1990s compared with the previous two decades, continuing the well-documented long-run slowdown in growth rates (Table V.1). However, the trend was reversed in the United States and in several smaller OECD countries (most notably Australia, Ireland, the Netherlands and Norway, see Appendix, Table V.5).[4] As demographic changes are generally slow, trend growth rates in GDP per capita – which are more relevant from a national living standard perspective – presented broadly the same picture (Table V.1).[5] These different growth patterns are reflected in a widening of GDP growth disparities in the 1990s as compared with the 1980s (Appendix, Table V.5).

Differences in income per capita remain wide…

Reflecting these growth trends, data for 1998 show the United States at the top of the OECD income distribution followed by Norway and Switzerland with GDP per capita about 15-20 percentage points below the US level (Figure V.1). The bulk

Table V.1. **Growth performance in OECD countries**

Average annual rates of change

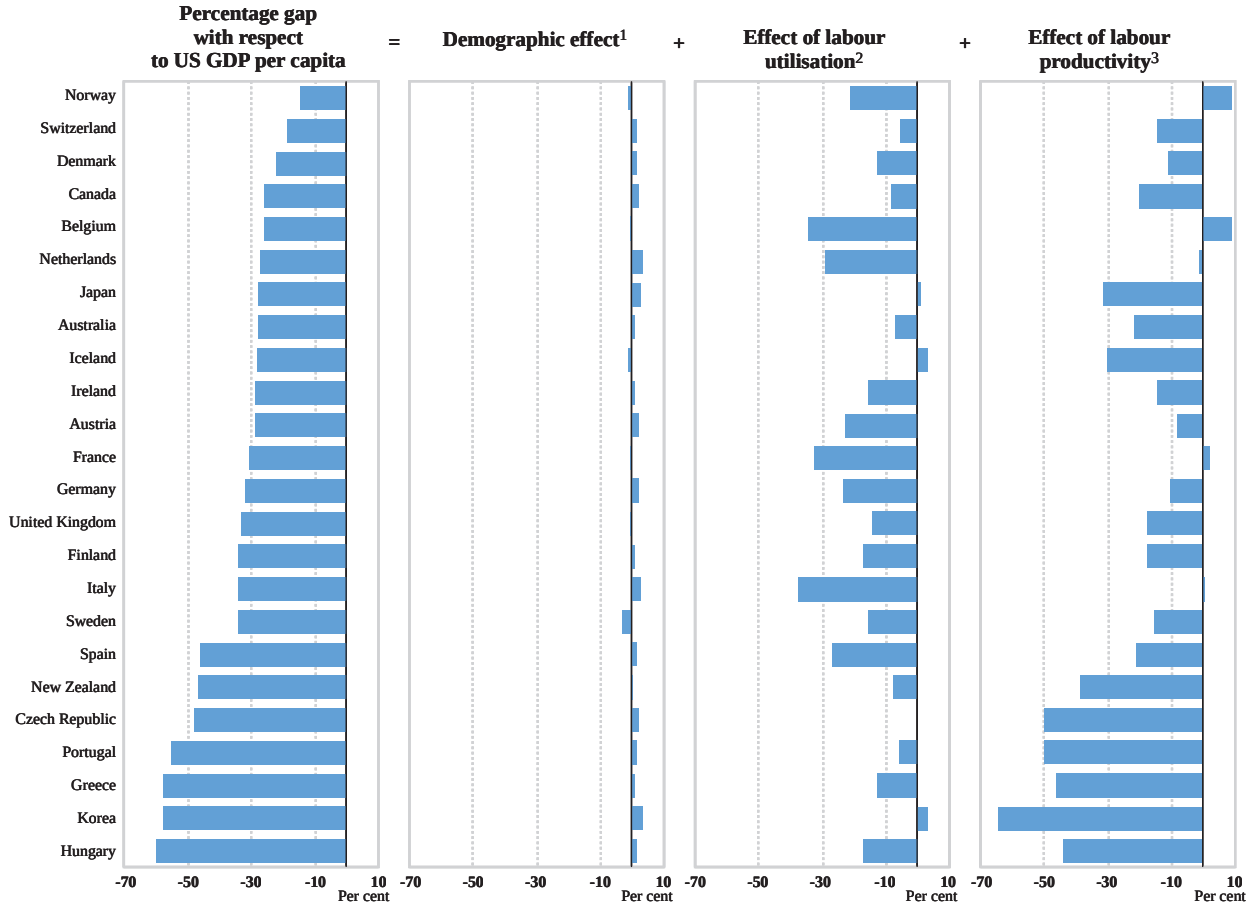
	Actual growth of GDP				Trend growth of GDP		Trend growth of GDP per capita	
	1970-80	1980-90	1990-98	1999	1980-90	1990-98	1980-90	1990-98
United States	3.2	3.2	3.0	4.2	2.9	3.1	2.0	2.2
Japan	4.4	4.0	1.4	0.3	3.8	1.9	3.3	1.6
European Union[a]	3.0	2.4	1.7	2.3	2.3	1.8	2.0	1.5
OECD total [a, b]	3.4	3.0	2.3	2.7	2.8	2.4	2.1	1.8

a) Growth rate for EU15 and OECD total is computed as a weighted average of country growth rates, using country GDP levels expressed in 1993 EKS PPPs as weights.
b) Excluding Czech Republic, Hungary, Korea and Poland.
Source: OECD.

4. Denmark also figures in the Appendix Table with an acceleration in trend GDP growth. However, the data used in this chapter do not include the latest (May 2000) revisions of the Danish National Accounts. These revisions suggest a somewhat slower GDP growth rate in the 1990s.
5. Strictly speaking, per-capita GNP growth would be an even better measure, but in practice there is little difference between the two concepts in trend growth rates terms. There are, however, a few exceptions, including Switzerland and Ireland: for the former actual annual growth rate of GNP was 0.2 percentage point higher than the GDP growth rate (0.5 per cent); for Ireland, it was 0.6 percentage point lower than the GDP annual growth rate (6.1 per cent).

Figure V.1. **Differentials in GDP per capita and their determinants, 1998**

Percentage point differences in PPP-based GDP per capita with respect to the United States



1. Based on the ratio of working age population (15-64 years) to total population.
2. Based on employment rates and average hours worked.
3. GDP per hour worked.

Source: OECD.

of the OECD, including all the other major economies, lag behind per capita GDP in the United States by 25-35 percentage points.

… and convergence in income per capita has generally come to a halt

In the 1950s and 1960s many OECD countries grew rapidly towards the much higher US income levels, partly through imported US technologies and knowledge but also, in some cases, as a result of post-war reconstruction. The process of convergence slowed in the 1970s and 1980s and, considering both levels and growth rates, there are now only a few countries (*e.g.* Ireland, Korea) that seem still engaged in a process of catching-up. Strong US growth in the 1990s meant that the gap between its per-capita income levels and those of most other OECD countries started to widen again over the decade.

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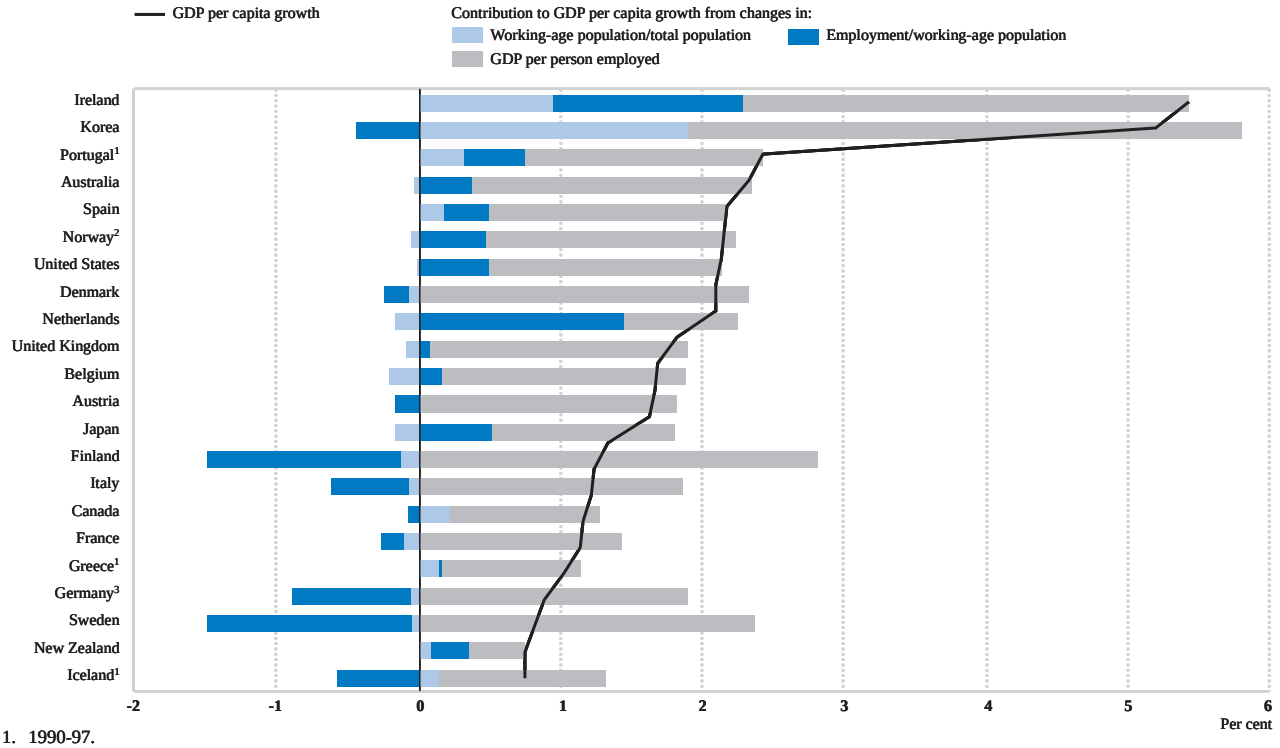
Decomposition of growth in GDP per capita: demographics, labour productivity and labour utilisation

Decomposition of growth in GDP per capita shows that…

A useful way of viewing growth in GDP per capita is to break it down into three major components, comprising growth rates of: *i)* the ratio of persons of working age (15-64 years) to the total population; *ii)* the ratio of employed persons to the working-age population (the "employment rate"); and *iii)* labour productivity (Figure V.2).

Figure V.2. **Trend growth in GDP per capita and its components, 1990-98**

Average annual percentage change



1. 1990-97.
2. Mainland only.
3. 1991-98.

Source: OECD.

… demographic changes play only a small role in growth of GDP per capita

For the vast majority of OECD countries, demographic trends were a relatively minor component of growth in GDP per capita over the 1990s. The only countries where demographic change made a positive and significant contribution to growth in GDP per capita were Korea and Ireland, the latter having experienced a reversal in traditional migration flows in the 1990s (OECD, 1999*c*). However, in some OECD countries, demographic trends have begun (in this accounting sense) to act as a slight drag on growth in GDP per capita. This tendency is set to strengthen in the future due to a more rapid increase in the share of older persons in total population (OECD, 1998).

By comparison, labour productivity plays a major role…

Rising labour productivity, defined as GDP per person employed, accounted for at least half of GDP per capita growth in most OECD countries over the 1990s. Compared with the previous decade, it picked up in a number of countries, including the United States, Australia, Norway, Portugal – where it was associated with stable or rising employment rates – and in Germany, Finland, Sweden – where it was associated with declines in employment rates (see Appendix, Table V.5).

Since hours worked fell in most countries over the 1990s, especially in Continental Europe, labour productivity growth was higher on a hourly basis than when measured on a head-count basis. Declines in hours worked reflect both shorter statutory (or collectively agreed) working weeks as well as, especially in a number of European countries, a substantial increase in part-time work. Strong growth in part-time work has generally been associated with growing female labour-force participation (OECD, 1999*b*).

... together with changes in employment rates

The 1990s witnessed striking differences in the evolution of employment rates: amongst the major economies, increases in the United States and Japan contrast sharply with declines in Germany, France and Italy. Even stronger contrasts are found amongst some smaller countries; strong upward trends in employment rates in Ireland and the Netherlands compare with declines in Finland and Sweden.

This decomposition is also reflected in comparisons of GDP per capita levels across countries

Labour utilisation is also an important factor in accounting for differences in the *level* of GDP per capita across countries. This is illustrated in Figure V.1 above, which suggests large disparities in labour utilisation (employment rates combined with hours worked), whereas differences in the age composition of the population play a very minor role. A number of countries (*e.g.* the United States, Japan) have high employment rates and higher than average hours worked, while most of the Nordic countries have even higher employment rates, but this is offset by lower hours worked. By contrast, low employment rates in some countries (*e.g.* Germany, France, Italy, Austria, Belgium and Spain), combined with relatively low hours explain more than 20 percentage points of the gap between their per-capita income and that of the United States.

The contributions of labour productivity and labour utilisation to GDP per capita are inter-related: non-employed people of working age generally have lower education levels – and thus potential productivity – than those in employment. Convergence towards the US level of labour utilisation might therefore be associated with a drop in relative productivity in countries with low labour utilisation. Nevertheless, even if labour productivity at the margin is only half the average productivity level, rising labour utilisation in these countries would still substantially raise GDP per capita.

The role of skills and labour utilisation in labour productivity growth

Growth in labour productivity can partly be explained by the up-skilling of employment…

Growth in GDP per person employed is partly attributable to increases in the average level of skills, or "human capital", of those in employment. This is illustrated in Figure V.3, which identifies the impact of changes in the average human capital of workers on growth in trend GDP per hour worked. The human-capital adjustment is based on a measure of labour input which sums groups of workers with different levels of formal education, each weighted by their relative wage. The rationale behind this measure is first that education attainment accounts for a good proportion of human capital embodied in workers; and second, that relative wages

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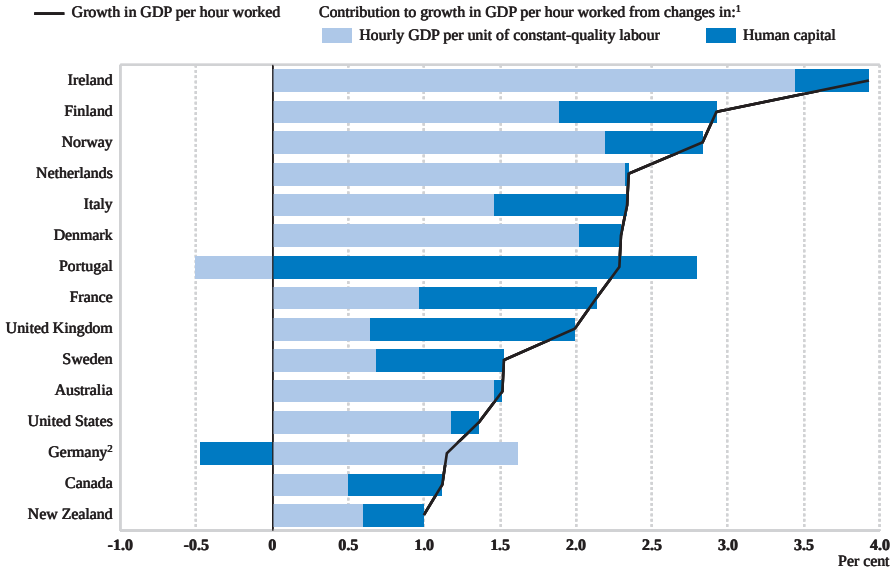
Figure V.3. **Effects of human capital on growth of hourly labour productivity, 1985-96**

Average annual percentage change



1. This is based on a simple quantitative decomposition: growth in GDP per hour worked = (labour productivity adjusted for hours and human capital) + (growth in human capital). Changes in human capital are proxied by changes in the education composition of employment, see main text.
2. Before 1991, data refers to Western Germany.

Source: OECD.

between different levels of education provide a reasonable quantitative proxy for the relative productivity of workers with different levels of education.[6] Given the secular increase in educational attainment in OECD countries, it is not surprising that for most countries human capital made a positive contribution to growth in GDP per person employed;[7] and as a corollary, "quality" adjusted growth rates in productivity are typically lower than those based on standard calculations. In terms of magnitude, the data suggest that rising levels of human capital provided a significant contribution to trend growth of GDP per hours worked, although not as large as the contribution from productivity growth within each education group of the workforce (*i.e.* growth in hourly GDP per constant-quality labour).

6. Data availability constrains the country coverage and the time period (1985-96). The calculation is made separately for men and women to account for the markedly different wage patterns between the sexes. In principle, other factors that potentially determine human capital could be taken into account in the measure, such as years of work experience; however, a lack of comparable data across countries prevented a more refined measure in this instance. It should be stressed that the assumption that wages reflect relative labour productivities is commonly made but, strictly speaking, only holds where firms operate under constant returns to scale in competitive input and product markets, and maximise their profits by equating compensation with each worker's contribution to output. The Bureau of Labor Statistics (BLS, 1993) discusses how deviations from these conditions affect the relationship between the contribution to output and compensation.
7. The result for Germany reflects the discrete fall in the average education level of the workforce because of the unification with the Eastern Länder.

… but in some countries this partially reflects the exclusion of the low skilled from employment…

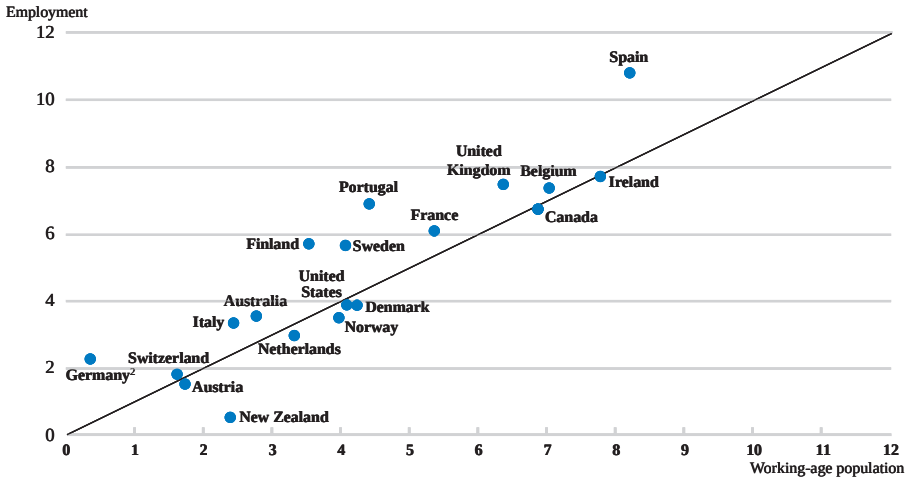
Skill upgrading amongst workers is particularly marked in Europe, where it has been accompanied by sluggish employment growth, productivity gains having been achieved in part by dismissing or not employing workers with low skills.[8] By contrast in the United States, Australia, Denmark and the Netherlands, skill upgrading has played a relatively modest role in GDP growth per employed person. Improving labour-market conditions have widened the employment base in these countries, especially in the 1990s, allowing low-skilled workers to get a foothold into employment.

… as shown by the higher degree of up-skilling in employment with respect to the total working-age population

In order to shed further light on this, Figure V.4 plots changes in the share of persons with upper-secondary education or above in employment against changes in their share in the total working-age population. While up-skilling among the employed is largely associated with a generalised improvement in the educational level of the working age population, there has been a general tendency for employment changes to be biased towards the better educated (most countries are located above the diagonal in Figure V.4). However, this is not a generalised phenomenon: countries which maintained favourable labour-market conditions or experienced significant improvements have had a more balanced relative employment performance (they tend to be located at or below the diagonal in Figure V.4).

Figure V.4. **Human capital growth in total working-age population and in employment, 1989-96**

Percentage point change of the share of individuals with higher educational levels[1] in total



1. Higher education levels refer to ISCED codes 5, 6 and 7.
2. 1991-96.

Source: Calculations based on data from OECD, *Education at a Glance*, various issues.

8. From the discussion in the previous paragraph, skill upgrading should be interpreted as a shift in the composition of the workforce towards better educated workers, and not as an improvement of individual workers' human capital.

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The role of sectoral shifts in aggregate labour productivity growth

Sectoral shifts play a minor role in explaining labour productivity trends in individual countries…

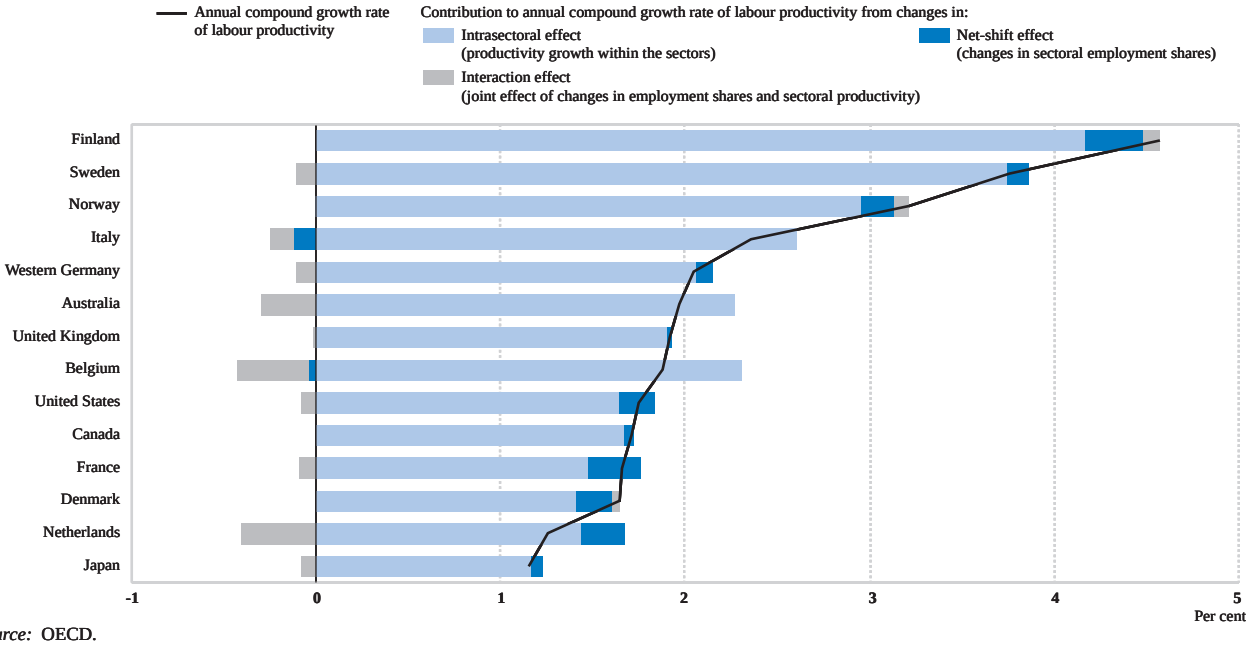
In the past, shifts in employment from less to more productive sectors were often a significant factor in explaining long-run growth trends and cross-country differences in labour productivity. However, evidence for the 1990s suggests that the most important contribution to overall productivity growth patterns came from productivity changes within industries, rather than as a result of significant shifts of employment across industries. This is illustrated in Figure V.5, which shows a decomposition of labour productivity growth into a within-industry effect, a between-industry effect and an interaction effect.[9] The within-industry labour productivity growth accounted for most of the overall productivity growth over the 1990s, although the rather broad industries used in the decomposition may have some bearing on the result.[10]

… although the small size of service sectors in some of them suggests that there is scope for further structural change

The evidence that productivity growth is largely a matter of improved performance within industries is perhaps not surprising for the countries examined in Figure V.5, where shares of services sectors in overall value added have stabilised at around 70 per cent. However, other OECD economies, including Ireland as well as some low-income countries, have much smaller service sectors, suggesting that there may be further scope for structural change at this broad level. In addition, there is

Figure V.5. **Breakdown of compound growth rate of labour productivity into intra and inter sectoral effects, 1990-97**

Non-farm business sector



Source: OECD.

9. A negative contribution from the interaction effect occurs when industries with growing relative productivity decline in size or when industries with falling productivity grow in size. The data are from the OECD ISDB-STAN database (2-digit ISIC for services and a 3-4 digit ISIC for manufacturing).
10. The evidence of a strong within-industry contribution is, however, confirmed by firm-level studies. For a recent summary of firm-level data on productivity see Bartelsman and Doms (2000).

likely to be scope for further structural change and improved resource allocation across the industries considered in Figure V.5. This is particularly the case for those service sectors that cover a broad range of activities (*e.g.* business services).

The role of information and communication technology

ICT has the potential to affect output and productivity growth

Much of the current discussion about growth focuses on the role of information and communication technology (ICT). There are three main channels through which ICT can affect potential growth rates: *i)* an acceleration of productivity in the ICT-producing sectors themselves, and a growing size of ICT-producing sectors in the economy; *ii)* capital deepening across the economy, driven by rapid investment in ICT equipment, and resulting in a boost to labour productivity; and *iii)* widespread spillover effects on productivity arising from the IC technology. This section focuses on the first two contributions of ICT, while the third is discussed in the next section in the broader context of the analysis of multi-factor productivity trends.

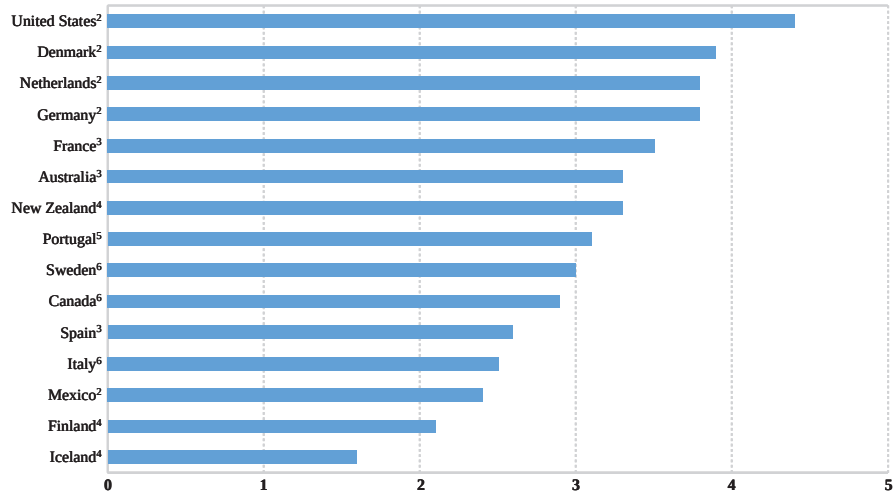
The ICT-producing sector

The ICT-producing sector is still relatively small…

The contribution made by output of the ICT sector itself to aggregate output is still small in most OECD countries (Figure V.6). Internationally-comparable data compiled by the OECD on value added originating in the three principal segments of

Figure V.6. **Share of value added of ICT industries[1] in total GDP, mid-1990s**

Per cent of GDP



1. Defined as ISIC Rev.2 classes 3825 (Office and computing equipment), 3832 (Radio, TV and communication equipment) and 72 (Communication services).
2. 1996.
3. 1997.
4. 1995.
5. 1993.
6. 1994.

Source: OECD (2000), *OECD Information Technology Outlook*, Paris.

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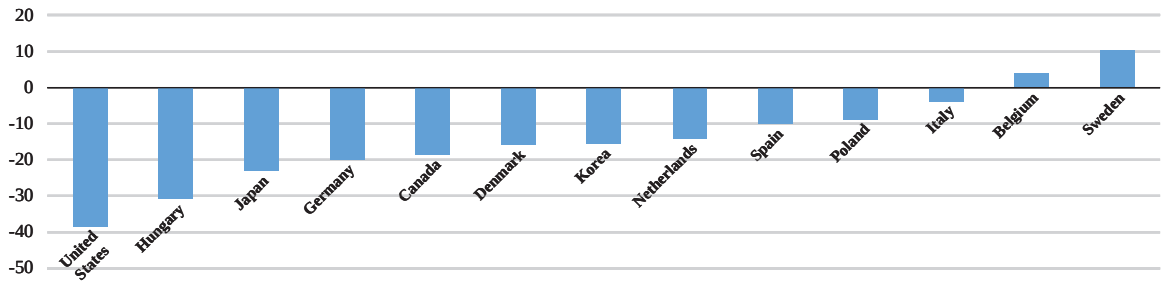
Box V.1. Computer production and spending: accounting for price and volume developments

The rapid pace of technological advance in the computer industry complicates the statistician's task of how to divide nominal changes into volume and price developments. The ability of a "standard" personal computer to process, store and send information has risen dramatically in the past 10-15 years. Over the 1990s the standard microprocessor speed has increased 16-fold, and both the standard storage capacity and the transmission speed have risen more than 200 times. With all these quality changes in the basic personal computer, it is difficult to equate one unit today with one unit a decade ago or with an even more distant relative. There had been striking developments also in the price/quality characteristics of telecommunications equipment.

Different methods are applied to measure price and quantity developments in computer production and spending (see also Schreyer, 2000). They range from no effort to adjust for quality changes, over judgmental approaches to more complete quality adjustments with "hedonic" and similar methods. When no adjustment is made, the price index computed from the price per computer unit, and the quantity index is based on the number of units produced or sold. The "hedonic" method unbundles the market price of the computer into its most important technical characteristics, and prices each characteristic separately, using a regression analysis approach. The "hedonic" price index is the average price of all the characteristics, and the quantity index is based on nominal values deflated by this price index. The large discrepancies in producer price developments in the office, accounting and computing equipment sectors across countries are likely to reflect to a large extent different methodologies. Thus, the sharp measured drop in prices of such goods in the United States reflects the use of "hedonic" methods. By contrast, the modest fall or even increases in producer prices of office, accounting and computing equipment in many European countries may be due to the predominant "conventional" methods in deriving price indices. This suggests that quantities produced, and productivity trends, in the office, accounting and computing equipment sector are under-estimated in these countries. If computer prices are upward biased, a downward bias enters volume measures, such as real investment or consumption. The extent to which overall GDP measures are affected depends on the importance of a country's ICT industry, and on its propensity to import ICT equipment.

Producer prices of office, accounting and computing equipment

1999, 3rd quarter, as a percentage change from 1995 average



Note: With the exception of the United States, the data come from OECD, *Indicators of Industrial Activity.* Data for the United States are weighted averages of producer prices for electronic computers, and office and store machines and equipment.
Sources: OECD, *Indicators of Industrial Activity*; US Department of Labor.

the ICT sector (but excluding software) show that it did not reach 5 per cent of GDP in the mid-1990s in any of the countries for which data are available. Higher contributions in some countries have been obtained using more comprehensive data (including *inter alia* software): for example, more than 7 per cent of GDP in the United States and Japan is estimated to have originated in the broadly-defined ICT sector. However, in most continental European countries, the ICT sector remains small even on an extended definition.

… though it has made a marked contribution to labour productivity growth in the United States

The ICT-producing industry experienced a major surge in productivity in the United States, especially in the latter part of the 1990s. Notwithstanding the small share of ICT in total value added, this within-sector acceleration is estimated to have raised labour productivity growth in the US business sector as a whole by 0.2 to 0.3 percentage point in the 1995-99 period.[11] Furthermore, there is some preliminary evidence of accelerating productivity in the ICT-producing sector in other countries. In assessing this evidence, it should be stressed that some countries may be underestimating quality improvements in ICT goods (see Box V.1). Bearing this in mind, industrial statistics confirm that labour productivity in the two sectors most heavily engaged in the production of ICT equipment (office, accounting and computing equipment; and radio, television and communications) typically rose significantly faster than in the manufacturing sector at large, especially in the latter part of the 1990s (Table V.2).

Table V.2. **Labour productivity in manufacturing and two ICT sectors in third quarter 1999**

1995 = 100

	Office, accounting and computing equipment	Radio, television and communications equipment	Manufacturing
United States	460	172	125
Japan	..	112	104
Germany	186	129	117
France	..	128	115
United Kingdom	160	..	103
Canada	97	141	105
Austria	116	134	130
Denmark	99	151	109
Finland	127	193	119
Korea	454	322	150
Mexico	117	144	119
Portugal	..	195	122

Source: OECD (1999), *Indicators of Industrial Activity*, No. 4.

ICT investment and capital deepening

Falling ICT prices induce substitution into ICT investment and capital deepening

The second channel through which ICT affects output and labour productivity is through capital deepening. Technological progress has manifested itself, in part, through falling prices of ICT equipment (especially when adjusted for quality). When appropriate adjustment is made for quality improvements, annual declines in prices of IT equipment have typically exceeded 10 per cent. The falling prices have not only induced substitutions from other assets to ICT equipment, but also increased the overall level of investment, *i.e*. generating capital deepening.

ICT makes up a rapidly increasing share of investment

ICT has certainly had an impact on investment patterns across OECD countries. In the major seven countries, the share of IT capital goods in total investment expenditure rose steadily over the 1990s, and accounted for up to 13 per cent of total non-residential gross fixed capital formation by 1996, the latest year for which internationally comparable figures are available (Table V.3). The share of communication equipment also rose, though less rapidly, and accounted for around 5 per cent of total

11. See Gordon (1999); Oliner and Sichel (2000); Council of Economic Advisors (2000).

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Table V.3. **The evolution of investment in ICT, G7 countries**

	Canada	France	Western Germany	Italy	Japan	United Kingdom	United States
Share in non-residential Gross Fixed Capital Formation:							
IT equipment							
1985	6.9	6.1	3.4	3.4	3.4	5.2	6.3
1990	7.3	5.0	3.5	4.1	3.8	7.5	8.7
1996	10.1	6.0	6.1	4.2	4.6	11.7	13.4
Communication equipment							
1985	4.2	4.0	3.7	2.4	0.8	5.2	5.8
1990	5.3	3.8	3.7	3.6	1.5	5.8	7.0
1996	6.1	4.9	4.8	5.4	3.5	6.6	6.5
Average annual rate of growth of constant price expenditure on:							
IT equipment							
1985-90	17.2	16.2	18.8	20.8	23.6	25.5	19.6
1990-96	17.6	11.0	18.6	12.9	14.5	17.6	23.8
Communication equipment							
1985-90	20.6	19.0	18.4	25.6	34.7	20.3	16.7
1990-96	4.3	2.1	3.4	9.2	15.0	2.2	5.1
Price deflator:[a]							
IT equipment							
1985-90	–9.4	–10.2	–10.3	–8.1	–12.0	–6.7	–10.4
1990-96	–11.1	–9.2	–10.7	–9.1	–12.5	–9.1	–11.5
Communication equipment							
1985-90	1.3	0.5	0.4	2.7	–1.3	4.0	0.3
1990-96	–0.7	1.2	–0.4	1.3	–2.2	1.2	–1.1

a) Figures refer to "harmonised" deflator indices based on the assumption that the differences between price changes for ICT capital goods and non-ICT capital goods are the same across countries.
Source: Schreyer (2000).

non-residential investment. Moreover, volumes of IT capital investment rose at annual rates ranging from 11 per cent in France to 24 per cent in the United States in the 1990-96 period. Recent evidence for the United States points to an acceleration in IT investment to a growth rate of about 38 per cent annually in the 1996-99 period.

This has resulted in a higher, though still small, contribution of ICT capital to output growth…

Strong investment in ICT has made a rising contribution to overall output growth. During the 1980s, ICT capital (hardware) accounted for only about 0.1-0.2 percentage point per year of business-sector output growth (Figure V.7).[12] The growth contribution from ICT was still relatively small since the already high rate of growth of ICT capital applied to a small base. In the first half of the 1990s, the contribution of ICT capital to output growth increased in most countries, and particularly so in the United States where it reached 0.4 percentage point per year, and accounted for about 14 per cent of total output growth.

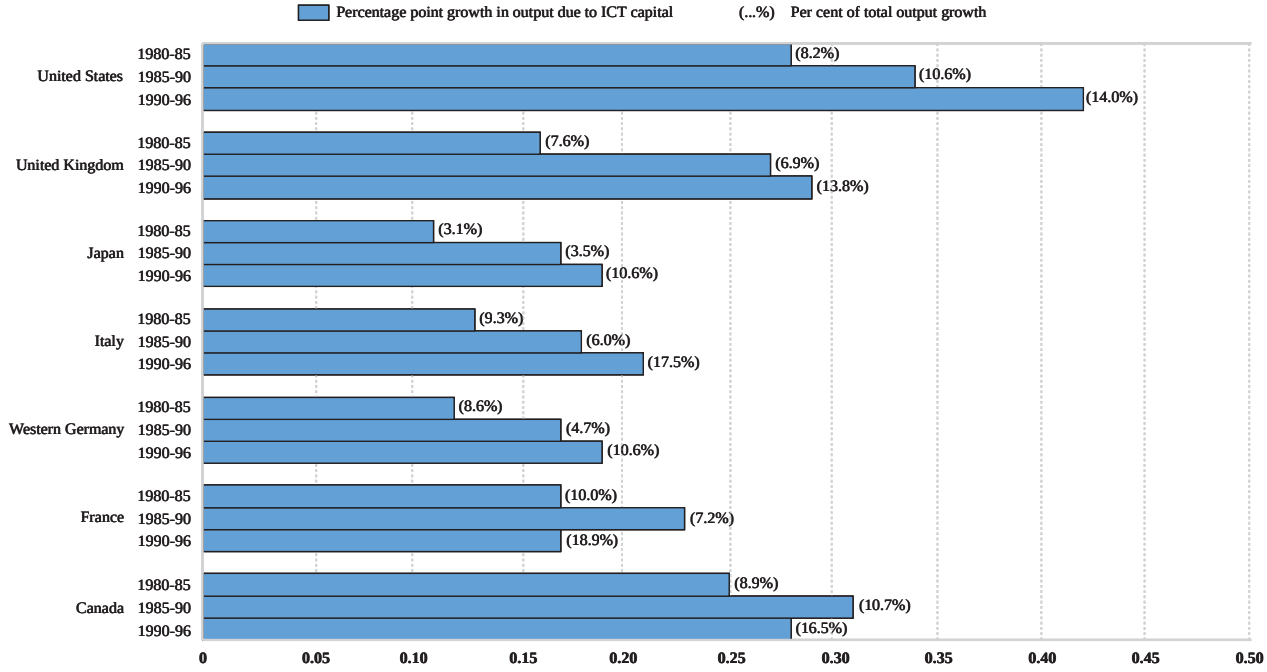
… which , however, has further increased in the most recent years, at least in the United States

More recent evidence for the United States (Oliner and Sichel, 2000) suggests that the contribution of ICT to output growth surged in the second half of the 1990s due to a strong acceleration in the rate of growth of ICT capital: in particular, the growth rate of hardware and communication equipment doubled in the 1996-99 period as compared to the first half of the decade. The overall contribution of ICT capital (including software) to output growth was about 1.1 percentage point, almost double that recorded in the early 1990s.

12. The output share of the ICT sector across the G7 countries averaged only 1 to 3 per cent.

Figure V.7. **The contribution of ICT capital to output growth**

Total industries, based on harmonised ICT price index



Source: Schreyer (2000).

Multi-factor productivity growth

Measures of multi-factor productivity highlight different elements of technological progress

In addition to the effects that ICT has on output and labour productivity *via* the production and use of capital goods, ICT equipment can generate spillover or "network" effects in the economy. For example, the economic benefits of improved business-to-business communication through the Internet do not all arise directly from quality improvements in the stock of individual computers but also from different – and cheaper – ways of organising production and sales (*i.e.* some gains are "disembodied"). These network effects and other disembodied aspects of technological change can, in theory, be detected in estimates of multi-factor productivity (MFP) growth. This concept represents the residual output growth once the direct contribution of changes in the quantity and quality of capital and labour are accounted for. In practice, however, such a clear definition of multi-factor productivity is difficult to apply for at least two reasons: *i)* quality and compositional changes in the capital stock are not fully grasped by the asset decomposition used in this chapter and are captured by the productivity residual; and *ii)* for countries outside the G-7, available data do not allow the assessment of the direct or indirect effects of ICT (nor other compositional/quality changes in capital) but, again, these are captured by the productivity residual.

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Table V.4. **Estimates of Multi-Factor Productivity growth rates in the G7 countries, 1980-98**

Average annual growth rates
(based on trend series time-varying factor shares)

		1980-90	1990[a]-98[b]	1995-98[b]	1990[a]-96
United States	MFP growth	0.8	1.0	1.0	1.0
	with control for human capital	0.8	0.8	1.0	0.9
	... and composition/quality of physical capital	0.6	..	..	0.8
Japan	MFP growth	2.0	1.6	1.6	1.5
	with control for human capital	..	..	..	..
	... and composition/quality of physical capital	..	..	..	..
Germany[c]	MFP growth	1.6	1.4	1.5	1.4
	with control for human capital	1.6	1.9	1.3	2.0
	... and composition/quality of physical capital	1.5	..	..	..
France	MFP growth	2.1	1.1	1.1	1.1
	with control for human capital	1.9	0.7	1.0	0.5
	... and composition/quality of physical capital	1.5	..	..	0.4
Italy	MFP growth	1.5	1.2	1.0	1.2
	with control for human capital	1.4	0.6	0.7	0.5
	... and composition/quality of physical capital	1.3	..	..	0.4
United Kingdom	MFP growth	..	1.3	1.4	1.3
	with control for human capital	..	0.5	1.2	0.5
	... and composition/quality of physical capital	..	..	..	0.3
Canada	MFP growth	0.4	0.8	0.8	0.8
	with control for human capital	0.4	0.8	0.8	0.8
	... and composition/quality of physical capital	0.2	..	..	0.4

Note: For each country, the first line shows estimated MFP growth rate without control for composition/quality changes in labour and capital; the second controls for changes in the composition of labour; while the third also controls for composition/quality changes in physical capital.
a) 1991 for Germany.
b) 1997 for Italy and United States, 1996 for United Kingdom.
c) Western Germany before 1991.
Source: OECD.

Following these arguments, Table V.4 presents different measures of multi-factor productivity growth in the business sector of the major seven countries over the past two decades. The first measure is computed as the residual after allowing for aggregate hours worked and gross capital stock as inputs (*i.e.* not adjusted for changes in the quality of labour and capital inputs). This is the broadest measure of productivity growth that incorporates the effects of progress in human capital as well as embodied (in physical capital) and disembodied technological progress.[13] The second measure corrects for the general rise in education levels by using a quality-adjusted measure of labour input. Finally, the third measure of the residual also takes into account changes in the "quality" and composition of the capital stock input (obtained aggregating over six types of assets). This measure can be considered as a proxy for the truly disembodied technological progress, although the decomposition of capital assets is still very limited and thus does not capture shifts occurring at a finer level of disaggregation.[14] For the smaller countries, only the first two measures of MFP could be calculated (see Appendix, Table V.6).

13. For countries that use hedonic (or similar) price indices for certain investment goods (*e.g.* ICT), this measure of MFP growth rate does not incorporate technological progress embodied in them (as the capital stock is augmented by the improvements in quality of ICT goods). Bassanini *et al.* (2000) try to identify this component of broad MFP growth by considering the differences in growth rates of hedonic and non-hedonic price indexes of ICT. For the United States, the additional (embodied) part of MFP growth would be about 0.2 percentage point in the 1980-90 period and about 0.3 percentage point in the 1990-96 period.

MFP growth varied significantly across the major seven countries

Comparisons of the different MFP estimates in Table V.4 indicate significant variation among the major seven countries. The United States and Canada recorded a recovery in MFP growth that reversed a longstanding downward trend.[15] Conversely, all measures of MFP growth rates decreased significantly in France and Italy. The correction for changes in the composition of labour and capital inputs tends to reduce measured MFP insofar as part of the productivity growth is assigned to improvements in the quality of factors used in the production process (*i.e.* embodied in inputs).

Only in a few smaller countries did MFP growth unambiguously and significantly increase in the 1990s compared with the previous decade. Thus, Australia, Denmark, Finland, New Zealand, Norway and Sweden all experienced increases in average growth rates of MFP of at least 0.5 percentage point (in most cases from relatively low rates in the 1980s).

Recent evidence for the United States suggests a significant pick-up in productivity, driven by the ICT industry and by greater utilisation of ICT equipment in other sectors…

It should be stressed that trend series as estimated in this chapter could underestimate the potential pick-up in output and productivity that might have occurred in the most recent years. According to a very recent study (Jorgenson and Stiroh, 2000), the acceleration of MFP in the ICT industry in the second half of the 1990s was sufficiently strong to positively affect the economy-wide MFP growth rate in the United States. Two additional studies (Whelan, 2000; Oliner and Sichel, 2000) also relate the growing utilisation of computer hardware and software to faster aggregate MFP growth in the United States. Their estimates suggest an almost doubling in labour productivity growth in the 1996-99 period as compared with the first part of the decade: the use of information technology and the production of computers accounted for about two-thirds of this acceleration.

… although measurement of output in sectors using ICT equipment remains problematic…

Available data do not allow a clear identification of spillover effects (*i.e.* a boost to disembodied technological progress) in ICT-using sectors, partly reflecting measurement difficulties. In particular, there are serious problems associated with the recording of output in some of the industries using ICT most intensively. For example, measurement of the output of banks and financial institutions, which are heavy users of information technology, is generally regarded as poor, and any productivity-raising effects of computers in these sectors could go largely unrecorded in national accounts.

… and the "network" effects (due to the spread of e.g. Internet, e-commerce) may only start to materialise now

In addition, it is difficult to assess the impact of innovative ICT-based businesses and markets, most of which are at an early stage of development. For example, any productivity gains from business reorganisation to take advantage of Internet and other networks are likely to become clearly visible only after a certain threshold in network use has been passed. However, there is anecdotal evidence that Internet – which became available for business only in the mid-1990s – is now producing significant changes in several parts of the economy, especially in business-to-business transactions. Businesses are taking greater advantage of better real-time information systems, rationalising costly precautionary inventory stocks and the distribution of

14. A number of assumptions were also made in computing capital stocks by six different assets; in deriving user costs expressions; and in aggregating across assets. For example, particular effort was made to derive a set of internationally harmonised price indices (based on hedonic adjustments) for investment in the asset type "information and communication technology" (see Schreyer, 2000 for more details).
15. Germany also had somewhat higher MFP growth rates based on labour-quality-adjusted measures in the 1990s compared with the 1980s, although reversion to the mean can be observed in the most recent years. It should be stressed, however, that quality adjusted measures for Germany are somewhat less reliable because reunification implied a slump in input quality at the beginning of the 1990s that was subsequently recovered, without changes of equal magnitude on output.

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their products. Businesses have also started to reduce costs by integrating their suppliers more closely in the design and manufacturing of products, while also using the web to outsource tasks previously carried out internally. With greater information exchange between customers and producers, companies are likely to reduce labour hoarding required to meet unanticipated increases in product demand. As regards business-to-consumer transactions, electronic commerce is still in its infancy and unlikely to have had much effect on aggregate productivity to date, but fast expansion in the future could have major effects on distribution efficiency and work to strengthen competition, with beneficial effects on productivity as well as on consumer choices (see Chapter VI of this Outlook).

Concluding remarks

There were wide disparities in growth rates across the OECD countries in the 1990s…

This chapter provides evidence of wide disparities in growth performance across the OECD countries in the 1990s, even after abstracting from cyclical influences. These disparities are driven by persistently higher than average trend growth rates in some catch-up countries (*e.g.* Korea and Ireland) but also by high growth rates in some relatively affluent countries, such as the United States, Australia, the Netherlands, and Norway and low growth rates in much of Continental Europe as well as Japan. Disparities in trend GDP growth have widened in the 1990s as compared with the 1980s, largely because of growing differences in labour utilisation.

… which could have been partially driven by the spread of ICT in some countries

In the particular case of the United States, faster growth of output and labour productivity in the 1990s was associated with significant technological change, as estimated by faster growth rates of multi-factor productivity – especially in the most recent years. Evidence is accumulating that most of the productivity acceleration results from the spread of information and communication technology. Steeply rising productivity in the ICT-producing industry itself made a significant contribution to the speed-up of labour and multi-factor productivity at the macro level in the 1990s. Moreover, ICT capital deepening in other industries made a contribution to aggregate output and productivity growth, rising in the most recent years. In addition, some scattered evidence suggests a rapid growth in "network" aspects of ICT in the United States *via* the penetration of Internet and e-commerce, although its impact on MFP growth is yet to be unequivocably demonstrated and is complicated by measurement problems. Some of these trends are likely to continue and could signal a move towards relatively higher potential growth rates for some time to come.

There is also evidence of a speed-up in ICT investment and a growing role of the ICT-producing industry in other OECD countries, though generally starting from a lower level than in the United States. Likewise, ICT-related networks have spread in most countries, rendering possible substantial changes in the way businesses operate and potentially creating new opportunities for growth.

… but also by the capacity of others to mobilise labour and capital inputs, which ultimately depend on product and labour market reforms

Differing speeds of adjustment to new technologies provide only part of the picture in explaining growth performance across OECD countries. Macroeconomic conditions have some importance; countries with higher growth trends over the past decade also experienced buoyant cyclical conditions, low inflation and improving public finances. Microeconomic "framework" conditions also play an important role: a significant increase in MFP growth has occurred in most countries with a record of

structural reforms and a higher employment content of growth than in the past. Structural changes seem to have permitted higher utilisation of labour as well as a more productive use of factor inputs (or greater factor productivity if quality changes in factor inputs are taken into account).

The development of ICT also indicates specific areas for policy action. Thus, exploiting IC technologies to their full is likely to call for identifying new business opportunities, starting new enterprises, changing the organisation of existing ones, etc. This suggests that framework conditions that allow a flexible reallocation of resources within economies may become even more important than in the past.

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APPENDIX

Table V.5. Growth performance in OECD countries

Average annual rates of change

	Actual growth of GDP				Actual growth of GDP per capita				Trend growth of GDP per capita		Trend growth of GDP per person employed	
	1970-80	1980-90	1990[a]-98	1999	1970-80	1980-90	1990[a]-98	1999	1980-90	1990-98	1980-90	1990-98
United States	3.2	3.2	3.0	4.2	2.1	2.3	2.0	3.2	2.0	2.2	1.1	1.7
Japan	4.4	4.0	1.4	0.3	3.3	3.4	1.1	0.1	3.3	1.6	2.6	1.3
Germany	2.7	2.2	1.4	1.5	2.6	2.0	1.0	1.4	1.9	0.9	1.6	1.9
France	3.3	2.4	1.4	2.9	2.7	1.8	0.9	2.5	1.6	1.2	1.9	1.4
Italy	3.6	2.2	1.3	1.4	3.1	2.2	1.2	1.3	2.3	1.3	2.2	1.9
United Kingdom	1.9	2.7	2.0	2.1	1.8	2.5	1.7	1.7	2.2	1.8	1.9	1.8
Canada	4.3	2.8	2.2	4.2	2.8	1.6	1.1	3.4	1.5	1.2	1.0	1.1
Australia	3.3	3.3	3.5	4.4	1.9	1.7	2.3	3.1	1.6	2.4	1.2	2.0
Austria	3.7	2.3	1.9	2.2	3.5	2.1	1.3	2.1	2.1	1.7	2.0	1.8
Belgium	3.4	2.0	1.8	2.5	3.2	1.9	1.5	2.3	1.9	1.7	1.8	1.7
Czech Republic	..	..	0.4	-0.2	..	..	0.4	-0.1	..	..	..	..
Denmark	2.2	1.9	2.3	1.6	1.8	1.9	1.9	1.2	2.0	2.1	1.5	2.4
Finland	3.4	3.1	1.5	3.5	3.1	2.6	1.0	3.2	2.2	1.3	2.4	2.9
Greece	4.7	1.6	2.0	3.2	3.7	1.1	1.4	2.9	1.3	1.3	0.9	1.0
Hungary	..	..	-0.2	4.5	..	..	0.1	4.9	..	..	..	..
Iceland	6.3	2.7	2.2	4.4	5.2	1.6	1.3	3.3	1.7	0.8	1.3	1.2
Ireland	4.7	3.6	6.3	8.7	3.3	3.3	5.5	7.4	3.0	5.6	3.5	3.2
Korea	7.6	8.9	5.2	10.7	5.8	7.6	4.1	9.7	7.2	5.3	5.6	4.0
Luxembourg	2.6	4.5	5.3	4.9	1.9	3.9	3.9	3.6	4.0	4.0	2.8	2.4
Mexico	6.6	1.8	3.0	3.7	3.4	0.0	1.3	1.4	0.3	1.2	..	-0.2
Netherlands	2.9	2.2	2.6	3.6	2.1	1.6	2.0	3.0	1.6	2.1	1.1	0.8
New Zealand	1.6	2.4	2.2	3.9	0.5	1.7	0.7	3.4	1.2	0.8	1.6	0.4
Norway[b]	4.2	1.5	3.1	0.8	3.6	1.1	2.6	0.2	1.4	2.2	2.1	2.5
Poland	..	..	3.5	4.0	..	..	3.4	4.0	..	..	..	..
Portugal	4.7	2.9	2.4	3.0	3.4	2.9	2.3	2.7	2.9	2.5	1.6	1.7
Spain	3.5	3.0	2.1	3.7	2.4	2.6	1.9	3.6	2.3	2.2	2.4	1.7
Sweden	1.9	2.1	1.1	3.8	1.6	1.8	0.6	3.7	1.5	0.9	1.6	2.4
Switzerland	1.9	2.1	0.5	1.7	1.7	1.5	-0.3	1.5	1.6	0.1	0.4	0.4
Turkey	4.1	5.2	4.2	-5.0	1.8	2.8	2.4	-6.6	2.0	2.3	2.8	2.6

Coefficients of variation of trend series[c]

	GDP		GDP per capita		GDP per person employed		GDP per hours worked	
	1980-90	1990-98	1980-90	1990-98	1980-90	1990-98	1980-90	1990-98
OECD[d]	0.47	0.54	0.56	0.66				
European Union	0.28	0.58	0.31	0.61	0.33	0.33	0.28	0.32
OECD 24[e]	0.28	0.51	0.32	0.61	0.40	0.41	0.35	0.40

a) 1991 for Czech Republic and Germany.
b) Mainland only.
c) Calculated as the ratio of the standardised deviation to the mean of trend growth rates across countries.
d) Excluding Czech Republic, Hungary and Poland.
e) Excluding Czech Republic, Hungary, Korea, Mexico and Poland.
Source: OECD.

Table V.6. **Estimates of Multi-Factor Productivity growth rates, smaller countries, 1980-98**

Average annual growth rates
(based on trend series time-varying factor shares)

		1980[a]-90	1990-98[b]
Australia	MFP growth	0.9	2.1
	with control for human capital	0.9	2.0
Belgium	MFP growth	1.4	1.0
	with control for human capital	..	..
Denmark	MFP growth	1.0	1.8
	with control for human capital	0.9	1.9
Finland	MFP growth	2.4	3.2
	with control for human capital	2.2	2.8
Greece	MFP growth	0.6	0.3
	with control for human capital	..	..
Ireland	MFP growth	3.9	3.9
	with control for human capital	3.8	3.6
Netherlands	MFP growth	2.2	1.7
	with control for human capital	2.2	1.7
New Zealand	MFP growth	0.7	1.1
	with control for human capital	0.6	1.2
Norway[c]	MFP growth	1.1	2.1
	with control for human capital	0.9	1.9
Portugal	MFP growth	1.9	2.2
	with control for human capital	1.9	..
Spain	MFP growth	2.2	0.6
	with control for human capital	..	..
Sweden	MFP growth	0.8	1.3
	with control for human capital	0.6	1.0
Switzerland	MFP growth	..	0.2
	with control for human capital	..	0.2

Note: For each country, the first line shows estimated MFP growth rate without control for composition/quality changes in labour and capital; the second does control for changes in the composition of labour.
a) 1984 for Denmark, 1986 for New Zealand and Portugal.
b) 1997 for Australia, Belgium, Norway and Spain; 1996 for Finland, Greece, Ireland, New Zealand and Sweden; 1995 for Switzerland; 1992 for Portugal.
c) Mainland only.
Source: OECD.

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REFERENCES

BARTELSMAN, E.J. and M. DOMS (2000),
"Understanding Productivity: Lessons from Longitudinal Microdata", *Journal of Economic Literature*, forthcoming.

BASSANINI, A., S. SCARPETTA and I. VISCO (2000),
"Knowledge, Technology and Growth: Recent Evidence from OECD Countries", *National Bank of Belgium, Working Papers Series*, May, forthcoming.

BUREAU OF LABOR STATISTICS (1993),
"Labor Composition and US Productivity Growth, 1948-90", *US Department of Labor, Bureau of Labor Statistics, Bulletin 2426*. December.

COUNCIL OF ECONOMIC ADVISERS (2000),
Economic Report of the President-2000, February.

GORDON, R.J. (1999)
"Has the 'New Economy' Rendered the Productivity Slowdown Obsolete?", Northwestern University, mimeo.

HODRICK, R.J. and E.C. PRESCOTT (1997),
"Post-War US Business Cycles: An Empirical Investigation", *Journal of Money, Credit and Banking*, Vol. 29, No. 1.

JORGENSON, D.W. and K.J. STIROH (2000),
"Raising the Speed Limit: US Economic Growth in the Information Age", May, mimeo.

OECD (1998),
Maintaining Prosperity in an Ageing Society, Paris

OECD (1999*a*),
Economic Outlook, December, Paris.

OECD (1999*b*),
The OECD Jobs Strategy: Assessing Performance and Policy, Paris.

OECD (1999*c*),
OECD Economic Surveys – Ireland, Paris.

OLINER, S.D. and D.E. SICHEL (2000),
"The Resurgence of Growth in the late 1990s: Are Computers the Story?", *Journal of Economic Perspectives*, forthcoming.

SCARPETTA, S., A. BASSANINI, D. PILAT and P. SCHREYER (2000),
"Economic Growth in the OECD Area: Recent Trends at the Aggregate and Sectoral Level", *OECD Economics Department Working Paper*, forthcoming.

SCHREYER, P. (2000),
"The Contribution of Information and Communication Technology to Output Growth: A Study of the G7 Countries", *OECD STI Working Paper* 2000/2.

WHELAN, K. (2000),
"Computers, Obsolescence and Productivity", Federal Reserve Board, February, mimeo.