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Working Paper

Catching the Celtic Tiger by its tail

Economic and Financial Report, No. 2002/01

Provided in Cooperation with:

European Investment Bank (EIB), Luxembourg

Suggested Citation: Ferreira, Luisa; Vanhoudt, Patrick (2002) : Catching the Celtic Tiger by its tail, Economic and Financial Report, No. 2002/01, European Investment Bank (EIB), Luxembourg

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European Investment Bank

Economic and Financial Report 2002/01

Catching the Celtic Tiger by its Tail

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Catching the Celtic Tiger by its Tail

Luisa Ferreira and Patrick Vanhoudt *

Abstract

The paper attempts to assess the major sources behind the exceptional Irish growth performance in the 1990s. Contrary to other Tigers, Ireland's growth is due to efficiency gains, rather than capital deepening, but the causes for the swift growth in total factor productivity cannot be pinned down to a single factor. Human capital, foreign direct investment, Social Partnership agreements, sound budget and economic policies since the late 1980s, EU membership, all seemed to have interacted to produce this high-growth economy. This paper focuses on the two mostly quoted catalysts—i.e. FDI and human capital. It provides evidence that—although crucial as enablers for the Irish economic performance—neither the rapid expansion of the compulsory education system in the 1970s and 1980s nor the sheer volume of FDI inflows can by themselves explain why Ireland has grown so much faster than other world economies. Instead, it argues that higher education, especially the vocational/technical slant of educational provision, and the sector composition of FDI in favour of high-tech industries, were self-reinforcing factors and have been decisive for the Republic's extraordinary boom.

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Catching the Celtic Tiger by Its Tail

Is fearr lán doirn de cheird ná lán mála d'ór
(A handful of skill is better than a bagful of gold)
– Irish proverb

1. Introduction

Over the last fifteen years Ireland saw its GNP per head rise from somewhat less than 60 percent of the EU average to around parity today (see Figure 1)¹. In addition to a stunningly robust real growth rate averaging roughly 6.5 percent over the last decade (Figure 2) the country created four times as many (net) jobs during the 1990s as the UK. Journalists and commentators in the Republic these days are therefore understandably exercised by the question whether the economy will retake its growth path when the current cyclical downturn will have passed away. Yet in order to provide a tentative answer to their concern, a question of more fundamental importance needs to be assessed. Key to the matter is to investigate what driving factors have contributed to the Republic's success, and to what extent the structural part of economic growth has been affected.

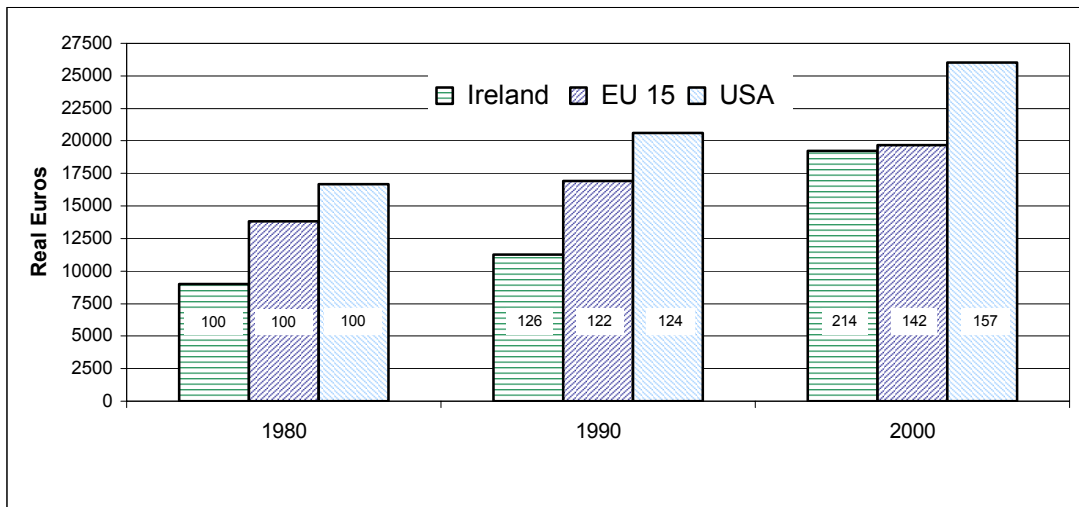
The current paper attempts to assess the major sources behind the more than average Irish growth performance in the 1990s. The recent Irish "Economic Miracle" has been the subject of much analysis, and it seems undoubtedly true that the extraordinary growth in the 1990s cannot be pinned down to a single factor. Human capital, foreign direct investment, Social Partnership agreements, sound budget and economic policies since the late 1980s, EU membership, flexible labour market and an English-speaking population all seemed to have interacted to produce this high-growth economy.

Nevertheless, this paper adds to the literature that seeks the main causes behind the growth in labour productivity, in inflows of foreign direct investment, as well as in the availability of human capital, but by focusing on "quality" (composition) rather than "quantity" (volume). Our main thesis is twofold. On the one hand, the paper argues that—although crucial as enablers for the Irish economic performance—neither educational outcomes nor the sheer volume of FDI inflows can by themselves explain why Ireland has grown so much faster than other economies. It is argued that higher education and especially vocational/technical slant of the educational provision and the sector composition of FDI, which were somehow two self reinforcing factors (though initially one could say that sector specific FDI was in part triggered by availability of human capital), seem to have been more decisive for the Republic's extraordinary boom than the actual size of the inflows, on the other.

In order to develop our arguments, we adopt a top-down approach. The next section starts with an analysis of the macroeconomic picture. Central issues here will be the evolution of the demand and supply side, as well as the growth effects of capital deepening and total factor productivity. Section three looks deeper into Ireland's educational outcomes over the last two decades, and the impact of FDI. A final section summarizes and concludes.

¹ In terms of GDP per capita in PPP terms, Eurostat expects Ireland to be at 122 percent of the EU average in 2002.

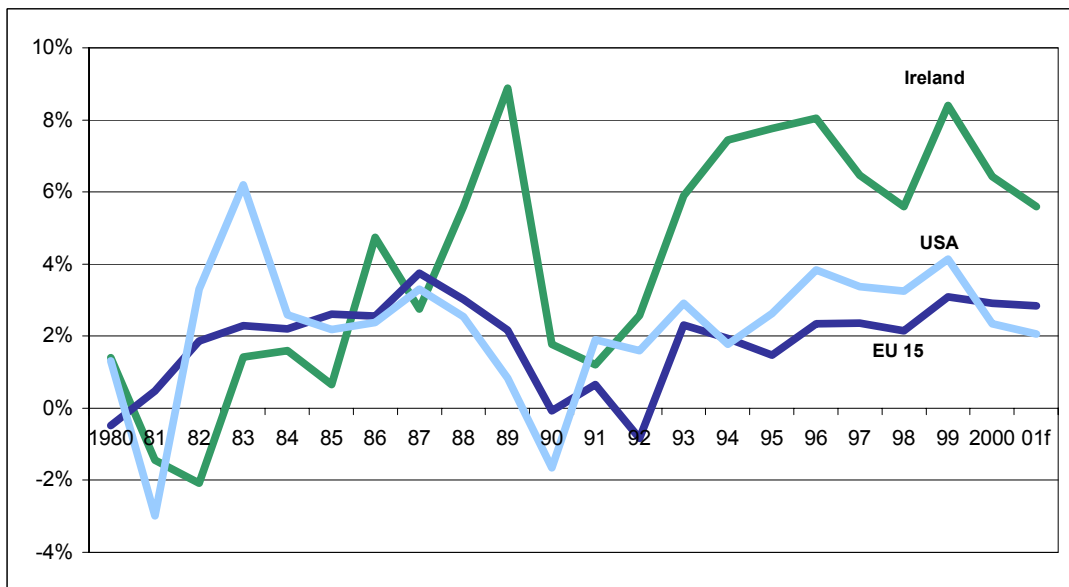
Figure 1: Standards of Living (GNP Per Capita) in Ireland, the EU15 and the USA



Source: AMECO, DG EcFin, 2000

Note: real Euros are in prices and exchange rates of 1990

Figure 2: Growth Rates of Real GNP Per Capita in Ireland, the EU15 and the USA



Source: AMECO, DG EcFin, 2000

Note: calculations based on real Euros in prices and exchange rates of 1990

2. Are Irish Living Standards Based on Solid Fundamentals?

2.1. Structure of the Economy

The supply-side structure of the Irish economy continued to change in the 1990s, with marked sector differences. Table 1 indeed shows that the contribution of the agricultural sector—the most important sector in the Republic in 1960—dropped from about 9 percent of the economy-wide generated value added in 1990 to 3 percent in 1999. By contrast, the services sector saw its relative share increasing from 58 to 63 percent, while the industrial sector

maintained its position at roughly one third. The data for the sub sectors reveal that value added has grown particularly strong in the branch of real estate.

In addition, capital formation increased from 18 to 27 percent of GDP (see Figure 3) and the increase was almost entirely accounted for by demand for property and infrastructure construction (see Table 2)². In addition, private sector investments were accompanied by non-trivial support from the Community Support Frameworks (CSFs). These programs have helped the Irish government to keep its investment at about 2.5 percent of GDP, implying that public investment grew roughly in pace with GDP. Authors such as FitzGerald (1998, 2000) argue that, “*although the structural fund payments from the EU have played a significant role in underpinning essential public investment in the 1990s, their overall role in promoting economic convergence has been limited, though nonetheless welcome*”. Indeed, without such a stimulus, Ireland may have found itself suffering from under investment in public capital in the face of increasing growth—which may have constituted an impediment to further rapid growth. The same author argues that probably more important than the actual investment was the way the Structural Fund process has affected the administrative and political system—the CSFs have enforced the introduction of long-term planning and shifted policy makers’ focus away—at least in part—from merely short-term political-economic pressures.

Impressive changes have been observed on the demand-side of the economy in the 1990s, as indicated in Table 2. On the one hand, consumer expenditures fell back from 58 percent of GDP in 1990 to 49 in 1999, and consumption outlays by the general government dropped from 18 to 12 percent of GDP. On the other hand, and more important, trade was boosted substantially. While exports went up from approximately 60 percent of GDP to almost 90 percent, imports moved only up to about 75 percent, coming from 50 percent.

Table 1: Supply-Side Structure of the Irish Economy in the 1990s

	Nominal value added				
	percent of total		billions IEP		annual growth
	1990	1999	1990	1999	1990-99
Agriculture	9	4	2.4	2.3	-0.2
Industry	33	34	8.5	20.7	10.5
Services	58	63	14.8	38.4	11.2
Total GDP	100	100	25.7	61.5	10.2
Nace-17 classification:					
Real estate, renting and related business activities	13	21	3.2	13.0	16.6
Mining and quarrying	1	1	0.1	0.4	14.5
Financial intermediation	3	3	0.7	2.1	12.9
Electricity, gas, and water supply	1	2	0.3	0.1	12.4
Hotels and restaurants	2	3	0.6	1.8	12.1
Health and social work	5	6	1.3	3.6	11.5
Construction	5	6	1.4	3.7	11.5
Transport and communication	6	6	1.5	3.6	10.4
Manufacturing	28	28	7.2	17.0	10.0
Other community services	3	3	0.7	1.7	9.9
Education	5	4	1.3	2.6	8.1
Wholesale retail, and repair activities	13	10	3.3	6.2	7.3
Public administration	6	4	1.5	2.6	6.0
Agriculture, hunting, fishing and forestry	9	4	2.4	2.3	-0.2
Total GDP	100	100	25.7	61.5	10.2

Source: Eurostat, New Cronos

² Ireland has nonetheless faced physical constraints on the capacity to expand housing in the short run. Consequently, in addition to the property boom, the economy is currently suffering from property price inflation well in excess of income growth (IMF, 2000).

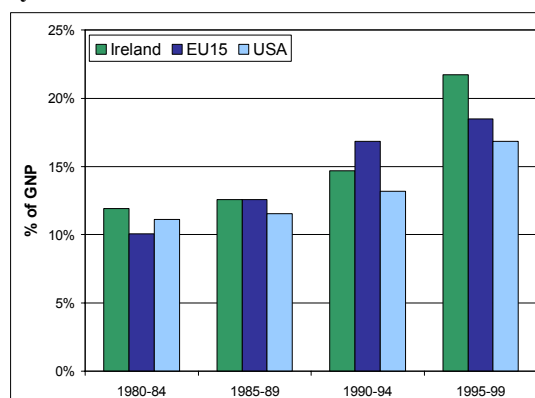
Table 2: Demand-side Structure of the Irish Economy in the 1990s

	% of GDP		% of GNP	
	1990	1999	1990	1999
Household consumption	58	49	63	57
+ General government consumption	18	12	20	14
+ Gross fixed capital formation	18	27	20	31
<i>Metal products and machinery</i>	4	4	4	5
<i>Transport equipment</i>	4	4	4	5
<i>Construction work: housing</i>	4	9	4	10
<i>Construction work: other constructions</i>	6	9	7	10
<i>Other products</i>	0	1	0	1
+ Exports	56	87	61	100
- Imports	50	75	54	87
Total GDP	100	100		
+ Net factor income (- denotes outflow)			-9	-15
Total GNP			100	100

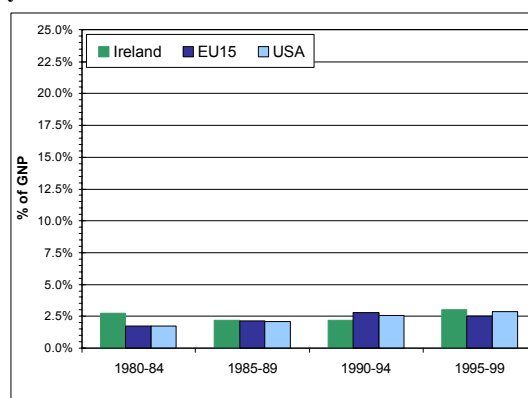
Source: Eurostat, New Cronos, and Word Development Indicators

Figure 3: Gross Fixed Capital Formation in Ireland

By the Private Sector



By the Public Sector



Source: Author calculations based on AMECO data

In fact, according to the Central Statistical Office, the Irish trade surplus has increased from IEP 1.9 billion (€ 2.4 billion or some 7 percent of GDP) in 1990 to IEP 22.0 billion (€ 27.9 billion or roughly a third of GDP) in 2000. Interestingly, with FDI inflows going up from 0.2 percent of GDP in 1990 to roughly 5 percent of GDP by the end of the 1990s, one would have expected to see a pressure on the exchange rate. Increasing capital outflows – as much as 15 percent of GNP in 1999, mainly profit repatriations – helped, however, in easing that phenomenon.

Trade reorientation and increasing openness dates back to the 1960s and early 1970s. The outward orientation of foreign trade and the abandonment of the protectionist import-substitution strategy have been accompanied by a new industrial policy that encouraged the development of export-oriented manufacturing industries through tax and financial incentives. Especially the foreign sector became increasingly outward orientation as a result. Barry and Bradley (1997), for instance, documented that much of the economy's exports emanate from the foreign-owned sector of Irish manufacturing. They illustrated that its export-output ratio is around 90 percent, compared to less than 40 percent for indigenous manufacturing. Furthermore, while over 40 percent of indigenous-sector exports go to the UK, only around 20 percent of the exports of the foreign-owned segment flow in that direction. Also Murphy (2000) indicates that a great deal of the export story may be explained by isolating the five

main areas of multinational exports. These are 1) soft drink concentrates (cola concentrates etc.) classified under “miscellaneous edible products”; 2) chemicals, classified under “organic chemicals”; 3) medical and pharmaceutical products (such as e.g. Pfizer with Viagra); 4) computers (e.g. Intel with Pentium chips), classified as “office machinery and equipment”; and 5) software (Microsoft) which can be found under “recorded media” (see Table 3). As a result, the weight of high technology goods in the economy’s total exports has increased from about one third in the early 1990s to roughly 40 percent in 1999 (IMF, 2000).

Table 3: Export Break Down – Percent of Total, and Growth Rate

	Percent of total exports		Average annual growth rate, in percent
	1988	1995	1988-95
Exports			
Miscellaneous edible products	5.8	6.4	14.3
Organic chemicals	5.5	9.2	21.2
Medical & pharmaceutical products	3.0	4.8	20.4
Office machinery and equipment	18.4	21.3	16.0
Recorded media	3.4	7.9	28.1
Sub total	36.1	49.6	17.9
Remainder	63.9	50.4	8.5
Total exports	100.0	100.0	12.3

Source: Murphy, 2000

In sum, growth in Ireland has been predominantly led by increased trade performance and a boost in fixed capital formation. Standards of living—as measured by output³ per head of the population—have subsequently increased more rapidly in Ireland over the past 15 years than elsewhere in the world. A casual look at Figure 2 even suggests that the Irish economy has irrevocably shifted to a permanently higher growth trend since 1993. But is this really a structural shift? In order to provide an answer to that question, one can decompose the growth of the standard of living in its various components.

2.2. Factors That Influence the Standard of Living

Growth of the standard of living can, in fact, arise from policies that affect three broad factors as indicated by the identity below:

$$\frac{\text{output}}{\text{capita}} = \frac{\text{output}}{\text{worker}} \cdot \frac{\text{workers}}{\text{active population}} \cdot \frac{\text{active population}}{\text{total population}}$$

³ According to the Commission’s DG EcFin’s data, the average difference between the Irish GNP and GDP over the period 1997-2000 is 12 percent of GDP. The difference stood at about 5 percent in the mid/late-80s, going to 10 percent in 1997, and increased to 14 percent in 2000. This mainly represents net factor income outflows that result from profit repatriation by multinational companies. Consequently, gross national product (GNP) is a more accurate measure for Irish output than gross domestic product (GDP).

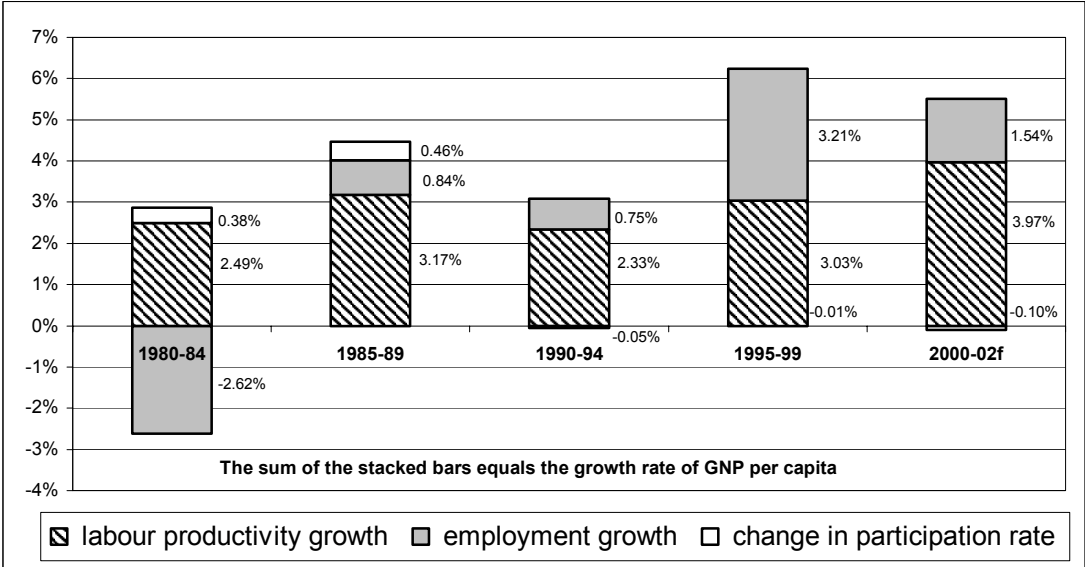
However, the FDI stock as a percentage of GDP did not change dramatically in Ireland (Figure 7 illustrates this). The question is whether the evolution in the GDP-GNP gap is then justifiable based on the actual return to FDI. The stock of FDI amounted to some 25 percent of GDP in 1997. When one allows for a “normal” 20 to 25 percent return on foreign capital, one would expect thus to see profits repatriated in the order of magnitude of 5 to 6 percent of GDP – half of the difference between GNP and GDP actually observed over the last few years thus.

Thus, a higher output per capita can be due to a combination of increased labour productivity (output per worker), to a rise in the employment rate (employees as a percent of the active population, i.e. those between 15 and 65 years of age), or to an improvement of the participation rate (share of active population in total population).

Figure 4 shows the evolution of these components for the Irish economy, and it becomes clear that *sustained high growth of labour productivity has been the main driver behind the Irish performance since the early 1980s*. Employment growth has been non-negligible too, but it has been less of a constant factor over time.

Labour productivity growth, in turn, may increase either because of *capital deepening* – i.e. providing each worker continuously with more physical capital to operate with – or because of better efficiency with which capital and labour are combined. The latter phenomenon is referred to as gains in *total factor productivity* (TFP) and captures the structural part of economic growth. Major aspects that influence TFP improvements are unremitting technological innovations, or more and better human capital. In addition, external benefits may play a role in the growth rate of TFP. Externalities can result from things such as continuous efficiency gains that arise from learning-by-doing experiences with newly purchased equipment and replacement investments, or from network effects that may show up as a side product of some sorts of capital (e.g. the internet, communication equipment, or public infrastructure). By contrast, growth effects of capital deepening are usually temporary – unless the investment share keeps on rising – because physical capital is accumulated under decreasing marginal productivity. That is, with a constant investment share the marginal gains of adding capital will become smaller as time evolves.

Figure 4: Growth Rates of Labour Productivity, Employment and Participation



Source: AMECO, DG EcFin, 2000

Hence, in trying to assess whether the growth of the standard of living is a temporary or solid permanent trend, the questions that one should try to answer are twofold. On the one hand it needs to be investigated to what extent the structural part of productivity growth has been affected. Subsequently one may assess the question what has caused TFP growth, by looking at policies that may correlate well with that concept for the evolution in Ireland over time, and – perhaps more importantly in terms of lessons for other countries – across comparable economies.

2.3. Efficiency Gains or Capital Deepening?

Which of the two has been key in the Irish performance? A convenient tool to grasp a firm idea of the driving sources behind productivity growth performances still is the old – yet elegant and well-established – technique of growth accounting. In fact, starting from a simple neoclassical production function it can be shown that labour productivity growth can be decomposed as follows:

$$\gamma_{\frac{Y_t}{L_t}} = \gamma_{A_t} + \alpha \cdot \gamma_{K_t} - \alpha \cdot \gamma_{L_t}$$

Thus, productivity growth ($\gamma_{Y/L}$) is the weighted sum of the percentage change in the net capital stock (γ_K) and employment (γ_L), plus the progress in total factor productivity (γ_A). The parameter α denotes the degree to which the accumulation of production factors is subject to diminishing marginal productivity. In a competitive environment with well-defined property rights this concept also coincides with the share of capital in output, as reported in the national accounts. Consequently TFP growth can easily be distilled from this equation.

Such a growth accounting exercise for Ireland yields a surprisingly interesting result. Contrary to most of the European economies, Ireland's growth of output per worker has not been driven by pouring more capital on each worker. In fact, the growth rate of the capital-labour ratio has been persistently downward, and close to zero – even slightly negative – over the last few years (see Figure 5). Table 4 illustrates that this phenomenon is rather due to extremely rapid increases in Irish employment – presumably thanks to investment – than to sluggish growth in the net stock of capital. To the contrary, Ireland's capital stock has recently grown among the fastest in the world, which has originated mainly from capital formation in the private sector.

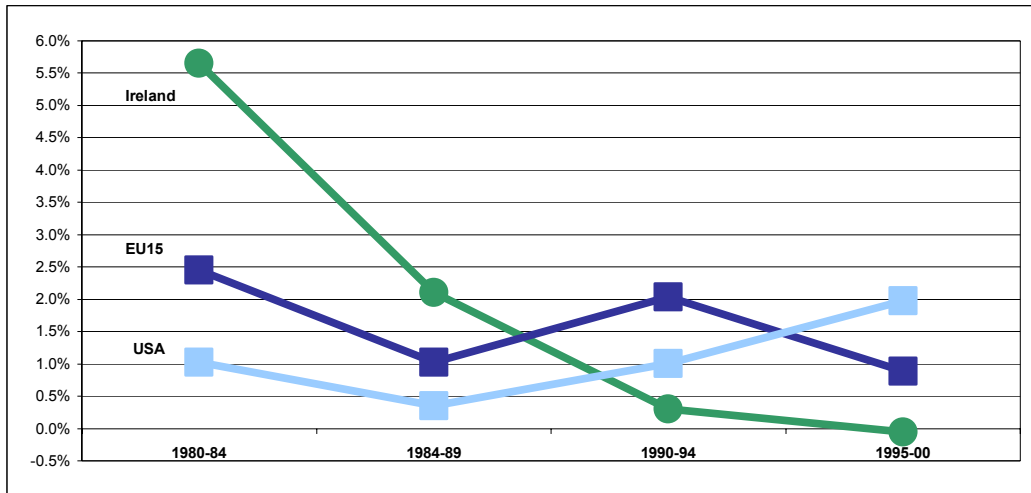
Table 4: A Closer Look at the Growth Rate of Capital Per Worker (%)

Ireland		1980-84	1985-89	1990-94	1995-00
	Growth of net capital stock	4.43	2.37	2.15	4.58
less	Employment growth	-1.46	1.11	1.95	4.85
equals	Growth of capital per worker	5.89	1.26	0.20	-0.27
EU15		1980-84	1985-89	1990-94	1995-00
	Growth of net capital stock	2.16	2.37	3.09	2.14
less	Employment growth	-0.32	1.43	0.86	1.32
equals	Growth of capital per worker	2.49	0.95	2.23	0.82
USA		1980-84	1985-89	1990-94	1995-00
	Growth of net capital stock	2.39	2.61	2.02	3.59
less	Employment growth	1.49	2.18	1.13	1.75
equals	Growth of capital per worker	0.90	0.42	0.90	1.84

Source: AMECO, DG EcFin, 2000

So in spite of this extraordinary evolution in investment figures, the growth accounting exercise shows that capital deepening has not been driving rapid labour productivity growth. Ireland has, by contrast, experienced a remarkable increase in the efficiency of its production factors, that is, its TFP growth. Figure 6 reveals that this “structural” growth part has even strongly outperformed the US “new” economy over the last decade. The currently negative growth rate of the capital-to-labour ratio combined with rapid job creation does suggest, moreover, that additional transitional growth may be expected in the near future, until this ratio has again reached its equilibrium value.

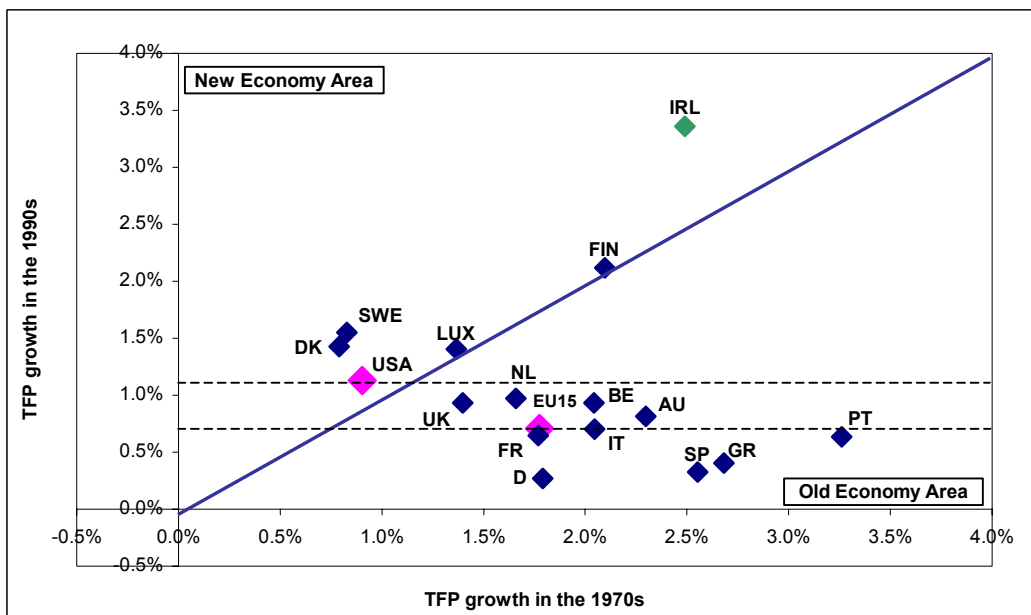
Figure 5: Growth Rates of Workers' Net Capital Stocks Compared



Source: Author calculations based on AMECO data

Thus, efficiency gains, rather than capital deepening, have been key to the rapid increase in the Irish standard of living. And it suits to emphasize here that precisely this is the most marked difference between the Celtic and Asian Tigers. Indeed, as Krugman (1996) wrote “the remarkable record of East Asian growth has been matched by input growth so rapid, that the Asian economic growth, incredibly, ceases to be a myth”. But what has caused efficiency to increase so rapidly in Ireland? What explains the Irish “myth”?

Figure 6: TFP growth – the Celtic Tiger Outruns the American Eagle by Far



Source: Author calculations based on AMECO data

3. What Has Contributed to the Increases in Overall Efficiency in Ireland?

By now there seems to be some agreement on the major economic factors that may have played a role in the Irish TFP story. Generally included among the favourable factors are, the increased educational attainment of the workforce, the wage moderation and peaceful labour relations that have characterised the last decade (the “new social contract”), sound economic and budget policies since 1987, and continued success in attracting foreign direct investment (FDI) inflows. This section will look at education and FDI as possible drivers of Irish TFP.

3.1. Human Capital – A Question of Degree?

A recent study by Bassanini and Scarpetta (OECD, 2001) shows that in Ireland—like in Greece and Spain—a high level of growth is attributable to changes in human capital. A quick glance at the available indicators in Table 5 indeed shows that Irish education levels have increased rather steadily over the last forty years.⁴ While in 1960 an Irish citizen (25 years and older) would spend on average approximately 6.5 years in school, this figure had increased to 7.6 in 1980 and to 9.0 in 1999, an almost 20 percent increase every 20 years. This progression was gender-balanced, with both males and females recording similar gains.⁵ Significantly, the higher education segment appears as the main culprit for the substantial improvement in the education indicators. Between 1960 and 1999, the average number of years spent by the Irish in higher education institutions went through an almost four fold increase, having gone from about 0.1 to 0.6 years, with most of the gains concentrated between 1980 and 1999.

Table 5: Average Years of Schooling in Ireland (people 25 years of age or older), by Level of Education

	1960	1980	1999	Ratios of Improvement	
				1999 as pct of 1960	1999 as pct of 1980
Primary	4.9	5.2	5.3	109	103
Secondary	1.4	2.2	3.1	214	141
Higher	0.1	0.3	0.6	471	245
All	6.5	7.6	9.0	140	119

Source: Barro-Lee (2000.)

The improvement of the educational attainment of the population at large has been reflected in a sharp increase in the supply of skilled labour in recent years. For instance, while in 1970 over 60 percent of the adult population of working age had only primary education, this figure is forecasted to be under 10 percent by 2010 as a result of changes in educational attainment and associated policies. In parallel, the percentage of persons in the labour force with a third level education increased from 11 percent in 1981, to 18 percent in 1991, and it is expected that over 40 percent of the working population will hold a third level of education by 2010. This rather dramatic change in the educational profile of the Irish labour force is the outcome

⁴ This draws heavily from the so-called “Barro-Lee data set,” as included in Barro and Lee (2000), and which updates and revises the 1996 version constant in Barro and Lee (1996). A revised version of the 1996 version of the Barro-Lee data set for a sample of 21 OECD countries is also available in de la Fuente and Donénech (2000). Significantly, the Barro-Lee 2000 update and de la Fuente correction, despite some data differences, provide a very similar picture of the Irish educational achievements.

⁵ Additional tables including all countries, and for population 15 and older, as well as females only are included in appendix 3.

of a dynamic process by which cohorts containing a high proportion of relatively less educated workers reach the retirement age, and simultaneously those with relatively high levels enter the labour force. The level of educational attainment of those in the labour force is greater than for the others, and within the labour force the level of education is greatest among those employed (see Table 6.) In particular, the increased educational attainment is responsible for increased female participation in the labour market.

Table 6: The Irish Labour Market (1998)

Labour Force Participation Rates (ages 25-64)	Men	Women
Below Upper Secondary	81	38
Upper Secondary and Post-secondary non-tertiary	92	63
Tertiary	95	80
All	87	55
Unemployment Rates (ages 25-64)	Men	Women
Below Upper Secondary	11.7	11.4
Upper Secondary and Post-secondary non-tertiary	4.2	4.8
Tertiary	2.9	3.9
All	7.4	6.5

Source: OECD, 2001.

Moreover, the key role of human capital in the Irish growth performance is well signalled by the marginal productivity of education, or, equivalently, the rate of return to education. Studies show, for instance, that returns to education have been rising throughout the recent process of economic development in Ireland. They did so disproportionately for those with the highest education levels, despite the steadily increasing supply of better-educated younger entrants into the labour force, as the demand has risen apace (Barrett, Callan, and Nolan, 1997). Denny and Harmon (2001), using data for 1987 and 1994, estimate returns to education to be in the region of 8 percent to 10 percent per year of schooling for men and 10 percent to 14 percent for women, with the higher returns for women reflecting the lower participation rate in the labour market. Moreover, in a spatial comparison, Heinrich and Hildebrand (2001) show that the rates of return to second and third level education in Ireland are, along with Luxembourg, Spain, and Portugal among the highest in the EU. The magnitude of these returns outperformed real interest rates—which can be taken as a measure for the rate of return to physical capital—by far.

Table 7: Main Policy Reforms and Impact

When?	What?	Expected Impact
1967	Abolished secondary education fees	Increase access to secondary and tertiary
	Creation of Regional Technical Colleges	Increase access to tertiary and indirectly increase retention in secondary
1972	Increase minimum school leaving age from 14 to 15	Increase retention in secondary and indirectly increase access to tertiary
1996	Abolished fees for full-time undergraduate third level education-	Increase access to tertiary and indirectly increase retention in secondary
1998	Increase minimum school leaving age to 16.	Increase retention in secondary and indirectly increase access to tertiary
2000	Raises the minimum school leaving age to sixteen years or the completion of three years of junior cycle education, whichever is later (Education (Welfare) Act, 2000).	

Without the underlying main educational reforms—summarized in Table 7—Ireland would thus not have reached the same standard of living than it has today. As FitzGerald (1999) put it: *“In terms of domestic policy, the failure to develop the education system in the first 50 years of independence after 1922 was probably [...Ireland’s] most glaring mistake and investment in education in the last 25 years is one of the country’s major successes. The changing educational attainment of the population is having a very wide impact on Irish Society, not least on the pattern of demographic change.”* In addition, on the one hand demographic factors become an asset. The existence of a relatively young population meant that additional labour was available to meet demand without creating wage pressures, and towards the end of the 1990s immigration played an important role in expanding the productive capacity of the economy. On the other hand, the same demographic factors lead to a very rapid rise in the labour supply that would not have become employable if it were not for the investment in human capital.

But are changes in educational attainment themselves able to explain the extra-ordinary growth when compared to what has happened in other countries? Let us therefore contrast the quantity and quality of education in Ireland with that observed in other economies in somewhat more detail.

3.1.1. Is It Quantity of Education that Differentiates Irish Human Capital From Other OECD Countries?

All Irish improvements notwithstanding, they need to be evaluated against a background of a worldwide increased access to education in general, and the countries with whom the Irish case is usually compared with in particular.

In fact, the relative position of the Irish educational system in the context of OECD countries was not much altered during the last forty years. In other words, while the increase in Irish human capital was quite rapid, other OECD countries paralleled it. Some figures may help to stress this point.

- As far as the average number of years of total education is concerned, the Irish population (25 years and older) ranked 16 in 1960 among OECD countries; in 1999, it dropped down one position to 17 (although it improved slightly its relative position since 1980, where it stood in the 19th position).
- Even the spectacular increase in the higher education levels previously reported does not come across as impressive in this context: while Ireland moved upwards 5 positions from 18 to 13 between 1980 and 1999, this relative improvement represents a downward slippage from its 10th position in 1960.

Indeed, other OECD countries witnessed far more impressive gains than Ireland in the education sector. In 1960 Korea ranked 25 among OECD countries in terms of average years of education of its population, a position that was slightly improved to 21 in 1980. However, after two breath-taking decades, the Korean population now holds an average of 10.46 schooling years (a 53.3 percent increase) and ranks 7 among all OECD countries. Another country whose achievements stand out is Norway, which moved from the 14th position in 1980 to 2nd in 1999, with an average of 11.86 years of schooling for its population.⁶ Ireland's gains in overall number years of education between 1980 and 1999 (or even between 1960 and 1999) were instead rather median among OECD countries.

Even in a direct comparison with its EU partners, Ireland's performance does not particularly stand out, ranking 7 (out of 14) in 1999, the exact same position it held in 1960. While the best overall EU performances come from the countries that held the worst records at that time,⁷ there were, however, a few countries with similar educational records to those of Ireland in 1960 that moved up in the European ladder, namely the Netherlands and, more substantially, Finland. (see Table 8).

Not surprisingly, the rapid pace of increase in access to higher levels of education has generated a skewed distribution of educational attainment by age group in Ireland, with the younger age cohorts disproportionately more educated (see Table 9, and Tables A.31 and A.32 in appendix). Given the current participation rates in Irish higher education—in 95/96 with 27 percent of the relevant age group enrolled in a HE institution, Ireland had one of the highest participation rates in the EU—this trend of increasing educational achievement for the young cohorts is expected to continue. (See Table A.36 in appendix).

From this we thus learn that, even though the increase in Irish human capital formation was quite rapid, other developed countries experienced similar—if not better—evolutions. In other words: the mere quantity of human capital formation correlates badly with observed TFP patterns across countries. How about the quality of educational output?

⁶ Korea and Norway are the two countries that have most improved their *relative* position among OECD countries between 1960 and 2000. As far as the increase in the average years of education is concerned, Korea is the best achiever of OECD countries during the period, with Turkey taking the lead between 1980 and 2000. However, Turkey and other countries with similar performances such as Mexico and Portugal remain very much at the bottom of the list of OECD countries in 2000.

⁷ Portugal and Spain which, their achievements notwithstanding, have not improved their relative position in any significant manner.

Table 8: A Comparison of Educational Attainment Across Selected OECD Countries: Average Years of Total Education in the Population 25 Years and Older

Country	Total Average Years of Education			Rank		Ratio of Improvement		Rank with Respect to Improvement	
	1960	1980	1999	1960	1999	1999 in % of 1960	1999 in % of 1980	1999 to 1960	1999 to 1980
New Zealand	9.6	11.4	11.5	1	3	121	101	22	24
Australia	9.4	10.0	10.6	2	6	112	105	25	20
Denmark	9.0	9.2	10.1	3	10	113	110	24	19
United States	8.7	11.9	12.3	5	1	141	103	16	23
Canada	8.4	10.2	11.4	6	4	137	112	18	17
United Kingdom	7.7	8.2	9.4	8	14	122	114	21	16
Sweden	7.7	9.5	11.4	9	5	148	120	12	12
Japan	6.9	8.2	9.7	13	12	141	118	15	14
Ireland	6.5	7.6	9.0	16	17	140	119	17	13
Norway	6.1	8.3	11.9	17	2	194	143	6	5
France	5.8	6.8	8.4	18	23	145	124	13	9
Iceland	5.6	7.1	8.8	19	20	155	123	10	10
Finland	5.4	8.3	10.1	20	9	189	122	7	11
Netherlands	5.3	8.0	9.2	21	15	175	116	9	15
Greece	4.6	6.6	8.5	22	22	183	130	8	8
Italy	4.6	5.3	7.0	23	25	154	132	11	7
Spain	3.6	5.2	7.3	24	24	199	141	5	6
Korea	3.2	6.8	10.5	25	7	324	154	1	3
Turkey	2.0	2.8	4.8	27	28	240	171	4	1
Portugal	1.9	3.3	4.9	28	27	253	150	3	4
Average	6.3	7.9	9.3						

Source: Barro-Lee (2000).

Table 9: Percentage of the Population Having Attained at Least Upper Secondary Education (1999): A Comparison Across Some OECD

			Ratio of Age group 25-34 to Age Group 55-64, in pct
	Ages 25-34	Ages 55-64	
Australia	65	44	148
Austria	83	59	141
Belgium	73	36	203
Czech	93	75	124
Finland	86	46	187
France ³	76	42	181
Greece	71	24	296
Iceland	64	40	160
Ireland	67	31	216
Italy	55	21	261
Korea	93	28	332
Portugal	30	11	273
Spain	55	13	423
Turkey	26	12	217
United	66	53	125
United States	88	81	109
Country	72	45	

Source: OECD, 2001.

3.1.2. Quality of Human Capital Formation

An important issue in the discussion of the role of human capital in the Irish case is its intrinsic quality. Not unexpectedly, there is a paucity of educational statistics covering this angle, but there are nonetheless some features that can be brought into the analysis. The first question one may try to answer is whether is it quality of basic education that differentiates Ireland from other OECD countries?

3.1.2.1. Quality of Basic Education?

While the figures presented thus far portray the Irish educational system as rapidly expanding—*extensive margin*—but not substantially faster than most of its relevant peers—they do not shed much light on what is perhaps the crux of the question: is Ireland doing a better job than others at preparing and training its young—the *intensive margin*. The few available results do not point in that direction. According to the results of various International Test scores in Math, Science, and Reading (see Table 10 below) compiled for a group of 24 OECD countries, in 1993-98 Ireland ranked 10 in Math and 12 in Sciences, with scores that are essentially undistinguishable from the average. Furthermore, scores of international reading tests only reinforce the perception that quality of education in Ireland is not significantly better than in other OECD countries. In 1990-91 13 years old scored rather low (and so did 9 years old) and among a group of 18 countries Ireland ranked 16.⁸ Finally,

⁸ In 1995 Ireland was one of the 45 countries that participated in TIMSS (Third International Mathematics and Science Survey).⁸ Though Ireland performed above the international average in mathematics and sciences at the fourth grade—with a score of 550 and 539 which compares with an international average of 529 in math and 524

recent results from the PISA study (OECD, 2001)⁹ though may indicate a relative superiority of Ireland regarding reading scores (Ireland ranked 5 among the 32 countries), Irish mathematical literacy does not stand out: Ireland ranked 16 among the 32 participating countries and below the OECD average.

Table 10: Results from International Test Scores in Math, Science, and Reading: A Comparison Across Some OECD Countries

Subject	Math.	Math.	Rank in Math Test	Science	Science	Rank in Science Test	Reading	Rank in Reading Scores
	1990-91	1993-98		1990-91	1993-98		1990-91	
Canada	62.0	49.4	12	68.8	49.9	10	52.2	11
United States	55.3	47.6	16	67	50.8	8	53.5	8
Japan		57.1	2		53.1	4		
Korea	73.4	57.7	1	77.5	53.5	3		
Finland							56	1
France	64.2	49.2	13	68.6	45.1	21	54.9	2
Germany		48.4	14		49.9	10	52.2	11
Ireland	60.5	50	10	63.3	49.5	12	51.1	16
Netherlands		51.6	5		51.7	7	51.4	15
Portugal	48.3	42.3	24	62.6	42.8	24	52.3	10
Spain	55.4	44.8	22	67.5	47.7	19	49	18
United Kingdom	60.6	47	18	68.3	49	13		
Czech Republic		52.3	4		57.4	1		
Slovak Republic		50.8	7		54.4	2		
Un-weighted Average of OECD Countries	62.1	49.2		69.1	49.4		52.5	

Source: Barro-Lee Compiled Data Set. Additional Results are available in Appendix.3.

While international test scores of students at the primary and secondary levels provide useful information on the quality of education, an adult literacy survey measures directly the skills of the workforce. The recent results from the International Adult Literacy Survey (OECD, 2000)¹⁰ highlighted the lack of basic skills in employed people in highly developed countries, Ireland not being an exception. Again the results do not point for particularly good outcomes of the Irish Education System. Among a group of 20 developed countries, which account for about 50 percent of the world GDP, Ireland ranks 14 regarding prose literacy proficiency with no statistically significant difference from countries like UK, Belgium, Czech Republic, or

in science—it scored around the international average at eighth grade in both subjects (It ranked 9 in math 4th grade and 12 in sciences in 4th grade, and 17 in math 8th grade and 15 in sciences 8th grade).

⁹ The Project of International Student Assessment (PISA) survey was first conducted in 2000, with 265,000 students from 32 (28 OECD member countries). PISA 2000 assessed students' capacities to apply knowledge and skills in reading, mathematics, and science, seen as necessary pre-requisites for students to be well prepared for adult life.

¹⁰ The International Adult Literacy Survey, is a twenty-country comparative study of adult literacy in the workplace. Countries included are: Sweden, Finland, Norway, Netherlands, Canada, Germany, New Zealand, Denmark, Australia, United States, Belgium, the Czech Republic, U.K., Ireland, Switzerland, Hungary, Slovenia, Poland, Portugal, and Chile.

Switzerland, and only significantly better literacy proficiency than Hungary, Slovenia, Poland, Portugal and Chile.

3.1.2.2. Quality of Higher Education?

A crucial point, commonly invoked in the discussions of the Irish case and already alluded to, is whether the educational attainments of the Irish population are relatively more concentrated in the higher education segment, and whether improvements in this sector in Ireland outpaced those of its main competitors. Although the Irish standing in the sector is currently not particularly remarkable—with on average 0.6 years of higher education attained by its population it ranked only 13th among OECD countries in 1999—the Republic has witnessed rapid progress over the last twenty years (see Table 11). With average years of higher education growing at about 4.8 percent per annum between 1980 and 1999 (compared to approximately 3.2 for the OECD), Ireland has put forward the sixth best OECD performance (fifth among EU countries) during the period.¹¹ As a result, the number of years spent by the Irish in higher education institutions more than doubled, having gone from 0.25 to 0.61 in just twenty years. This performance comes in the footsteps of government policies designed to provide easier access to higher education through a combined supply- and demand-side strategy of simplifying the entry process and of providing additional places for students, particularly in the technological sector (e.g. Bradley 2001; MacSharry and White 2000).

Table 11: Average Years of Higher Education in the Population 25 Years and Older, Selected OECD Countries

	Number of years			Rank		Ratio of improvement	
	1960	1980	1999	1960	1999	1999 as pct of 1960	1999 as pct of 1980
USA	0.53	0.96	1.61	1	1	304	168
Denmark	0.51	0.54	0.67	2	12	131	124
Finland	0.13	0.38	0.73	10	7	562	192
Ireland	0.13	0.25	0.61	10	13	469	244
Korea	0.09	0.31	0.90	17	5	1000	290
Austria	0.07	0.10	0.47	18	21	671	470
Netherlands	0.04	0.35	0.69	25	11	1725	197
Portugal	0.03	0.10	0.37	26	25	1233	370
OECD average	0.16	0.37	0.67			419	181

Source: Barro-Lee (2000)

Education may not only make a contribution to growth via increases in the skills of the workforce but also a contribution via innovation: investment in higher education is particularly relevant because of the innovation channel.¹² Table 10 reveals that a distinctive

¹¹ This is consistent with Barro (2001) most recent work, which finds the effect of primary schooling in growth to be statistically insignificant. The particular importance of schooling at the secondary and higher levels (for males) supports the idea that education affects growth by facilitating the absorption of new technologies—which are likely to be complementary with labour educated to these higher levels. Primary and secondary schooling is, however, critical as pre-requisite for higher education—and the impact/importance of expanding access to secondary education in the 1960s is now showing its effect.

¹² Ireland promoted on-plant research on foreign-owned manufacturing industry. A Study by Ruane and Kearns (The Irish Times, Monday 5-10-2001) shows that “plants actively engaged in R&D have a life expectancy that is 40 percent higher than that of plants which are not research-active. Furthermore, the average duration of jobs in those plants, which conduct research activities in Ireland, is twice that of those which do not engage in research here.” In this context investment in HE, particularly in the science fields is of specific importance.

feature of higher education in Ireland is the relative concentration of graduates in mathematics and science related fields, at a “college” (ISCED 5A) and even more so at “polytechnic” (ISCED 5B) level (data for ISCED5A graduates is provided in Table A. 35, Appendix3), as a result of the creation of Regional Technical colleges that not only increased access to third level education, but even more importantly provided a different form of third level education, getting away from the pure academic university education to a more technical and modern skills-based system. Consequently, Ireland has a leading position in the output of scientific and engineering graduates, which is also reflected in the disproportionate representation of science graduates in the youth Labour Force in Ireland (cf. Table A.38, Appendix 3). To this adds the fact that a large proportion (about 30 percent) of HE graduates are returning emigrants and immigrants—an Ireland-specific phenomenon—which are embodied with specific human/social capital.¹³

Table 12: Tertiary Graduates by Field of Study (1999), in Percent of all Graduates

	Life Sciences, Physical Sciences, and Agriculture		Mathematics and Computer Science	
	ISCED 5B Graduates	Ranking	ISCED 5B Graduates	Ranking
Ireland	10.6	1	10.5	3
UK	5.7	3	8.4	7
New Zealand	4.1	4	0.8	18
Czech Republic	3.9	5	3.3	14
Canada	3.5	6	5.3	9
Germany	3.4	7	0.3	19
Sweden	2.1	8	9.5	6
France	2.1	9	4.4	11
USA	1.8	10	4.2	12
Finland	1.8	11	3.0	16
Korea	1.2	15	1.5	17
Japan	0.6	17	Na	na
Norway	0.1	19	13.6	2
OECD average	2.3		5.1	

Source: OECD, 2001

Note: According to the International Standard Classification for Education (ISCED), ISCED 5A Programmes are largely theoretically based and are intended to give access either to the advanced research programmes found in ISCED 6 or to professions with high skills requirements (e.g. medical doctors) while ISCED 5B Programmes focus on occupationally specific skills geared for direct access to the labour market. Usually they are shorter than programmes at ISCED 5A. The broad picture presented in table 7 prevails when ISCED 5A data are used.

3.1.3. Spending on Education

A quick comparison with other OECD countries indicates that although Ireland has devoted considerable resources of its public outlays to the sector—expansion of basic education and secondary education for all during the 1960s and the 1970s—the expansionary behavior cannot be considered an outlier. True, Ireland devoted additional financial resources to the sector to meet the expansionary pressure arising from the large cohorts of school age and the increased access to education. However, Ireland has never been an outlier among OECD countries in the recent past regarding overall public spending with the educational sector. For instance:

¹³ Work by Barrett and O’Connell show that returning emigrants earn 10 percent more over their lifetime because of what they learnt abroad.

- In terms of share of GDP devoted to public education, both in 1970 and 1987 Ireland was at par with the OECD average with a value of 6.2 percent. In 1997, OECD public expenditure on education had declined to 4.9 percent of GDP, with Ireland only slightly below that average at 4.6. However, spending in the educational sector increased less rapidly than total government spending;

Table 13: Public Expenditure on Education as Percent of GDP, 1997

	Primary	Secondary	Tertiary	All
Ireland	1.6	2.0	1.3	4.9
EU 15	0.9	2.5	1.1	5.0

- Ireland has not been significantly different from other countries regarding the share of public expenditure devoted to education. In 1970 this share ranged from 9.4 percent in Germany to as much as 24.4 percent in Canada. Ireland with a share of 13.1 percent ranked 8 among a sample of 11 highly developed OECD countries. Seventeen years later, Ireland still ranked 8 (out of 18 countries), though the share had slightly declined to 11.8 percent. In 1997, Ireland devoted 13.8 percent of its total government outlays to education, which was approximately the OECD's average of 14 percent;
- Also public educational expenditure per student relative to income per head reveals that Ireland's effort was largely in line with the rest of OECD countries. This share ranged for instance from 19.7 percent in 1986 in Portugal to as much as 35.5 in Sweden. Ireland recorded the 6th but lowest share among 20 OECD countries with a value of 23 percent.

Taken together, the previous three facts then seem to contradict the often-heard claims that education was a protected sector in Ireland, and that special efforts were being put into the sector. For instance, between 1970 and 1987 Ireland registered a high growth rate (3.8 percent per year) of real public expenditures on education; however, education spending was outgrown by total government spending, and its share of total government spending declined at 4.4 percent a year during the same period.

As shown thus far, the most distinctive achievement of the Irish educational system—at least by comparison with similarly developed countries—has been the relative concentration on higher education.¹⁴ To what extent did this result from carefully designed government policies? The evidence contained in spending figures indicates that the approach of the Irish government can be broadly defined as pro-expansionary towards Higher Education and that public resources were relatively more focused on higher education than in other OECD countries. In 1987, for example, public expenditure per student in Ireland's higher education sector corresponded to 72.8 percent of the country's GDP per capita, the second largest figure among OECD countries. At 94.5 percent, Netherlands had the highest such figure, while for other OECD countries it ranged from 23.3 in Germany to 68.7 in Switzerland. The most

¹⁴ It is worthwhile noticing that World Bank Studies show (e.g. East Asian Miracle, 1993) that the dramatic economic growth of the 8 high-performing Asian economies is due to increased skilled labour force by providing universal primary schooling and better primary and secondary education. It seems to be the case that though this may be true for developing countries, might be different for countries like Ireland that have already reached some level of development.

recently available data show that higher education remains Ireland’s relative priority. One interesting aspect of the Irish demand-side policies regarding Higher Education (HE) is the importance of student aid in comparison with EU countries. While on average the amount spent annually by EU countries with financial aid accounts for almost a fifth of all public expenditure on HE, Ireland, along with the Nordic Countries, and the UK devotes a distinctly higher than average proportion of GDP to public financial support for Higher Education Students.

Table 14: Public Spending per Student in Purchasing Power Parities

	1988		1998		
	Ireland	OECD	Ireland	OECD	EU (1999)
Pre-primary	1,060	1,677	2,559	3,788	
Primary	1,125	2,711	2,574	3,769	3,533
Secondary	1,891	3,150	3,864	5,507	4,940
Tertiary	4,250	5,534	7,998	10,893	7,075
All	1,666	3,372			

In part, this may have been induced by increasing demand for high skilled labour by a growing number of foreign firms.¹⁵ We will come back to this issue in the next section, which deals with FDI in a broader context.

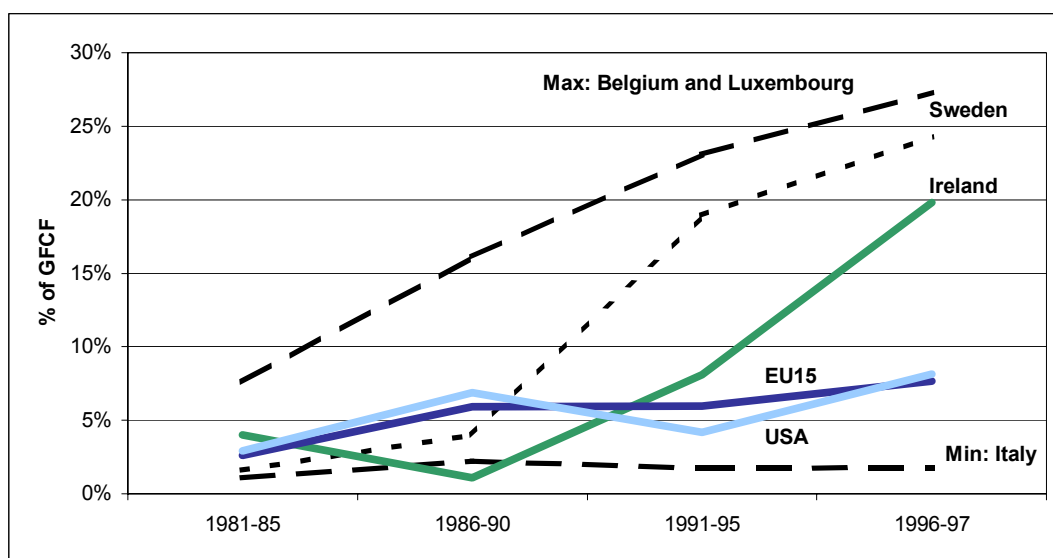
In conclusion, a rapid glance at the available indicators shows that the educational characteristics of the Irish population improved rather rapidly over the last three or four decades. However, and despite some quite particularly successful policies in first expanding access to secondary education, and afterwards in the area of higher education, the Irish achievements have not brought the country to an educational level significantly different from that of its more direct competitors. Therefore, human capital has been an enabler (necessary condition) but not necessarily a driver (sufficient condition) of the “Irish miracle.”

¹⁵ Evidence of this is the fact that throughout the recent process of economic development in Ireland returns to education have been rising, and disproportionately so for those with the highest education, levels despite the steadily increasing supply of better-educated younger entrants into the labour force, as the demand has risen apace. (See appendix 2 for estimates of rates of return).

3.2. FDI—Does Volume Matter?

Perhaps the most quoted catalyst in the Irish performance is the inflow of foreign direct investment. Figure 7 indeed indicates that the FDI component of gross fixed capital formation has boosted more rapidly in the Irish economy than in any other economy, particularly since the late 1980s.

Figure 7: Inward FDI Flows as a Percentage of Gross Fixed Capital Formation, Selected Countries



Source: *World Investment Report, 1995, 1999*

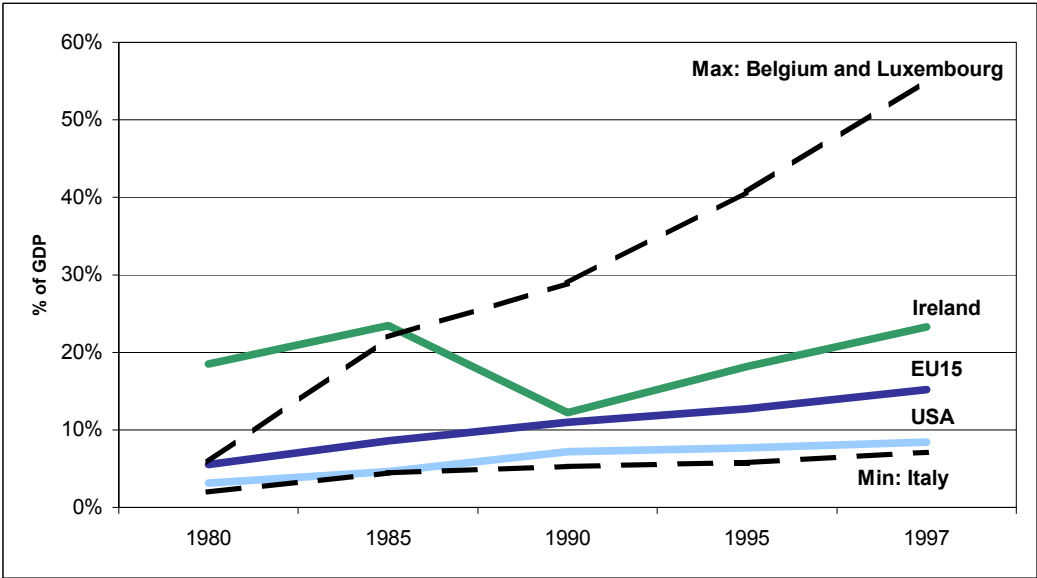
The World Investment Report (1999) reveals that as a result, the FDI inward capital stock has increased from approximately USD 3.7 billion in 1980 to 23.9 in 1998. By consequence, Ireland ranks number 1 in terms of growth in its foreign-owned capital stock with a solid performance of 20 percent a year on average over the time span 1990-98, closely followed by Sweden. This contrasts sharply with the pre-1990 situation, when Ireland was among the lowest ranked in terms of attracting foreign companies. For comparison, net FDI inward stocks for Western Europe as a whole grew at an annual rate of only 9 percent during the same time span, while the US recorded 10.5 percent a year. It is the positive correlation between the growth of FDI inflows and GDP growth that has led many commentators to the conclusion that the volume of foreign capital has been key to the Irish story.

The picture looks somewhat different, though, if one looks at relative figures – that is, at how much output has been generated per unit of FDI capital or, in other words, the inverse foreign capital productivity. Figure 8 shows that rather Belgium and Luxembourg take the lead in terms of the level and growth rate of FDI capital productivity (55 percent of GDP in 1997). The Netherlands ranked second (35 percent) in 1997, and with a solid 23 percent of its GDP, Ireland took the third position in the EU. However, foreign capital productivity in the Irish economy has hardly improved since the 1980s.

Yet in spite of higher FDI productivity neither the Netherlands nor Belgium/Luxemburg or Sweden have experienced a similar growth pattern of labour productivity and TFP than Ireland. Among the developed countries Finland came the closest to the Republic's TFP performance, but did so with far less of an FDI intensity. Also, the US economy grew without the assistance of equally important inward investment inflows in the 1990s. Casual

empiricism thus seems to suggest that increased FDI intensity by itself cannot be the sole story behind the huge leap forward of the Celtic Tiger in terms of TFP growth. Indeed, in growth theories (see e.g. Barro and Sala-I-Martin, 1995, for an overview) foreign capital flows may generally hasten convergence, but it has proved difficult to identify the precise channels through which growth is stimulated by FDI in particular (see e.g. Blomström et al, 1994, or Bornstein and De Gregorio, 1998).

Figure 8: FDI Inward Capital Stocks Relative to GDP. Ireland did not experience increased foreign capital productivity



Source: World Investment Report, 1999
 Note: With a capital-output ratio in 1997 of 3.0 for Belgium/Luxembourg and 3.1 for Italy, these data imply that the foreign stock as a percent of the total physical capital stock fluctuates between 20 percent in Belgium/ Luxembourg and 2.5 percent in Italy.

The ambiguous effect of FDI on cross-section economic performance mainly arises because FDI may “crowd out” or “crowd in” national investment. Crowding out (or in) can take place in either financial or product markets.

In financial markets “crowding out” may take place, for instance, when relatively large FDI inflows are leading to an appreciation of the exchange rate. In that case the host country’s export sector would become less competitive thereby discouraging domestic investments in export-oriented activities.

Crowding out of product markets may happen when indigenous and foreign firms are operating within the same industry. For example, domestic firms may give up on investment projects to avoid the prospect of competing with more efficient foreign competitors. Consequently, the net effect of FDI depends on what happens with the released resources. If they go to other activities in which domestic firms have a greater competitive advantage, there will be no crowding out of economy-wide investment. By contrast, crowding in takes place when investment by foreign affiliates stimulates new investment in downstream or upstream production, or increases the efficiency in the sector. For example, competitors may have to raise their efficiency due to FDI pressures, leading to investment in new technologies and higher profitability.

In the 1980s Ireland was well positioned to experience the “crowding in” effects of FDI to the fullest. This was, in fact, the result of an absence of a well-established industrial sector already paying substantial corporate profit taxes as in other EU countries, combined with the fruits of well thought and consistent development plans that started as early as the 1960s. More precisely, the Industrial Development Authority targeted emerging multinationals, particularly in high-tech sectors such as computers, software, pharmaceuticals and chemicals. In part, Irish policy makers were able to attract these multinational companies by offering very low corporate tax rates.¹⁶

But, in spite of a zero corporate tax rate that dates back to as early as 1957, Irish FDI became only a phenomenon in the late 1980s and the 1990s. Rather key to this issue was a limited supply of electrical engineers, scientists and technicians. Therefore, the university sector was expanded, and priority was given to third level education. By as early as 1979 new and expanded courses in electrical engineering were under way. Thus, a development strategy that was focussed on attracting foreign high-tech investments indirectly brought about demand pressures on higher education. We have indeed documented earlier in this paper that—even though Ireland never was an outlier regarding overall resources spend on education—it has prioritised the higher education sector, was characterized by very high returns to higher education, and holds a top rank regarding graduates in mathematics, computer science, and engineering.

In addition, wages remained surprisingly competitive, largely thanks to lenient social partnership arrangements ensuring minimal wage inflation. Moreover, statutory add-on costs are one of the lowest in Europe, and Irish workers are far less expensive than what is observed on average in the EU. According to the US Department of Labour (2000), for instance, the total hourly compensation costs in 1999 for production workers in manufacturing was USD 13.3 in Ireland, compared to USD 16.4 in the U.K., USD 18.1 in Japan, USD 18.3 in France, USD 18.6 in the USA, USD 20.6 in the Netherlands, and USD 27.2 in Germany. Only Greece, Spain, and Portugal have lower labour costs, but international comparisons reveal that the level of human capital is lower in those three countries, and knowledge of foreign languages, in particular of English, is not very impressive.¹⁷ Also important was the fact that Ireland was fully committed to the Europeanisation process in the late 1980s, giving it an extra edge over the UK. All this may explain why Ireland became a favourable location for foreign investors. But how did it crowd in domestic investment better than other countries?

The next few tables may help to understand this. To start with, evidence presented in Table 15 suggests that foreign plants tended to be larger, and have realized a substantially higher labour productivity than indigenous ones. Secondly, while FDI was predominantly concentrated in relatively high-skill or high-tech intensive activities in the Irish manufacturing sector—such as chemicals, computers, and communication—Table 16 shows that this was far less so the case in other host economies. As a result, the trend of economic activity in increasing returns to scale (IRS) sectors¹⁸ has been upward in Ireland in the 1980s—as opposed to downward

¹⁶ Initially a zero percent corporate tax rate on the profits of manufactured exports, and, later, a 10 percent flat rate on manufacturing profits and internationally traded services profits.

¹⁷ European Commission (2000, 2001).

¹⁸ i.e. sectors in which the minimum efficient scale is reached only at a relatively high production volume

anywhere else (see Table 17)—with economic activity by foreign companies predominantly concentrating in relatively high-tech intensive activities within the IRS sectors (Table 18).

Table 15: Indicators of Size and Productivity: Foreign versus Indigenous Firms

Nationality of ownership	No. of plants		Employment		Employment per plant		Gross Value Added Per Worker
	1995	1998	1995	1998	1995	1998	1998
							(1000 IEP)
Irish	3879	3771	116714	126,690	30	34	29.4
Other EU	346	302	36043	36,671	104	121	89.6
Non EU	379	351	67821	78,843	179	225	132.6
Total foreign	725	653	103864	115,514	143	177	118.9
Total	4604	4424	220578	242204	48	55	72.1

Source: Census of Industrial Production, 1995, 1998

Table 16: FDI Capital Stock as Percent of Total Capital, Manufacturing Sector, 1995-97

	Germany	France	Netherlands	Portugal	UK	USA
manufacturing of:						
chemicals, chemical products	23.5	16.2	28.5	16.1	14.2	33.1
office machinery and computers	3.1	4.1	1.6	0.0	6.6	1.2
communication equipment and apparatus	5.6	6.7	8.7	0.0	10.5	10.0
rest	67.8	73.0	61.3	83.9	68.7	55.7

Source: New Cronos, Eurostat

Table 17: Proportion of Total Manufacturing Employment Located in IRS sectors

Country	1983	1989	Change
Ireland	40	45	+5
Netherlands	54	54	=
Greece	36	35	-1
Italy	56	55	-1
Belgium	55	53	-2
Germany	65	63	-2
Spain	39	37	-2
Portugal	28	25	-3
France	55	51	-4
Sweden	na	na	na
UK	na	na	na
USA	na	na	na

Source: Barry, 1999

Thus, it turns out that FDI inflows into Ireland have not only been increasingly channelled into high skill sectors, but also in sectors in which there are increasing returns at the firm level. This has two important implications.

On the one hand, firms characterized by increasing returns to scale typically need a substantial production capacity in order to reach their optimal efficiency scale in order to optimise the use of their sunk investment costs (special machinery, R&D equipment, etc.). As a result of their large scale they may have an important impact on input demand from indigenous firms. They usually also operate with low unit costs and high labour productivity due to having already attained scale economies through well-established distribution networks.

On the other hand, when these firms are high-skill and technology intensive, they may induce learning-by-observing by other firms and thus indirectly transfers technology and efficiency.

There are thus a number of important indirect effects related to FDI that need to be mentioned too. This is what we will assess next.

Table 18: Employment in Increasing Returns Sectors (IRS) in Ireland

Nace excl IRS sector	Indigenous manufacturing employment as a percent of total manufacturing employment			Foreign owned manufacturing employment as a percent of total manufacturing employment		
	1973	1996	Change	1973	1996	Change
High technology or skill intensive						
34 Elec. Eng.	4.01	5.06	1.05	5.75	19.78	14.03
33 Office machinery	0.10	1.57	1.47	0.83	11.23	10.40
25 225 Chemicals	2.91	3.03	0.12	6.49	13.71	7.22
37 Ind. Eng.	0.29	1.34	1.05	4.09	10.23	6.14
32 Mech. Eng.	2.09	4.33	2.24	2.47	3.59	1.12
Less technology or skill intensive						
26 Man-made fibers	0.01	0.00	-0.01	1.06	1.52	0.46
423 Other foods	0.97	2.82	1.85	2.06	2.18	0.12
242 Cement etc.	0.57	0.32	-0.25	0.00	0.00	0.00
247 Glass, glass wear	2.37	2.40	0.03	0.38	0.04	-0.34
241 Clay prod.	1.30	0.46	-0.84	0.50	0.12	-0.38
421 Cocoa, choc.	0.36	0.44	0.08	3.09	2.45	-0.64
471 Pulp paper	0.82	0.59	-0.23	0.97	0.10	-0.87
481 Rubber prod.	0.43	0.24	-0.19	1.99	0.85	-1.14
429 Tobacco	0.43	0.13	-0.30	1.99	0.68	-1.31
22 223 Metals	0.21	0.34	0.13	1.81	0.36	-1.45
36 Other transport	1.18	2.20	1.02	2.32	0.75	-1.57
35 352 Vehicles	1.02	1.15	0.13	8.59	5.35	-3.24
427 Brewing	0.15	0.15	0.00	5.21	1.60	-3.61
% of total manufacturing	19.22	26.58	7.36	49.60	74.54	24.94
Total jobs	29040	31358	2318	37198	73605	36407

Source: Barry, 1999, who reports that the – admittedly somewhat ad-hoc – selection and definition of the IRS sectors is based on O'Malley, 1992, which is in turn largely drawn on Pratten, 1988.

3.3. FDI, Knowledge Generation, and Spillovers

How may FDI have had economy-wide implications? This is where knowledge generation and spill-overs of foreign firm-specific human capital investments enter the picture. Suppose for instance that foreign firms employ the highest skilled workers to develop new techniques and knowledge within their organization as efficiently as possible. One could make then the following conjectures.

Firstly, as some of the trained workers moved on from foreign to indigenous firms, or perhaps simply thanks to social interactions such as after-work exchange of experiences, the improved human capital gradually affected the economy-wide efficiency, and thus TFP. The first step in documenting this conjecture is difficult, as it would require data on job flows from foreign to indigenous firms, which are currently unavailable. In a second step one would have to show that foreign owned firms have been demanding higher skills than indigenous firms. Here some suitable data are available but they may admittedly illustrate the point only in part. Nevertheless, when one looks for instance at the skill intensity—as measured by the number of workers with a higher education as a percentage of total sector employment – within the manufacturing sector, it is striking that this intensity has increased the most in those sectors in which foreign firms were predominantly active, notably 1) chemicals and chemical products 2) medical and pharmaceutical products; 3) office machinery and equipment; with the exception of food products and beverages (see Table 19).

A second conjecture is that the growth of foreign firms in the skill intensive industries resulted in more research and development, which in turn may have benefited TFP through technological progress. Barrell and Pain (1997) precisely found econometric evidence that the stock of FDI in manufacturing is statistically significantly related to productivity growth in the manufacturing sector as a whole. Interestingly, the boost in FDI inflows indeed went hand in hand with a more than average growth in Irish R&D expenditures when compared to Europe as a whole (see Table 20).

Table 19: Skill Intensity of Irish Manufacturing Sectors and Its Change

NACE:	Share of employment with higher education		Change 1994-97
	1994	1997	
chemicals, chemical products and man-made fibres	30.0	39.7	9.7
electrical and optical equipment	30.8	37.3	6.5
<i>office machinery and computers</i>	41.1	47.0	5.9
<i>electrical machinery and apparatus n.e.c.</i>	27.7	26.3	-1.4
<i>communication equipment and apparatus</i>	31.4	51.7	20.4
<i>medical, precision and optical instruments, watches and clocks</i>	23.1	26.7	3.7
electricity, gas and water supply	19.6	25.8	6.2
transport equipment	26.7	32.4	5.7
pulp, paper and paper products; publishing and printing	21.5	26.4	4.9
machinery and equipment n.e.c.	18.8	23.5	4.7
wood and wood products	6.7	11.4	4.7
basic metals and fabricated metal products	14.3	17.7	3.4
food products and beverages	16.1	19.0	2.9
rubber and plastic products	17.8	19.2	1.5
construction	12.9	14.4	1.4
textiles and textile products	9.4	8.3	-1.1
other non-metallic mineral products	17.2	15.8	-1.4
leather and leather products	18.1	14.1	-4.0
coke, refined petroleum products and nuclear fuel	34.2	N/A	N/A
mufacturing n.e.c.	N/A	12.4	N/A
Manufacturing total	19.4	24.1	4.8

Source: New Cronos, Eurostat

Table 20: Evolution of R&D Efforts

	R&D expenditure % of GNP		Annual average growth of R&D expenditure, %
	1987	1997	1987-97
Ireland	1.0	1.8	12.7
EMU area	1.7	2.2	4.2

Source: World Development Indicators

4. Conclusions

This paper has tried to assess the major sources of the extraordinary Irish growth performance in the 1990s. It focussed thereby largely on the mostly quoted catalysts—i.e., FDI and human capital. Our main findings can be summarized as follows.

- The Republic's growth performance has not been driven by capital deepening, but by systematic efficiency gains. This is an important difference with the experience of other Tigers. Moreover, a declining Irish capital-labour ratio combined with the world's highest total factor productivity (TFP) growth suggests that relatively fast structural growth is likely to continue in the near future.
- The evolutions in educational attainment and volume of FDI have been crucial to the Irish economy. Without increases in human capital and FDI inflows, the Republic would not have been able to catch up with the average European standard of living. However, they were necessary (*enabler*) but not sufficient conditions (*driver*), as these factors alone cannot explain Ireland's performance when compared to other developed countries. For instance, the evolution in the stock of human capital has not been different than what has been observed in the OECD area on average. Neither has Ireland been an outlier regarding resources spent on the educational sector among such countries. Moreover, although FDI inflows have grown fast for a variety of reasons, foreign capital productivity (the FDI inward capital stock relative to GDP) has not changed as substantially in Ireland as it has in some other Member States.
- What stands out in the Irish case, however, is twofold: (i) the consistent development strategies and the pressure this brought about on the educational system, and (ii) the willingness of players in the labour market to commit to a social contract that trades off less than average wage growth for more than average employment growth via investment.
- Not only has incoming investment in Ireland been channelled in increasing return to scale (IRS) sectors, but also were development policies successful in attracting high-tech and high-skill intensive firms within the IRS sectors. This combination had three important implications.
 - Firstly, for such a development strategy to work it was imperative that a sufficient supply of science and engineering graduates was available in the past and could be guaranteed in the future. Consequently, public resources largely focussed on financing and impacting higher education (the creation of Regional Technical Colleges was instrumental in providing access to a diversified supply of third-level education, away from pure academic university education), after having concentrated on producing enough critical mass at the secondary level (free secondary education introduced on the late 1960s).
 - Secondly, the sector composition of foreign firms was well suited to crowd in domestic investment.
 - Thirdly, the particular type of FDI inflows, favourable taxes, the absence of a well-established industrial sector in the beginning of the 1990s, and an increasingly skilled work force ensured fruitful spill-overs from foreign firm-specific human capital investments to indigenous firms.

Consequently, the evidence presented so far seems to point towards the conclusion that the sector composition of FDI – and with it the induced demand pressures for skills and education, the linkages to local companies, and the thereby associated crowding in of domestic investment in key sectors – may have been of more importance for TFP and long run growth than the actual size of the inflows, or spending patterns on education by themselves.

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Annex 1. Overview of the Education Reforms

After the Second World War many European countries embarked on major education reforms. But it was only twenty years later (1967) that Ireland—as the result of a study commissioned to the OECD in 1965—embarked on major reforms to the education sector that over time helped accelerate the modernization of the economy. The OECD study singled out two issues: (i) limited access to secondary and higher education and (ii) inequality of opportunity for children from poorer backgrounds.

Free Secondary Education. In 1967 the Government abolished all secondary school fees¹⁹ and provided free school transport in the rural areas. This fee-paying aspect of secondary education constituted a hurdle for the least off families, so typically among the older generation, those that received secondary and third level education come from a better-off background. This reform addressed both OECD criticisms mentioned in the previous paragraph and resulted into greater participation at secondary level. In 1967 alone enrolments increased by more than 10 percent from 149,000 to 167,000. Thirty years later, about 370,000 students were in full-time education at second level, with as many as 40 percent of those of school leaving age moving on to third level. While in 1964 only 25 percent of 17-year-olds were still in secondary education, by 1994 that figure had risen to 83 per cent. This remarkable expansion of secondary level education created its own momentum, impacting also participation in third-level education.

Table A.21: Main Policy Reforms and Impact

When?	What?	Impact/Expected Impact
1967	Abolished secondary education fees	Increase access to secondary and tertiary
	Creation of Regional Technical Colleges	Increase access to tertiary and indirectly increase retention in secondary
1972	Increase minimum school leaving age from 14 to 15	Increase retention in secondary and indirectly increase access to tertiary
1996	Abolished fees for full-time undergraduate third level education-	Increase access to tertiary and indirectly increase retention in secondary
1998	Increase minimum school leaving age to 16.	Increase retention in secondary and indirectly increase access to tertiary
2000	Raises the minimum school leaving age to sixteen years or the completion of three years of junior cycle education, whichever is later (Education (Welfare) Act, 2000)	

Expansion of Higher Education. At third level the Government pursued and is still pursuing a policy of providing easier access for more students through a combined supply- and demand-side strategy of simplifying the process of entry and of providing additional

¹⁹ In 1966 the government announced free secondary education through a scheme whereby second level schools, that relied on student fees, could receive a grant per pupil in return for eliminating fees. The majority of schools opted into the system.

places for students, particularly in the technological sector. On the supply side around mid 1960s a set of third level institutions—called Technical Colleges in Dublin and Regional Technical Colleges (RTCs) elsewhere—were established in different industrial centres throughout the country.²⁰ In addition, over the past twenty years the opening of new universities in Limerick and Dublin, and the expansion of the RTCs have provided many additional third level places and courses. But the creation of Regional Technical Colleges not only increased access to third level education; more importantly it provided a different form of third level education, getting away from the pure academic university education to a more modern skills-based system. At the same time considerable growth has occurred in the established university sector in particular in the areas of business and technology, but also in the arts and social sciences.

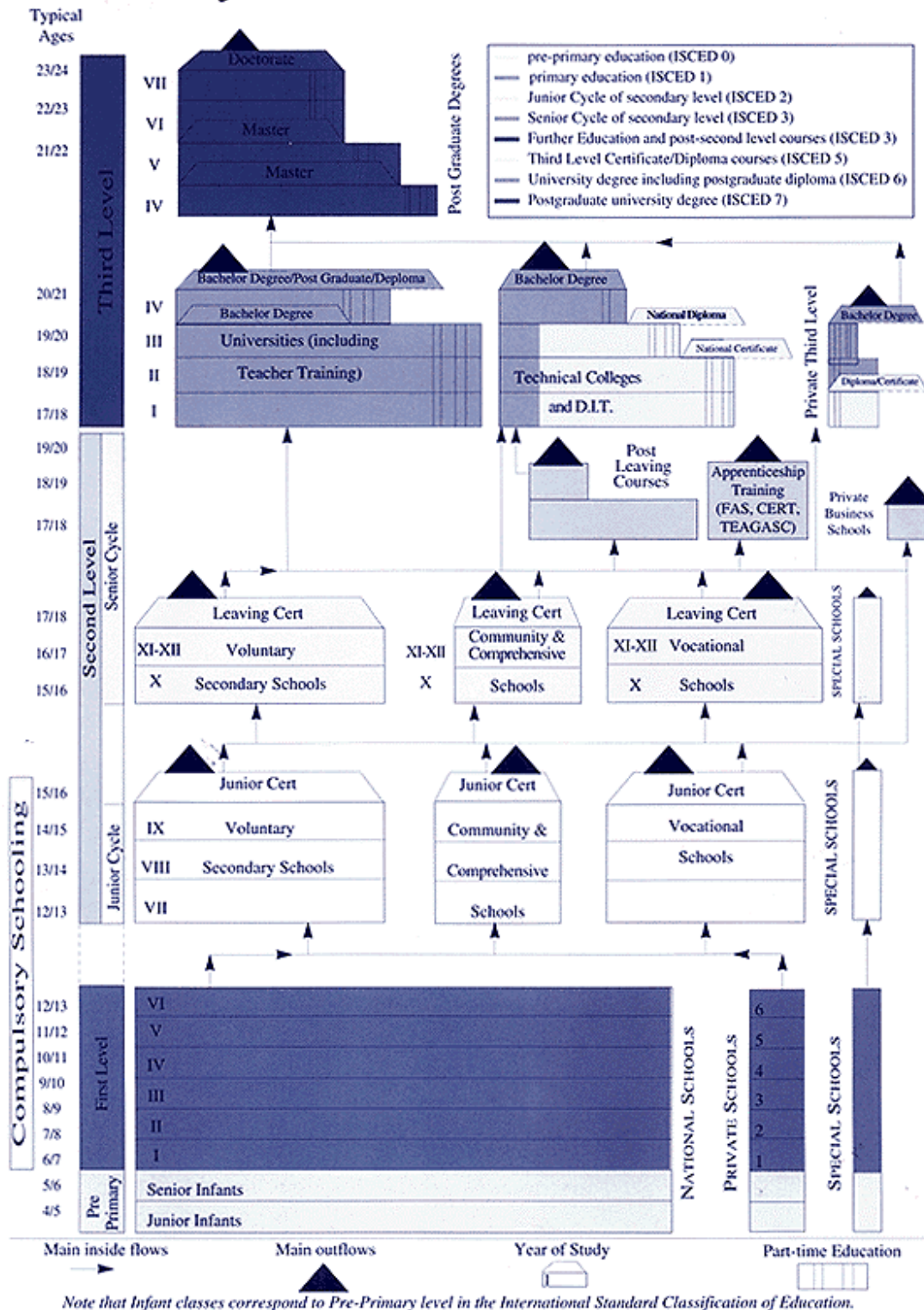
On the **demand-side** we should highlight the existence of means tested grants and scholarships, which made tertiary education more accessible to people from low-income households. Prior to 1968 grants for university students were awarded by the local authorities based on merit. In 1968 the *Higher Education Grants Scheme* was introduced. The grants for university students were subject to means testing and subject to academic criteria. In 1972 a means-tested grants scheme—Vocational Education Committee Scholarship Scheme—to assist non-university students in regional technical colleges and technological institutes was introduced. In 1984 in parallel with an increase in the tuition fees, a tax relief for parents who declared they paid an income to students was introduced (which was abolished later in 1995). In 1994 the academic criteria in establishing grants was abolished. In 1995/96 full-time students in publicly funded third-level institutions paid half tuition fees, and one year later, in January 1996, fees for full-time undergraduate third level education were abolished.

The expansion of supply, together with the introduction of a means-tested third level grant system and the high retention rates of an enlarged second level cohort has opened up the university system to many who otherwise would not have taken their education to this level: from 21,000 students in 1965 to over to nearly 97,000 in 1997 (53,500 of these are currently at University). In 2005, forecast enrolment in HE is 120,000. These rapidly-growing numbers reflect increasing retention rates at second level, demographic trends, and increasing transfer rates into third-level education.

²⁰ RTCs provide education at a sub-degree (diploma) level. However they do compete with Universities in areas such as engineering and architecture. The RTCS's success is mainly attribute to the close links they always kept with the local business. (fusion of the academic and industrial worlds). See Annex 2 for further details on RTCs and the Irish Education System.

Annex 2: Overview of the Education System

Education System in Ireland



The Irish education system consists of three levels: primary education, secondary and vocational schools; and the third level.

Under the **primary school** heading it is also included the pre-school group (Irish children can start primary education at the age of 4).²¹ The typical primary school divides pupils by age into eight-year groups or standards ranging from Junior and senior Infants to sixth class. The normal completion age is 12 years old. So in strict terms primary school education lasts for 6 grades. Six years of age also corresponds to the statutory school starting age as set out in the Education (Welfare) Bill, 1999, and compulsory education lasts for at least 9 years until the age of 16. The New education Bill (2000) raises the minimum school leaving age to sixteen years, or the completion of three years of junior cycle education, whichever is later. The primary education sector comprises primary schools, special schools, and non-aided private primary schools.

Post Primary Education (or Second-level education) consists of a three-year junior cycle followed by a two- or three-year senior cycle. The Junior Certificate examination is taken at the completion of the three-year junior cycle. In the senior cycle (15- to 18-year-old age group) there is an optional one-year transition programme followed by a choice of three two-year Leaving Certificate Programmes. Students normally sit for the examination at the age of 17 or 18, after 5 or 6 years of post-primary education. The second-level sector comprises general secondary (comprising about 60 percent of all secondary education), vocational, (26 percent of second-level students), and community and comprehensive schools (educating 14 percent of the students). An increasing number of courses are available to students after completion of second-level education. They include vocational preparation courses and pre-third level courses. There are more than 300 post-leaving certificate courses of either one or two years' duration.

Third-Level or Higher Education is provided mainly by universities, institutes of technology and colleges of education, and non-State aided private higher education colleges. The non-university or Institutes of Technology sector consists of degree and non-degree programmes whereas the majority of university programmes are for a degree. BAs degrees last from three years (Art, Law, Social Sciences) to 6 years for Medicine. The first post-graduate degree requires another one to three years of study, and a further two years are usually required for a PH.D, and four years for a Doctorate in Science. There are four Universities in Ireland: the National University of Ireland with colleges in Dublin, Cork, Galway and Maynooth, the University of Dublin (Trinity College), the Dublin City University, and the University of Limerick. The Higher Education Authority oversees the work of the universities on behalf of the Department of Education and Science. The Dublin Institute of Technology (DIT) is the biggest third level institution in Ireland with over 22,000 students. The Institutes of Technology—formerly Regional Technical Colleges—, which were introduced during the 1970s to provide for further technical needs, have evolved to become an integral part of the Irish third level system. There are now 14 Institutes throughout Ireland offering education and training, both full-time and part-time, for trade and industry over a broad spectrum of occupations and levels, in the areas of Business, Engineering and Technology and science, and paramedicine.

²¹ There is no national system of pre-school education in Ireland. However, primary (National) schools may accept pupils on or after their 4th birthday. Existing pre-school services are mainly private and not part of the formal education system. The average age to start school is five years.

Financing of Education

Primary Education. The current and capital costs of primary schools, including teacher salaries are predominantly funded by the State and supplemented by local contributions. In addition, special funding arrangements are in place for some schools, for example in disadvantaged areas and for children with special needs. All-Irish schools (schools where education is through the medium of Irish) receive full capital grants and an additional 50 percent of the normal capitation grants.²² Usually they also have an extra teacher. Teachers in all 87 all-Irish schools receive also a special annual allowance.

Second-Level Education. Voluntary secondary schools are privately owned and managed, but publicly aided—over 95 percent of the cost of teachers' salaries are met by the State, and in addition allowances and capitation grants are paid to the 95 percent of secondary schools which participate in the not for fee education system. Teachers who are recognized as being within the quota receive most of their salaries from the Department of Education and Science. Vocational education committees administer Vocational Schools. The state funds 93 percent of the total provision costs and receipts generated by the committees provide the remainder balance. Finally, community and comprehensive schools are allocated individual budgets by the State.

Third-Level Education. Higher education institutions receive state grants, charge tuition fees to students in some institutions, and (for universities and technological colleges) receive income from research and development. In addition to the annual state grants they receive to help meet operational expenses, they also receive grants for capital purposes. Concern about the equity of the student grant schemes led the Government to start, in 1997, to pay the tuition fees of all undergraduate full-time students in publicly funded third-level institutions, provided they have not repeated a year. Students eligible for a grant under the mean-tested student support schemes²³ do not pay registration fees.²⁴ Students enrolled in private HE institutions that are recognized by the state enjoy the same conditions as full-time students in public institutions. Part-time students have to pay registration and tuition fees, however, they are entitled to tax relief on their tuition fees. Post-grad students that receive state grants are exempt from the payment of fees. Means tested grants and scholarships are implemented by local authorities but they are controlled by the central Government.

Women's Labour Force Participation

Education has a very strong effect on the labour force participation of women in Ireland. The compound effects of differences in participation rates by education level combined with the increase on the average educational attainment of the female population accounts for about a third of the rise in female participation since the early 1980s. In the 1970s most women had only attained primary or limited secondary education. Today, those in their twenties, the vast majority have at least completed secondary education and for the cohort leaving school in 1997 the proportion entering third level education may be as high as 50 percent. Between

²² Most of the all-Irish schools function as denominational, with catholic Bishops as patrons.

²³ Award of support is linked to the income of students and their parents (if they are aged over 23 or if they live away from their parent's home only student's income is taken into account).

²⁴ Registration fees are set by the Government while tuition fees are set by the HE institution. In 1997/98 in ???EUR/PPP registration fees were 137 and tuition fees range between 2,456-4,580.

1988 and 1994 the participation rate for women who have completed higher education rose around by 20 percentage points.

Table A.22: Percentage of Women aged 30-44 in Employment, by Level of Educational Attainment (1995)

	Below Upper-secondary	Upper-secondary only	Tertiary non-university	Tertiary University	Total
min in EU	31 (Ireland)	51 (Greece and Spain)	55 (Spain)	77 (Spain)	43 (Spain)
Ireland	31	55	75	81	50
max in EU	69 (Denmark)	84 (Denmark)	94 (Portugal)	95 (Portugal)	83 (Sweden)
OECD average	55	68	81	82	66

Source: OECD (2000).

Rates of Return to Education

Throughout the recent process of economic development in Ireland returns to education have been rising, and disproportionately so for those with the highest education, levels despite the steadily increasing supply of better-educated younger entrants into the labour force, as the demand has risen apace (Barrett, Callan, and Nolan, 1997). Denny and Harmon (2001), using data for 1987 and 1994, estimate returns to education to be in the region of 8 percent to 10 percent per year of schooling for men and 10 percent to 14 percent for women, with the higher returns for women reflecting the lower participation rate in the labour market. A review on returns to education in Ireland (Denny *et al.*, 1999) finds returns to one additional year of education averaging 8 percent for each additional year of schooling, with females enjoying a larger increment at higher levels of education. On average, a junior certificate earns between 11 and 38 percent above that for a person with no qualification, with the mode close to 16-20 percent; leaving certificate estimates ranging from 24 to 46 percent but consistently around 30 percent; a 3rd level diploma earns a return of about 55 percent and a university degree earns on average 80 percent return. Similarly, Heinrich and Vildebrand (2001), using data for 1996, estimate returns to education for males to be between 4.5 and 8.4 percent, and for females between 7.6 and 9.0 percent. Besides providing estimates for the Irish case, Heinrich and Hildebrand (2001) also allows for consistent spatial comparisons with other EU member states. The results indicate that the rates of return to second and third level education in Ireland are, along with Luxembourg, Spain, and Portugal among the highest in the EU. In the Irish case this differential in the returns to third level education is mainly due to the fact that despite strong investment in Higher Education there is still a strong demand for higher education graduates.

		All	Male	Female
Returns to Years of Education		1.2-2.9 (1972)	1.8-2.6 (1972) 8.3 (1987) 7.0-8.2 (1994) 4.5-8.4 (1996)	7.6-9.0 (1996)
Returns to Levels of Education ¹	Intermediate/Junior Certificate		10-37.6	17.0-33.2
	Group Certificate		15-28.9	0.15-29.1
	Leaving Certificate		23.9-46.4	44.4—47.0
	Diploma/3 rd Level		51.0-60.9	60.9-74
	University		79.0-101	104-110

1/ Results from over 10 different studies, with data from 1987 and 1995

Annex 3: Additional Tables

Table A 23: Average Years of Total Education in the Population 25 Years and Older: A Comparison Across OECD Countries

	Total Average Years of Education			Rank			Improvement Ratios			Rank with Respect to Improvement		
	1960	1980	1999	1960	1980	1999	1999 to 1980	1999 to 1960	1980 to 1960	1999 to 1980	1999 to 1960	1980 to 1960
	2.41	4.01	6.73	26	26	26	1.68	2.79	1.66	2	2	3
	3.23	6.81	10.46	25	21	7	1.54	3.24	2.11	3	1	1
	9.43	10.02	10.57	2	6	6	1.05	1.12	1.06	20	25	25
	6.71	8.42	8.80	14	11	19	1.05	1.31	1.25	21	20	15
	7.46	7.85	8.73	10	18	21	1.11	1.17	1.05	18	23	26
	8.37	10.23	11.43	6	3	4	1.12	1.37	1.22	17	18	17
	8.95	9.16	10.09	3	9	10	1.10	1.13	1.02	19	24	27
	5.37	8.33	10.14	20	13	9	1.22	1.89	1.55	11	7	4
	5.78	6.77	8.37	18	22	23	1.24	1.45	1.17	9	13	21
Germany	8.28	8.41		7	12				1.02			28
Denmark	8.80	10.03		4	5				1.14			23
France			9.75			11						
Finland	4.64	6.56	8.51	22	23	22	1.30	1.83	1.41	8	8	7
Germany	5.63	7.11	8.75	19	20	20	1.23	1.55	1.26	10	10	14
Denmark	6.45	7.60	9.02	16	19	17	1.19	1.40	1.18	13	17	20
France	4.56	5.32	7.00	23	24	25	1.32	1.54	1.17	7	11	22
Germany	6.87	8.23	9.72	13	15	12	1.18	1.41	1.20	14	15	18
Denmark	5.27	7.99	9.24	21	17	15	1.16	1.75	1.52	15	9	5
Finland	9.56	11.43	11.52	1	2	3	1.01	1.21	1.20	24	22	19
Germany	6.11	8.28	11.86	17	14	2	1.43	1.94	1.36	5	6	11
Denmark	1.94	3.27	4.91	28	27	27	1.50	2.53	1.69	4	3	2
France	3.64	5.15	7.25	24	25	24	1.41	1.99	1.41	6	5	6
Germany	7.65	9.47	11.36	9	7	5	1.20	1.48	1.24	12	12	16
Denmark	7.30	10.07	10.39	11	4	8	1.03	1.42	1.38	22	14	9
France	2.00	2.80	4.80	27	28	28	1.71	2.40	1.40	1	4	8
Germany	7.67	8.17	9.35	8	16	14	1.14	1.22	1.07	16	21	24
Denmark	8.66	11.91	12.25	5	1	1	1.03	1.41	1.38	23	16	10
France			9.46			13						
Germany			9.19			16						
Denmark	7.19	9.36		12	8				1.30			13
France	6.65	8.81	8.81	15	10	18	1.00	1.32	1.32			
Germany	6.31	7.91	9.25									

Barro-Lee (2000)

Table A.24: Average Years of Primary Education in the Population 25 Years and Older: A Comparison of Selected Countries, 1960-1999

Country	Total Average Years of Primary Education				Rank				Improvement Ratios				
	1960	1980	1999		1960	1980	1999		1999 to 1980	1999 to 1960	1999 to 1960	1999 to 1960	
Canada	5.297	5.448	5.753		8	8	8		1.06	1.09	1.10	1.11	
Mexico	2.103	3.006	4.421		25	25	21		1.47	2.10	2.10	2.10	
United States	5.265	5.862	5.797		9	5	7		0.99	1.10	1.10	1.10	
Japan	4.898	5.246	5.544		12	14	13		1.06	1.13	1.13	1.13	
Korea	2.484	4.296	5.496		24	19	14		1.28	2.21	2.21	2.21	
Austria	3.014	3.687	3.691		23	22	25		1.00	1.22	1.22	1.22	
Belgium	5.996	5.766	5.713		5	7	9		0.99	0.95	0.95	0.95	
Denmark	5.496	5.392	5.562		7	10	12		1.03	1.01	1.01	1.01	
Finland	4.763	5.257	5.586		16	13	11		1.06	1.17	1.17	1.17	
France	4.25	4.151	4.37		18	20	22		1.05	1.03	1.03	1.03	
Germany, West	3.635	3.63	4.435		21	23	20		1.22	1.22	1.22	1.22	
Greece	4.059	4.803	5.376		19	18	17		1.12	1.32	1.32	1.32	
Hungary	6.156	7.456	6.681		4	2	3		0.90	1.09	1.09	1.09	
Iceland	4.792	5.072	5.312		15	17	19		1.05	1.11	1.11	1.11	
Ireland	4.882	5.172	5.324		13	16	18		1.03	1.09	1.09	1.09	
Italy	3.649	3.432	3.83		20	24	24		1.12	1.05	1.05	1.05	
Netherlands	4.731	5.277	5.449		17	11	15		1.03	1.15	1.15	1.15	
Norway	4.876	5.261	6.53		14	12	4		1.24	1.34	1.34	1.34	
Poland	5.972	7.268	7.667		6	3	1		1.05	1.28	1.28	1.28	
Portugal	1.624	2.302	2.826		27	26	27		1.23	1.74	1.74	1.74	
Spain	3.123	3.802	4.134		22	21	23		1.09	1.32	1.32	1.32	
Sweden	5.134	5.19	5.587		10	15	10		1.08	1.09	1.09	1.09	
Switzerland	5.067	5.394	5.396		11	9	16		1.00	1.06	1.06	1.06	
Turkey	1.665	2.095	3.424		26	27	26		1.63	2.06	2.06	2.06	
United Kingdom	6.699	5.82	6.062		2	6	6		1.04	0.90	0.90	0.90	
Australia	6.426	6.456	6.464		3	4	5		1.00	1.01	1.01	1.01	
New Zealand	7.316	7.508	7.424		1	1	2		0.99	1.01	1.01	1.01	
Average	4.569	4.965	5.328										

Source: Barro-Lee (2000)

Table A.25: Average Years of Secondary Education in the Population 25 Years and Older: A Comparison

Country	Average Years of Secondary Education				Rank			Improvement Ratios			Ratio
	1960	1980	1999	1960	1980	1999	1999 to 1980	1999 to 1960	1980 to 1960		
Canada	2.564	4.02	4.335	6	6	7	1.08	1.69	1.57	1	
Mexico	0.258	1.575	1.949	27	24	23	1.24	7.55	6.10		
United States	2.87	4.769	4.842	4	2	2	1.02	1.69	1.66		
Japan	1.769	3.092	3.397	10	11	12	1.10	1.92	1.75		
Korea	0.657	3.471	4.067	18	9	8	1.17	6.19	5.28		
Austria	3.626	4.272	4.631	2	4	4	1.08	1.28	1.18		
Belgium	1.319	2.103	2.304	13	20	22	1.10	1.75	1.59		
Denmark	2.939	3.922	3.853	3	7	9	0.98	1.31	1.33		
Finland	0.481	3.466	3.821	22	10	10	1.10	7.94	7.21		
France	1.464	2.938	3.449	11	13	11	1.17	2.36	2.01		
Germany, West	4.586	5.077	4.742	1	1	3	0.93	1.03	1.11		
Greece	0.486	2.043	2.605	21	21	21	1.28	5.36	4.20		
Hungary	0.357	1.387	1.657	24	26	26	1.19	4.64	3.89		
Iceland	0.723	2.416	2.948	17	17	16	1.22	4.08	3.34		
Ireland	1.444	2.755	3.084	12	14	15	1.12	2.14	1.91		
Italy	0.845	2.238	2.714	16	19	18	1.21	3.21	2.65		
Netherlands	0.501	2.749	3.101	20	16	14	1.13	6.19	5.49		
Norway	1.179	4.554	4.612	14	3	5	1.01	3.91	3.86		
Poland	0.646	1.648	1.824	19	23	24	1.11	2.82	2.55		
Portugal	0.282	1.407	1.714	26	25	25	1.22	6.08	4.99		
Spain	0.414	1.812	2.611	23	22	20	1.44	6.31	4.38		
Sweden	2.279	3.704	5.048	7	8	1	1.36	2.22	1.63		
Switzerland	1.939	4.202	4.488	9	5	6	1.07	2.31	2.17		
Turkey	0.308	0.811	1.104	25	27	27	1.36	3.58	2.63		
United Kingdom	0.912	2.349	2.688	15	18	19	1.14	2.95	2.58		
Australia	2.597	3	3.176	5	12	13	1.06	1.22	1.16		
New Zealand	2.136	2.753	2.947	8	15	17	1.07	1.38	1.29		
Average	1.466	2.909	3.249								

Source: Barro-Lee (2000)

Table 26: Average Years of Higher Education in the Population 25 Years and Older: A Comparison Across OECD Countries

Country	Average Years of Higher Education		Rank			Improvement Ratios			Rank with Respect to		
	1960	1999	1960	1980	1999	1999 to 1980	1999 to 1960	1980 to 1960	1999 to 1980	1999 to 1960	
Canada	0.508	0.95	3	2	2	1.42	2.65	1.87	24	24	21
Mexico	0.044	0.171	24	23	26	2.10	8.16	3.89	12	10	7
United	0.53	0.957	1	1	1	1.68	3.03	1.81	19	23	22
Japan	0.205	0.468	7	7	6	1.67	3.80	2.28	20	19	13
Korea	0.09	0.31	17	14	5	2.89	9.97	3.44	4	7	9
Austria	0.069	0.103	18	26	21	4.59	6.86	1.49	1	12	25
Belgium	0.145	0.312	8	13	10	2.29	4.92	2.15	8	15	14
Denmark	0.512	0.544	2	5	12	1.24	1.32	1.06	27	27	27
Finland	0.129	0.376	10	8	7	1.94	5.67	2.91	16	13	12
France	0.064	0.257	20	17	16	2.16	8.69	4.02	11	9	6
Germany,	0.058	0.216	21	21	15	2.64	9.83	3.72	5	8	8
Greece	0.098	0.298	16	15	17	1.79	5.45	3.04	17	14	11
Hungary	0.134	0.275	9	16	22	1.72	3.52	2.05	18	20	17
Iceland	0.116	0.221	13	20	20	2.20	4.20	1.91	10	18	20
Ireland	0.129	0.248	10	18	13	2.45	4.71	1.92	6	17	19
Italy	0.066	0.128	19	24	23	3.59	6.95	1.94	3	11	18
Netherlands	0.041	0.354	25	10	11	1.95	16.80	8.63	15	1	1
Norway	0.055	0.344	23	12	9	2.08	13.04	6.25	13	2	4
Poland	0.119	0.212	12	22	24	1.95	3.47	1.78	14	21	23
Portugal	0.032	0.103	26	26	25	3.61	11.63	3.22	2	4	10
Spain	0.106	0.223	14	19	18	2.28	4.80	2.10	9	16	15
Sweden	0.235	0.483	6	6	8	1.50	3.08	2.06	22	22	16
Switzerland	0.295	0.345	5	11	19	1.46	1.71	1.17	23	26	26
Turkey	0.023	0.113	27	25	27	2.37	11.65	4.91	7	3	5
United	0.056	0.371	22	9	14	1.61	10.70	6.63	21	6	3
Australia	0.407	0.665	4	4	4	1.40	2.29	1.63	25	25	24
New Zealand	0.104	0.848	15	3	3	1.36	11.07	8.15	26	5	2
Average	0.162	0.366									

Source: Barro-Lee (2000).

Table A. 27: Average Years of Education in the Female Population 25 Years and Older: A Comparison Across OECD Countries

Country	Total Average Years of Female Education			Rank			Improvement Ratios			Rank with Respect to Improvement		
	1960	1980	1999	1960	1980	1999	1999 to 1980	1999 to 1960	1980 to 1960	1999 to 1999	1999 to 1980	1980 to 1980
Mexico	2.13	3.61	6.32	26	27	27	1.75	2.97	1.69	2	4	3
Korea	2.04	5.42	9.42	27	24	10	1.74	4.62	2.66	3	1	1
Australia	9.21	9.54	10.30	2	5	6	1.08	1.12	1.04	22	25	27
Austria	5.16	7.11	7.99	21	20	23	1.12	1.55	1.38	19	12	8
Belgium	7.26	7.50	8.41	10	19	20	1.12	1.16	1.03	20	24	28
Canada	8.46	10.07	11.38	5	3	4	1.13	1.35	1.19	18	20	20
Denmark	8.82	8.32	9.25	3	10	14	1.11	1.05	0.94	21	26	29
Finland	5.48	8.20	9.86	20	12	7	1.20	1.80	1.50	12	8	6
France	5.55	6.74	8.14	18	22	22	1.21	1.47	1.21	11	15	18
West	7.57	8.20		8	12				1.08	27	27	25
East	7.65	9.29		7	6				1.21	27	27	19
Germany			9.31			12				27	27	
Greece	3.85	5.79	7.46	25	23	24	1.29	1.94	1.50	8	6	5
Ireland	6.67	7.65	9.02	13	17	15	1.18	1.35	1.15	14	19	23
Italy	4.20	4.77	6.57	23	25	26	1.38	1.56	1.14	7	11	24
Japan	6.38	7.82	9.34	14	15	11	1.19	1.46	1.23	13	16	15
Netherlands	5.13	7.58	8.88	22	18	16	1.17	1.73	1.48	16	9	7
New	9.47	11.21	11.26	1	2	5	1.00	1.19	1.18	24	23	21
Norway	5.86	7.75	11.59	17	16	2	1.50	1.98	1.32	6	5	13
Portugal	1.53	2.84	4.80	28	28	28	1.69	3.14	1.86	4	3	2
Spain	3.88	4.53	7.14	24	26	25	1.58	1.84	1.17	5	7	22
Sweden	7.53	9.21	11.39	9	7	3	1.24	1.51	1.22	10	14	16
Switzerland	6.97	9.57	9.59	12	4	9	1.00	1.38	1.37	25	18	9
Turkey	1.06	1.64	3.91	29	29	29	2.38	3.69	1.55	1	2	4
United	7.69	8.11	9.30	6	14	13	1.15	1.21	1.05	17	22	26
United	8.74	11.85	12.21	4	1	1	1.03	1.40	1.36	23	17	10
Czech			8.86			17				27	27	
Slovakia			8.64			18				27	27	
Czechoslov	7.02	8.74		11	8		0.00	0.00	1.25	27	27	14
Hungary	6.24	8.43	8.21	15	9	21	0.97	1.32	1.35	26	21	11
Poland	6.18	8.28	9.74	16	11	8	1.18	1.58	1.34	15	10	12
Average	6.00	7.44	8.81									

Source: Barro-Lee (2000).

Table A.28: Distribution of the labour force 25 to 64 years of age by level of educational

	Pre-primary and primary	Lower secondary education	Pre-primary, secondary and lower secondary	Upper secondary education	Tertiary	Of which Univ. Programs (%)	All levels of education	Ranking of percent in	Highest Proportion in Primary (ranking)	Highest Proportion in Upper Secondary	Highest Proportion in Tertiary
Australia	38		38	33	29	0.664	100	9	8	20	7
Austria ¹	21		21	60	13	0.595	100	14	18	3	24
Belgium	11	21	32	35	33	0.485	100	19	12	19	4
Canada	16		16	28	43	0.487	100	18	22	23	1
Czech Republic	11		11	77	12		100		27	1	26
Denmark	N	17	17	54	28	0.226	100	22	20	8	10
Finland ¹	26		26	41	33	0.445	100	21	14	16	3
France	15	18	34	43	23	0.510	100	15	10	13	18
Germany	1	11	12	57	27	0.617	100	12	26	7	12
Greece ¹	39	9	49	27	20	0.735	100	6	5	24	20
Hungary	1	23	24	59	17		100		15	4	21
Iceland	2	35	37	29	22	0.764	100	5	9	22	19
Ireland	16	25	42	32	26	0.508	100	16	7	21	14
Italy	15	32	47	35	12		100		6	18	25
Japan	18		18	50	32	0.641	100	11	19	10	5
Korea	17	16	33	42	24	0.775	100	3	11	14	17
Mexico ¹	55	21	75	8	17	0.914	100	2	3	28	22
Netherlands	8	20	28	43	28		100		13	12	9
New Zealand	23		23	41	28	0.493	100	17	16	15	8
Norway ¹	0.1	14	14	39	28	0.917	100	1	25	17	11
Poland	17		17	67	13		100		21	2	23
Portugal	66	13	78	11	10	0.727	100	7	1	27	27
Spain	34	24	59	16	26	0.710	100	8	4	25	15
Sweden	9	12	21	49	30	0.465	100	20	17	11	6
Switzerland	16		16	59	25	0.601	100	13	23	6	16
Turkey	68	9	77	14	9		100		2	26	28
United Kingdom	14		14	59	27	0.657	100	10	24	5	13
United States	4	7	11	51	38	0.765	100	4	28	9	2
Country mean	20	18	32	41	24.05	0.62	100				

Source: OECD, 2001.

Table A.29: Educational attainment (ISCED) of persons aged 25-59 (in Percent)

Country	ISCED 0-2		Improvement	Ranking of Improvement	ISCED 3		Improvement	Ranking of Improvement	ISCED 5-7		Improvement	Ranking of Improvement
	1992 (Q2)	1997 (Q2)			1992Q2	1997 Q2			1992Q2	1997Q2		
B	47.3	39.3	0.83	2	30.4	33.6	1.11	6	22.2	27.0	1.22	7
DK	23.8	20.0	0.84	4	56.3	53.6	0.95	10	20.0	26.4	1.32	4
D	18.3	18.0	0.98	10	60.0	58.6	0.98	9	21.7	23.5	1.08	9
EL	60.3	50.6	0.84	3	26.3	32.4	1.23	2	13.4	16.9	1.26	5
E	74.7	64.9	0.87	5	11.9	15.2	1.28	1	13.4	19.9	1.49	2
F	.	37.3	.	.	.	43.4	.	.	.	19.3	.	.
IRL	55.9	48.7	0.87	6	26.5	28.1	1.06	7	17.5	23.2	1.33	3
I	64.6	58.6	0.91	8	27.6	32.3	1.17	4	7.7	9.1	1.18	8
L	63.9	52.2	0.82	1	23.4	27.3	1.17	5	12.6	20.4	1.62	1
NL	.	34.1	.	.	.	42.1	.	.	.	23.8	.	.
A	.	24.9	.	.	.	66.4	.	.	.	8.7	.	.
P	78.6	76.2	0.97	9	10.2	12.0	1.18	3	11.2	11.8	1.05	10
FIN	.	27.4	.	.	.	51.2	.	.	.	21.4	.	.
S	.	23.3	.	.	.	49.1	.	.	.	27.6	.	.
UK	50.2	44.8	0.89	7	30.6	31.9	1.04	8	19.2	23.4	1.22	6

Source : Labour Force Survey - 1992-97

Table A.30: Educational Attainment of the Population 25-59 (1997)

	ISCED 0-2	ISCED3	ISCED5-7	Total	Ranking witi
Be	39	34	27	99.9	8 8
Dk	20	54	26	100	14 3
De	18	59	24	100.1	15 2
Gr	51	32	17	99.9	5 9
Es	65	15	20	100	2 14
Fr	37	43	19	100	9 6
Ie	49	28	23	100	6 12
it	59	32	9	100	3 10
lu	52	27	20	99.9	4 13
nl	34	42	24	100	10 7
at	25	66	9	100	12 1
pt	76	12	12	100	1 15
fi	27	51	21	100	11 4
se	23	49	28	100	13 5
uk	45	32	23	100.1	7 11
EU weighted average	41	39	20	100	
EU unweighted average	41	38.5	20.2	99.993333	

Source: Labour Force Survey 1992-1997.

Year	1988	1990-91	1990-91	1993-98	1988	1990-91	1990-91	1993-98	1988	1990-91	1990-91	1993-98	1990-91	1990-91	1991
Country	13	10	14	13	13	9	13	13	13	9	13	13	9	1	1
Canada	52.3	59.9	62	49.4	50.6	62.8	68.8	49.9	50.6	62.8	68.8	49.9	50.6	10	52
United States	47.4	58.4	55.3	47.6	47.9	64.7	67	50.8	47.9	64.7	67	50.8	54.7	8	52
Japan				57.1				53.1				53.1		4	
Korea	56.8	74.8	73.4	57.7	55	67.9	77.5	53.5	55	67.9	77.5	53.5	53.1	3	
Austria				50.9				51.9				51.9		5	
Belgium				53.3				48.5				48.5	50.7	15	42
Denmark				46.5				43.9				43.9	47.5	23	52
Finland													56.9	5	
France			64.2	49.2	13		68.6	45.1	13		68.6	45.1	53.1	21	52
Germany				48.4	14			49.9	14			49.9	50.3	10	52
Greece				44	23			44.9	23			44.9	50.4	22	50
Hungary		68.2	68.4	50.2	9		62.5	51.8	9		73.4	51.8	49.9	6	52
Iceland				45.9	21			46.2	21			46.2	51.8	20	52
Ireland	50.4	60	60.5	50	10	46.9	63.3	49.5	12	56.5	63.3	49.5	50.9	12	52
Italy		67.8	64			66.9	69.9			66.9	69.9		52.9	7	51
Netherlands				51.6	5			51.7	5			51.7	48.5	7	51
Norway				46.1	20			48.3	20			48.3	52.4	17	51
Portugal		55.5	48.3	42.3	24		54.8	42.8	24		62.6	42.8	47.8	24	52
Spain	51.2	61.9	55.4	44.8	22		61.7	47.7	22		67.5	47.7	50.4	19	4
Sweden				47.7	15			48.8	15			48.8	53.9	14	52
Switzerland			70.8	50.6	8			48.4	8		73.7	48.4	51.1	16	52
United Kingdom	51	62.6	60.6	47	18	52	62.6	49	18	62.6	68.3	49		13	
Australia				49.8	11			50.4	11			50.4		9	
New Zealand				47.2	17			48.1	17			48.1	52.8	18	52
Czech Republic				52.3	4			57.4	4			57.4		1	
Slovak Republic				50.8	7			54.4	7			54.4		2	
Un-weighted Average	51.5	63.2	62.1	49.2	50.5	62.3	69.1	49.4	51.4	62.3	69.1	49.4	51.4	51.4	52

Source: Barro-Iee (2001)

Table A.32: Percentage of the Population that has attained at least upper secondary education (1999): A Comparison Across Countries

	Rankings									
	Ages 25-64	Ages 25-34	Ages 35-44	Ages 45-54	Ages 55-64	Ages 25-64	Ages 25-34	Ages 35-44	Ages 45-54	Ages 55-64
Australia	57	65	59	55	44	17	20	18	16	
Austria ²	74	83	78	69	59	10	12	11	12	
Belgium	57	73	61	50	36	18	16	17	20	
Canada	79	87	83	78	62	8	8	7	8	
Czech Republic	86	93	89	85	75	2	4	2	2	
Denmark	80	87	80	79	70	7	7	10	6	
Finland	72	86	82	67	46	12	10	8	13	
France ³	62	76	65	57	42	15	15	15	15	
Germany	81	85	85	81	73	5	11	5	3	

Japan	81	93	92	79	60	6	2	1	7	
Korea	66	93	72	47	28	14	3	14	21	
Luxembourg	56	61	57	52	41	20	23	22	19	
Mexico	20	25	22	16	9	28	28	27	27	
New Zealand	74	79	77	71	60	11	14	12	10	
Norway ²	85	94	89	79	68	3	1	3	5	
Poland ²	54	62	59	53	37	21	22	19	18	
Portugal	21	30	21	15	11	27	26	28	28	
Spain	35	55	41	25	13	25	25	25	25	
Sweden	77	87	81	74	61	9	9	9	9	
Switzerland	82	89	84	79	72	4	5	6	4	
Turkey	22	26	23	18	12	26	27	26	26	
United Kingdom ³	62	66	63	60	53	16	19	16	14	
United States	87	88	88	88	81	1	6	4	1	
Country mean	62	72	66	58	45					

Source: OECD 2001

	Ages 25-64	Ages 25-34	Ages 35-44	Ages 45-54	Ages 55-64	Ages 25-64	Ages 25-34	Ages
Australia	27	29	29	28	18	8	12	7
Austria ¹	11	13	13	10	6	25	24	2
Belgium	26	34	28	24	15	10	6	1 ¹
Canada	39	47	40	38	27	1	1	2
Czech Republic	11	11	13	10	9	26	27	2
Denmark	27	29	29	27	19	9	13	8
Finland	31	37	35	29	21	4	3	4
France	21	31	21	18	12	17	10	1 ¹
Germany	23	22	26	25	19	13	20	1 ¹
Greece	18	25	21	15	9	21	18	2 ¹
Hungary	14	14	14	14	11	22	23	2
Iceland	22	28	25	20	11	16	14	1
Ireland¹	21	29	22	16	11	18	11	1
Italy	9	10	11	10	5	28	28	2 ¹
Japan	32	45	42	25	14	3	2	1
Korea	23	35	24	13	9	14	5	1 ¹
Luxembourg	18	21	18	20	12	20	21	2
Mexico	13	16	15	9	5	23	22	2
Netherlands	23	25	25	21	17	15	19	1
New Zealand	27	26	29	29	23	7	16	5
Norway ¹	27	33	29	25	18	6	8	6
Poland ¹	11	12	10	11	10	24	25	2
Portugal	10	12	10	9	7	27	26	2
Spain	21	33	23	15	9	19	7	1 ¹
Sweden	29	32	31	30	21	5	9	5
Switzerland	24	26	26	23	18	12	17	1 ¹
Turkey	7	8	7	8	5	29	29	2 ¹
United Kingdom	25	27	26	24	19	11	15	1
United States	36	37	36	38	28	2	4	3
Country mean	22	26	23	20	14			

Source: OECD 2001.

Table A.34: Educational attainment of the population 25 to 64 Years of Age (1999): A Comparison Ac

	Pre-Primary, Primary, and Lower Secondary	Upper Secondary Education (in some countries also include ^{Post-secondary})	Tertiary	Of which University Programs	Ranking of percent of Univ. Programs in HE	Highest Proj in Prim: (rankin
Australia	43	31	27	0.662	16	9
Austria	26	57	11	0.563	21	18
Belgium	43	31	26	0.466	26	8
Canada	21	28	39	0.486	24	21
Czech Republic	14	75	11	1.000	1	28
Denmark	20	53	27	0.249	29	22
Finland	28	40	31	0.443	28	16
France	38	40	21	0.512	22	10
Germany	19	53	23	0.569	20	24
Greece	50	27	18	0.688	14	6

Korea	34	44	23	0.746	11	14		
Luxembourg	38	44	18	0.639	17	11		
Mexico	80	7	13	0.905	7	1		
Netherlands	35	42	23	0.891	8	13		
New Zealand	26	39	27	0.486	25	17		
Norway	15	56	27	0.925	6	27		
Poland	22	64	11	1.000	1	20		
Portugal	79	11	10	0.724	12	2		
Spain	65	14	21	0.707	13	4		
Sweden	23	48	29	0.458	27	19		
Switzerland	18	58	24	0.616	18	25		
Turkey	78	14	8	1.000	1	3		
United Kingdom	18	57	25	0.670	15	26		
United States	13	51	36	0.768	10	29		
Country mean	36	40	22					

Source: OECD 2001.

Table A. 35: Graduates by field of study (1999): Distribution of tertiary graduates in public and private institutions, by field of study

	Health and welfare		Life sciences, physical sciences & mathematics		Mathematics and computer science		Humanities, arts and education		Social sciences, business, law and services		Engineering, manufacturing and construction								
	Type B	Type A	Type B	Type A	Type B	Type A	Type B	Type A	Type B	Type A	Type B	Type A							
Australia	m	15.6	m	8.1	m	4.4	m	27.2	m	36.8	m	7.9			5	15			
Austria	m	9.4	m	10.2	m	3.3	m	22.9	m	36.8	m	16.9			16	6			
Belgium (Fl.) ¹	28.0	14.0	0.4	11.7	3.0	2.3	28.3	25.8	27.2	31.5	13.1	14.7			9	18	3	1	
Canada	19.4	7.9	3.5	9.4	5.3	3.9	12.7	28.4	41.1	39.8	17.1	8.2			11	21	6	9	
Czech Republic	30.8	9.8	3.9	8.6	3.3	3.5	14.7	21.4	37.3	36.3	10.2	20.3			7	15	5	12	1
Denmark	42.7	m	1.4	m	3.5	3.5	17.7	m	20.9	m	13.7	m			3	12	1		
Finland	35.7	16.9	1.8	7.5	3.0	3.2	4.0	22.9	42.2	25.7	13.4	23.8			6	4	11	18	1
France ¹	20.7	2.0	2.1	11.5	4.4	5.0	1.5	28.1	44.0	37.7	27.4	12.6			10	26	9	4	1
Germany	51.3	14.6	3.4	10.9	0.3	5.1	10.8	22.6	20.0	26.7	13.5	20.0			2	7	7	5	1
Hungary	m	6.9	m	5.6	m	1.3	m	34.2	m	38.0	m	14.0			22	22			
Iceland*	3.4	14.1	a	8.0	15.8	2.4	46.4	37.1	30.1	33.1	4.3	5.2			20	8	16		
Ireland	8.7	8.3	10.6	8.9	10.5	10.2	7.6	32.9	41.2	31.0	21.3	8.1			16	18	1	11	
Italy	a	15.5	a	7.0	a	4.0	100.0	20.5	a	37.0	a	15.9			6	19			
Japan ^{1,3}	16.6	4.9	0.6	7.9	n	x	23.8	24.5	15.3	37.5	16.4	21.4			12	24	17	17	
Korea	7.9	6.6	1.2	10.2	1.5	4.5	22.1	26.7	24.5	25.1	42.8	27.1			17	23	15	7	1
Luxembourg	m	m	m	m	m	m	m	m	m	m	m	m							
Mexico	m	8.0	m	4.2	m	6.9	m	20.2	m	46.9	m	13.7			20	26			
Netherlands	41.8	20.1	a	5.5	10.3	2.2	a	22.9	44.7	37.9	3.2	11.4			4	3	23		
New Zealand	7.5	13.9	4.1	14.3	0.8	1.6	48.2	32.9	35.2	28.5	3.8	6.4			18	10	4	1	1
Norway*	1.1	27.4	0.1	4.5	13.6	3.0	6.2	27.1	64.8	25.0	13.5	8.1			21	1	19	25	
Poland ²	a	3.2	a	5.1	a	1.7	100.0	27.2	a	50.1	a	12.6			25	24			
Portugal	m	m	m	m	m	m	m	m	m	m	m	m							
Slovak Republic	74.6	8.7	1.4	6.1	n	6.3	9.5	29.4	10.5	34.8	4.0	14.8			1	17	13	20	
Spain	9.6	11.1	0.6	8.6	9.6	3.9	10.3	23.0	43.4	41.0	26.5	12.3			15	13	16	13	
Sweden	10.3	23.8	2.1	5.6	9.5	3.1	12.7	26.5	30.8	22.0	32.7	18.9			14	2	8	21	
Switzerland	13.2	12.8	1.3	9.3	5.4	6.2	16.5	21.1	49.0	34.6	14.6	15.7			13	11	14	10	
Turkey	7.2	8.2	6.5	13.0	4.7	3.7	4.7	35.0	40.3	26.4	36.6	13.9			19	19	2	2	1
United Kingdom	39.5	12.2	5.7	9.8	8.4	5.9	15.1	30.3	21.3	29.5	10.0	12.2			5	12	3	8	
United States	30.4	10.2	1.8	8.3	4.2	3.2	3.0	27.1	42.4	44.2	17.2	6.9			8	14	10	14	1
Country mean	21.8	11.5	2.3	8.6	5.1	3.9	22.4	26.6	31.5	34.9	15.5	13.8							

Source: OECD 2001.

Table A.36: Participation in Tertiary Education: Percent of Relevant Age group

	1980	1997	Ranking in 1980	Ranking in 1997	Improvement between 1980 and 1997	Ranking of Improvement
Australia	25	80	13	3	3	4
Austria ¹	22	48	16	13	2.18	13
Belgium	26	57	11	8	2.19	12
Canada	57	90	1	1	1.58	22
Czech Republic	18	24	18	24	1.33	25
Denmark	28	45	7	18	1.61	21
Finland ¹	32	74	3	4	2.31	9
France	25	51	13	11	2.04	14
Germany	27	47	8	14	1.74	17
Greece ¹	17	47	23	14	2.76	5
Hungary	14	25	25	23	1.79	16
Ireland	18	41	18	20	2.28	11
Italy	27	47	8	14	1.74	17
Japan	31	43	4	19	1.39	24
Korea	15	68	24	5	4.53	1
Mexico ¹	14	16	25	28	1.14	28
Netherlands	29	47	6	14	1.62	19
New Zealand	27	63	8	6	2.33	8
Norway ¹	26	62	11	7	2.38	7
Poland	18	24	18	24	1.33	25
Portugal	11	38	27	21	3.45	3
Slovak	18	22	18	26	1.22	27
Spain	23	53	15	9	2.30	10
Sweden	31	50	4	12	1.61	20
Switzerland	18	34	18	22	1.89	15
Turkey	5	21	28	27	4.20	2
United Kingdom	19	52	17	10	2.74	6
United States	56	81	2	2	1.45	23
Mean	24.18	48.21			2.16	

Source: WDI

Table A.37: Human capital growth in the total working-age population and in the employed population (1989-1996): *Percentage point change in the proportion of individuals with tertiary qualifications¹ in the working-age population and in the employed population²*

	Reference period begins	Working-age population ²	Employed population ²	Ranking	
Australia	1989	2.80	3.58	14	12
Austria	1989	1.76	1.58	17	18
Belgium	1989	7.07	7.36	3	4
Canada	1989	6.90	6.77	4	6
Denmark	1989	4.22	3.89	8	11
Finland	1989	3.56	5.72	12	8
France	1989	5.38	6.09	6	7
Germany	1992	0.38	2.30	19	16
Ireland	1989	7.79	7.74	2	2
Italy	1990	2.46	3.39	15	14
Netherlands	1990	3.35	2.99	13	15
New Zealand	1989	2.43	0.56	16	19
Norway	1989	4.00	3.52	11	13
Portugal	1989	4.44	6.92	7	5
Spain	1989	8.21	10.78	1	1
Sweden	1989	4.09	5.69	10	9
Switzerland	1991	1.63	1.91	18	17
United Kingdom	1989	6.40	7.47	5	3
United States	1989	4.14	3.91	9	10

1. Data were classified according to ISCED-76.

2. "Working age population" and "employed population" refer to individuals between 25 and 64 years of age.

Source: OECD Economic Outlook, June 2000.

Table A.38: Science graduates in the youth labour force (1999): Number of science graduates per 100 000 persons in the labour force 25 to 34 years of age, by gender

	Tertiary-type B	Tertiary-type A and advanced research programmes	All tertiary education	Ranking		
Australia	m	1303	m		6	
Austria	m	392	m		20	
Canada	418	822	1240	6	11	8
Czech	127	544	671	14	19	17
Denmark	459	m	m	4		
Finland	422	1363	1785	5	3	3
France	628	1434	2063	2	1	2
Germany	141	693	835	13	14	12
Hungary	n	775	775		12	13
Iceland	204	546	750	11	18	15
Ireland	1448	1340	2789	1	5	1
Japan	566	1048	1614	3	8	5
Mexico	x	x	606			18
Netherlands	12	569	581	17	17	19
New Zealand	107	1388	1494	16	2	6
Norway	161	597	759	12	15	14
Poland	a	743	743		13	16
Spain	282	1077	1359	8	7	7
Sweden	127	902	1029	15	9	10
Turkey	409	569	978	7	16	11
United	266	1353	1620	9	4	4
United States	220	878	1098	10	10	9
Country	316	917	1199			

Note: Science fields include life sciences; physical sciences, mathematics and statistics; computing; engineering and engineering trades, manufacturing and processing, architecture and building.

Source: OECD, 2001..

Table A.39: Science Enrollments as a proxy for Graduates

		Year	Education	Humanities	Law and Social Sciences	Natural Sciences, Engineering and Agriculture	Medical Sciences	Others	Total
EU 15	Austria	1970	0.1240	0.2117	0.2472	0.2726	0.1396	0.005	1
		1980	0.0834	0.2273	0.3072	0.2200	0.1432	0.019	1
		1990	0.0568	0.1801	0.3823	0.2911	0.0818	0.008	1
		1995	0.0665	0.1555	0.4041	0.2836	0.0792	0.011	1
Belgium	1970	0.0467	0.1161	0.3536	0.2222	0.2558	0.006	1	
	1980	0.0610	0.1514	0.2730	0.2359	0.2725	0.006	1	
	1990	0.1022	0.0694	0.4422	0.2420	0.1310	0.013	1	
Denmark	1970	0.1040	0.1009	0.3694	0.2511	0.1349	0.040	1	
	1980	0.2022	0.2760	0.1899	0.1958	0.1250	0.011	1	
	1990	0.2258	0.1867	0.1895	0.2122	0.1658	0.020	1	
	1995	0.1221	0.1849	0.2735	0.2787	0.1161	0.025	1	
Finland	1970	0.1754	0.1775	0.2375	0.2101	0.1127	0.087	1	
	1970	0.0341	0.2893	0.3198	0.2972	0.0595	0.000	1	
	1980	0.0638	0.1458	0.2823	0.3901	0.1069	0.011	1	
	1990	0.1113	0.1438	0.1918	0.3854	0.1654	0.002	1	
France	1970	0.0957	0.1343	0.2237	0.3697	0.1691	0.008	1	
	1970	0.0000	0.3530	0.2254	0.1791	0.2059	0.037	1	
	1980	0.0000	0.3131	0.2465	0.1499	0.2180	0.073	1	
	1990	0.0110	0.2527	0.2011	0.1788	0.1229	0.233	1	
Germany	1970	0.0417	0.1497	0.3958	0.2466	0.1059	0.060	1	
	1992	0.0451	0.1480	0.2842	0.3597	0.1037	0.059	1	
	1994	0.0530	0.1525	0.2988	0.3376	0.1012	0.057	1	
	1995	0.0552	0.1544	0.3060	0.3224	0.1042	0.058	1	
Greece	1996	0.0582	0.1576	0.3054	0.3074	0.1078	0.064	1	
	1970	0.0430	0.1132	0.3751	0.2069	0.1501	0.112	1	
	1980	0.0526	0.1108	0.3699	0.3484	0.1094	0.009	1	
Ireland	1992	0.1718	0.0432	0.3454	0.3034	0.1088	0.027	1	
	1975	0.0979	0.2498	0.1843	0.3410	0.0822	0.045	1	
	1980	0.1042	0.2011	0.2070	0.3667	0.0731	0.048	1	
	1985	0.0659	0.1916	0.1991	0.3190	0.0554	0.169	1	
	1990	0.0431	0.1870	0.2534	0.3216	0.0476	0.147	1	
	1995	0.0220	0.1962	0.2601	0.3026	0.0465	0.173	1	
Italy	1996	0.0279	0.1766	0.2698	0.3013	0.0506	0.174	1	
	1970	0.0843	0.2821	0.2517	0.2485	0.1303	0.003	1	
	1980	0.0556	0.1491	0.2995	0.2662	0.2294	0.000	1	
	1990	0.0275	0.1486	0.4151	0.2793	0.1163	0.013	1	
	1995	0.0310	0.1543	0.4326	0.2874	0.0857	0.009	1	
Netherlands	1970	0.1677	0.1900	0.2235	0.3170	0.0633	0.039	1	
	1980	0.2512	0.1238	0.2601	0.2270	0.1025	0.035	1	
	1990	0.1145	0.1230	0.3873	0.2458	0.0957	0.034	1	
	1996	0.1196	0.0829	0.4795	0.2029	0.1004	0.015	1	
Portugal	1970	0.0127	0.3105	0.2587	0.2420	0.1606	0.016	1	
	1980	0.1205	0.1695	0.3023	0.2189	0.1491	0.040	1	
	1990	0.1299	0.1009	0.3960	0.2913	0.0570	0.025	1	
Spain	1995	0.1177	0.0843	0.4093	0.3078	0.0563	0.025	1	
	1970	0.0076	0.2577	0.1973	0.3161	0.1879	0.033	1	
	1980	0.1672	0.0667	0.3260	0.2442	0.1629	0.033	1	
	1990	0.0697	0.1089	0.4550	0.2650	0.0811	0.020	1	
		1995	0.0759	0.0966	0.4343	0.2997	0.0740	0.019	1

Table A.39: Science Enrollments as a proxy for Graduates

		Year	Education	Humanities	Law and Social Sciences	Natural Sciences, Engineering and Agriculture	Medical Sciences	Others	Total
	Sweden	1970	0.1158	0.2128	0.3799	0.2112	0.0802	0.000	1
		1980	0.1148	0.1538	0.2488	0.3239	0.1162	0.042	1
		1990	0.1236	0.1412	0.2752	0.2978	0.1530	0.009	1
		1995	0.1452	0.1555	0.2652	0.2930	0.1368	0.004	1
	UK	1970	0.2352	0.1543	0.2149	0.3361	0.0595	0.000	1
		1980	0.0996	0.1576	0.2883	0.3849	0.0632	0.006	1
		1990	0.0559	0.1133	0.2689	0.2812	0.1211	0.159	1
	Australia	1970	0.1802	0.2511	0.1915	0.2851	0.0710	0.021	1
		1980	0.1752	0.1832	0.3215	0.2463	0.0726	0.001	1
		1990	0.1541	0.2258	0.2452	0.2560	0.1123	0.006	1
		1995	0.0823	0.1297	0.3652	0.2939	0.1051	0.024	1
	Canada	1970	0.1285	0.4076	0.0968	0.1779	0.0417	0.148	1
		1980	0.0765	0.1703	0.2821	0.1748	0.0719	0.224	1
		1990	0.0494	0.0773	0.2129	0.1609	0.0519	0.447	1
		1995	0.0503	0.0904	0.2386	0.2155	0.0628	0.342	1
	Czech Rep.	1992	0.1875	0.0676	0.1960	0.4236	0.0973	0.028	1
		1995	0.1593	0.0862	0.2900	0.3528	0.1041	0.008	1
		1996	0.1649	0.0803	0.2610	0.3396	0.0983	0.056	1
	Hungary	1970	0.1737	0.0688	0.1468	0.5191	0.0916	0.000	1
		1980	0.3316	0.0427	0.1728	0.3556	0.0909	0.006	1
		1990	0.3676	0.0421	0.1755	0.2951	0.0918	0.028	1
		1994	0.2068	0.1159	0.2588	0.3202	0.0716	0.027	1
	Iceland	1970	0.0000	0.2972	0.3329	0.1553	0.2145	0.000	1
		1980	0.1465	0.2074	0.2453	0.1668	0.2341	0.000	1
		1991	0.1576	0.2066	0.2978	0.1602	0.1777	0.000	1
		1995	0.1978	0.2003	0.2518	0.1952	0.1549	0.000	1
	Japan	1970	0.0981	0.1568	0.4312	0.2399	0.0345	0.040	1
		1980	0.1037	0.1810	0.4040	0.2282	0.0592	0.024	1
		1991	0.0789	0.1940	0.3913	0.2219	0.0552	0.059	1
		1994	0.0793	0.1814	0.3785	0.2294	0.0814	0.050	1
	Korea	1970	0.1387	0.1362	0.2126	0.4166	0.0960	0.000	1
		1980	0.1208	0.1389	0.1815	0.4905	0.0673	0.001	1
		1990	0.0777	0.1897	0.2919	0.3651	0.0514	0.024	1
		1995	0.0629	0.1734	0.2715	0.3705	0.0540	0.068	1
	Mexico	1970	0.0000	0.1552	0.3498	0.3397	0.1499	0.005	1
		1980	0.1368	0.0175	0.3390	0.3326	0.1728	0.001	1
		1990	0.1043	0.0151	0.4164	0.3664	0.0860	0.012	1
		1995	0.1255	0.0161	0.4193	0.3134	0.0873	0.038	1
	New Zealand	1970	0.2266	0.3185	0.1424	0.2627	0.0316	0.018	1
		1980	0.1105	0.1623	0.3133	0.3079	0.0650	0.041	1
		1990	0.0970	0.2200	0.3562	0.2098	0.0662	0.051	1
		1995	0.1194	0.2212	0.3468	0.2037	0.0717	0.037	1
	Norway	1970	0.1611	0.2529	0.2044	0.2941	0.0833	0.004	1
		1980	0.1787	0.1414	0.2271	0.2389	0.1316	0.082	1
		1990	0.1274	0.1080	0.3396	0.2030	0.0955	0.126	1
		1995	0.1598	0.1236	0.3061	0.1845	0.1094	0.117	1
	Poland	1970	0.1290	0.0883	0.2012	0.4909	0.0907	0.000	1
		1980	0.1256	0.0690	0.2521	0.4246	0.1058	0.023	1
		1990	0.1834	0.1256	0.2462	0.2658	0.1512	0.028	1
		1993	0.1388	0.1224	0.3208	0.2926	0.1023	0.023	1

Table A.39: Science Enrollments as a proxy for Graduates

		Year	Education	Humanities	Law and Social Sciences	Natural Sciences, Engineering and Agriculture	Medical Sciences	Others	Total
	Slovakia	1992	0.1836	0.0805	0.1778	0.4750	0.0788	0.004	1
		1995	0.1757	0.0800	0.2087	0.4457	0.0866	0.003	1
		1996	0.1742	0.0799	0.2254	0.4296	0.0858	0.005	1
	Switzerland	1970	0.0614	0.2116	0.2589	0.2846	0.1835	0.000	1
		1980	0.0642	0.1861	0.2844	0.3303	0.1158	0.019	1
		1990	0.0470	0.1461	0.3970	0.3237	0.0850	0.001	1
		1995	0.0510	0.1416	0.4128	0.3130	0.0806	0.001	1
	Turkey	1970	0.0548	0.0822	0.3712	0.3615	0.1302	0.000	1
		1980	0.1188	0.0918	0.3202	0.3534	0.1099	0.006	1
		1990	0.0919	0.0554	0.5143	0.2423	0.0855	0.011	1
		1994	0.0963	0.0489	0.5272	0.2231	0.0970	0.007	1
	USA	1970	0.3118	0.1784	0.2450	0.2199	0.0174	0.028	1
		1975	0.1933	0.1434	0.3607	0.1724	0.0746	0.056	1
		1990	0.0702	0.1298	0.3013	0.1719	0.1027	0.224	1
OECD Average			0.0922	0.1473	0.3261	0.2662	0.0979	0.080	1
EU average			0.0729	0.1641	0.3195	0.2791	0.1195	0.045	1

Source: UNESCO DATABASE on line (2001).

Table A. 40: Total Hourly Labour Costs and Its Composition in Industry and Services (EUR), 1999

	Hourly Labour Costs (EUR)	of which Direct Costs(percent)	of which Direct Payment (percent)	of which Indirect Costs (percent)	of which Social Security (percent)
EU 15	21,5	75,0	65,7	25,0	23,0
Germany	26,8	74,7	63,2	25,3	23,1
Greece*	11,8**	69,8**	:	30,2**	27,1**
Spain	15,3	74,0	73,8	26,0	24,4
France	23,8	67,1	57,8	32,9	28,6
Ireland	16,2	84,0	73,8	16,0	13,4
Italy	18,8	65,5	60,7	34,5	32,7
Netherlands	21,7	75,6	65,9	24,4	22,1
Portugal*	7,0	76,2	69,9	23,8	20,4
UK	19,3	87,3	74,8	12,7	12,6

Source: EUROSTAT, 2001. * Data refer to 1998. ** Industry only.