

# PILOT

Policy and Innovation in Low-Tech

## **Structural change, growth and innovation: the roles of medium and low tech industries, 1980-2002**

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Contribution to the conference

### **Low-Tech as Misnomer: The Role of Non-Research-Intensive Industries in the Knowledge Economy**

Brussels  
29 + 30 June, 2005

The PILOT project and the conference are financed within FP5 Key Action  
Improving the Socio-economic Knowledge Base (HPSE-CT-2002-00112)

*It is often argued that high tech industries drive growth processes, and that they are the sources of growth in output, employment and productivity in the knowledge economy. This approach implies that low tech industries should exhibit declining shares of output for two reasons: their growth is lower (or they are declining absolutely) and they are relocating to low wage economies. That is, they should exhibit trade-driven 'hollowing out'. If true, these claims would imply that shares of high tech output are rising significantly in growing economies, while low tech shares are falling significantly, and that countries with larger high tech sectors will exhibit higher growth rates. This paper provides evidence not supporting the high tech argument.*

## **1. High Tech Industries and Structural Change Theories of Growth**

Because the high tech industries, by definition, are all located within manufacturing, we focus in this paper primarily on the manufacturing sector, and argue that the following broad set of hypotheses are implied by modern high tech-biased explanations of growth:

- The high tech model requires that there should not only be a significant rise in the share of high technology industries in total manufacturing output, but also a positive and significant correlation between shares of high tech in total output and levels and growth rates of GDP.
- If the high tech model is correct then long term growth will be accompanied by a reduction in structural diversity. Specifically, if growth is driven by *changes* in the shares of these sectors, then cross-country growth will lead to a convergence in structure across countries. Across the whole sample of countries, the rank correlations of the shares of the various sectors, between the beginning and the end of the period, should be low.
- If ICT is the key high tech industry of the recent past, then 'those countries which have experienced a rapid diffusion of ICT, or which have been involved in significant production of it, will be ahead of other countries, at least in the ascending phase of a long-term cycle' (Amable and Petit, 2003: 223).
- As structural change proceeds there should be falling employment in low tech sectors, both as a result of high tech growth and of trade effects, as low and medium tech industries move to low wage environments.

In what follows, we explore the primary evidence related to such claims, and test them with simple correlations. Our aim here is an overview and discussion of the relevant data, and a set of simple but robust tests to assess whether the long run manufacturing evidence can plausibly support the 'high tech' structural change views of economic growth.

## **2. Data and definitions**

Hatzichronoglou (1997) distinguished between industries in terms of R&D intensities, with those (such as ICT or pharmaceuticals) spending more than 4% of turnover being classified as high technology, those spending between 1% and 4% of turnover (such as vehicles or chemicals) being classified as medium-tech, and those spending less than 1% (such as textiles or

food) as low tech. This approach has since been modified by dividing the ‘medium technology’ group into medium-high and medium-low. Our analysis is based on this classification of manufacturing sectors from OECD. (Table 1)

**Table 1: OECD classification of manufacturing industries by technological intensity**

		ISIC 3 classification
High tech	Aerospace	35.3
	Computers, office machinery	30
	Electronics-communications	32
	Pharmaceuticals	24.4
Medium high tech	Scientific instruments	33
	Motor vehicles	34
	Electrical machinery	31
	Chemicals	24-24.4
	Other transport equipment	35.2+4+5
	Non-electrical machinery	29
Medium low tech	Rubber and plastic products	25
	Shipbuilding	35.1
	Other manufacturing	36
	Non-ferrous metals	27.2
	Non-metallic mineral products	26
	Fabricated metal products	28
	Petroleum refining	23
	Ferrous metals	27.1
Low tech	Paper, printing	21+22
	Textile and clothing	17+18+19
	Food, beverages and tobacco	15+16
	Wood products	20

In addition to this R&D classification of the above manufacturing industries, we also to a limited extent use the OECD definition of ICT producing industries. (See Table 2) This set of industries is defined in Pilat and Devlin (2004).

**Table 2: OECD definition of ICT-producing industries**

Office, accounting and computing machinery	3000
Insulated wire and cable	3130
Electronic valves, tubes, other electronic components	3210
Television and radio transmitters, line telephony etc.	3220
TV and radio receivers, sound or video recording, etc	3230
Instruments and appliances for measuring, checking, testing, etc	3312
Industrial processes control equipment	3313
Wholesale of machinery, equipment and supplies	5150
Renting of office machinery and equipment (incl. computers)	7123
Telecommunications	6420
Computer and related activities	7200

The following analysis uses the OECD's STAN database, which comprises data at 2 and 3 ISIC digit levels for the manufacturing sectors of OECD economies. This data is national accounts-compatible, has had errors and omission removed, and is available for some countries over a long time period. Our analysis looks at the 23-year period 1980-2002.

In order to illustrate structural developments in the entire period we present key trends in two separate periods, 1980-1991 and 1991-2002. We show results only for those OECD countries for which we have sufficient data on value added, employment, production, exports and imports for the entire period 1980-2002. There are 11 countries for which data is available during this period: Austria, Denmark, Finland, France, Italy, Japan, Norway, Portugal, Spain, Sweden and USA. The two most important countries which are excluded during this first period 1980-1991, on account of insufficient data, Germany and UK, are included in the second period covering the years 1991-2002. Value added is in constant 1995 US dollars. Purchasing power parities have been used to convert national currencies to dollars. The price deflator for GDP has been used to adjust for changes in price level. Data on GDP measured in constant 1995 US dollars for the various countries during the period 1980-2002 has been taken from the OECD *Statistical Databases on Annual National Accounts* (STAN). Three-year averages at the beginning and end of the period are used to compute growth rates, so most of our long run growth calculations are for 1981, that is average of 1980,1981 and 1982, and 1998, that is average of 1997, 1998 and 1999.

The OECD STAN database is delivered with a considerable time lag, presumably due to the time cost of removal of errors and omissions and the resource demanding preparation enabling comparison across countries. Despite this fact, we have just recently been able to update the time series to include the period around and after the millennium change, which is in particular interesting in this long term view of structural trends. The high tech industries, in particular ICT industries went through a crisis and downsizing after 2000 in the majority of the OECD countries. Many of the European countries, in particular, saw a sharp decline in ICT employment and output in 2001-2003 period with a moderate upswing in 2004. It is, therefore, likely that our results overestimate the degree of the structural change in favor of the high tech sectors, since the last period we covered, especially the period 1995-2000, shows relatively stronger growth in employment and value added in ICT sectors compared to other sectors in manufacturing, a trend which has been reversed after 2000. In other words, some of the results might be reflecting the overoptimistic growth rates that would characterize the path towards a peak that is broken by a crisis.

In our data, we observe that the effect of the crisis is noticeable already in 2001, the first year after the ICT peak. However, it has not been possible in this paper to provide an educated guess about the long term significance of the growth trends in high tech sectors, and in particular in ICT after 2002, that is trends in 2003, 2004 and the first half of 2005.

In the following presentation and analysis of the numbers we will refer to the four manufacturing categories (high tech, medium high tech, medium low tech and low tech). We will be comparing them with each other, their shares of total manufacturing, their growth patterns and

consequently their relative weight within manufacturing as a whole. In many cases we compare the single high tech category with the two low tech categories: medium low and low tech. The rationale for doing this is the following: The high tech argument, which we are challenging with this paper, is in our opinion by and large associated with the industries in the high tech category and not the medium high tech category. The expectations that are related to the high tech argument imply that countries typically make an effort to be successful in ICT, pharmaceuticals and advanced materials. Even though one could argue that there are high tech expectations related to parts of electrical machinery and scientific instruments (which are in the medium high tech category), the typical view to high tech industries includes the mentioned ICT and biotechnology industries and not motor vehicles, non-electrical machinery and the other industries in the medium high tech category.

### **3. Structural change across the OECD: output, growth, productivity, employment and trade**

This section first explores the overall process of structural change in OECD economies, and then the changing structure of manufacturing value added for the four technology classes of industries for the period 1980-1999. It then discusses the persistence of industrial structures across countries, correlations between high tech industries and growth performance, and trends in productivity and employment.

#### **3.1 The background: overall structural change 1980-99**

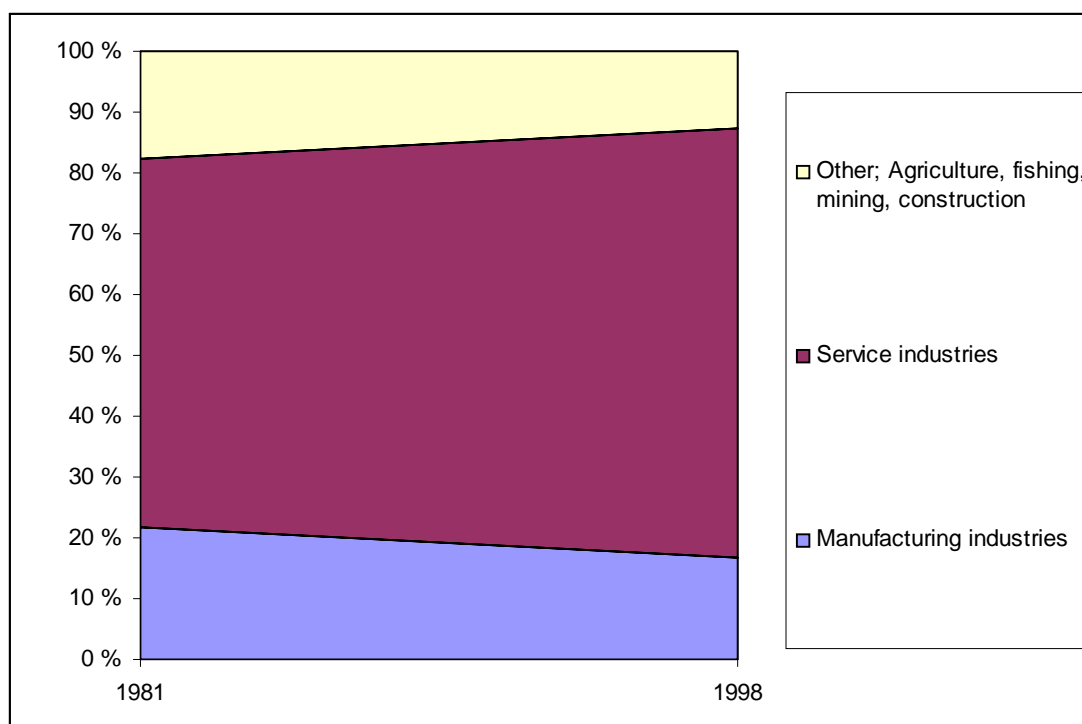
Before turning to structural change within manufacturing, it is important to note that the period 1981-1999 also exhibits significant structural change between manufacturing and other sectors. Table 3 breaks services – a large and heterogeneous sector – into four major components.

**Table 3: Share of total employment in the economy by nine sectors. 1981 and 1998. Average (unweighted) for fifteen countries (1981 = three year average 1980-1982; 1998 = three year average 1997-1999).**

Sectors	1981	1998	Change
Agriculture, hunting, forestry and fishing	8.7	5.0	-3.7
Mining and quarrying	0.7	0.4	-0.3
Total manufacturing	21.8	16.7	-5.1
Electricity, gas and water supply	0.9	0.7	-0.2
Construction	7.3	6.6	-0.7
Services:			
Wholesale and retail trade; restaurants and hotels	18.7	19.8	1.1
Transport, storage and communication	6.6	6.3	-0.3
Finance, insurance, real estate and business services	8.5	13.0	4.5
Community social and personal services	26.9	31.4	4.5
Sum all sectors	100	100	0

The figure below illustrates the development, however only by the two years 1981 and 1998. The share of services in employment grew strongly, from 60.7% to 70.5% of total employment. The main share growth in services occurred in two broad areas: financial services, and community and social services (the latter including such activities as health care and education). During the same period, 1981-1999, manufacturing employment declined from 21.8% to 16.7% of total employment.

**Figure 1: Industries share of total employment in 1981 and 1998, average, unweighted, 15 countries**



This overall process of structural change is important for two reasons. First, whether or not we regard overall growth as being driven by technology intensive activities depends to a considerable extent on how we assess the nature of rapidly growing service activities. Here it should be pointed out that neither of the service activities whose share is growing is particularly R&D intensive (although there are some R&D-intensive activities within them).

Second, it is worth noting that more than fifty percent of total employment is in two sectors: wholesale and retail trade, and community and social services. These are not high tech activities as conventionally defined. A final point to note here is that growth in technology-intensive activities within manufacturing may not translate into changes in the shares of such activities in overall GDP, because the decline in the share of manufacturing in GDP and employment may outweigh rising shares within manufacturing. This point will be illustrated in more detail in the sections below.

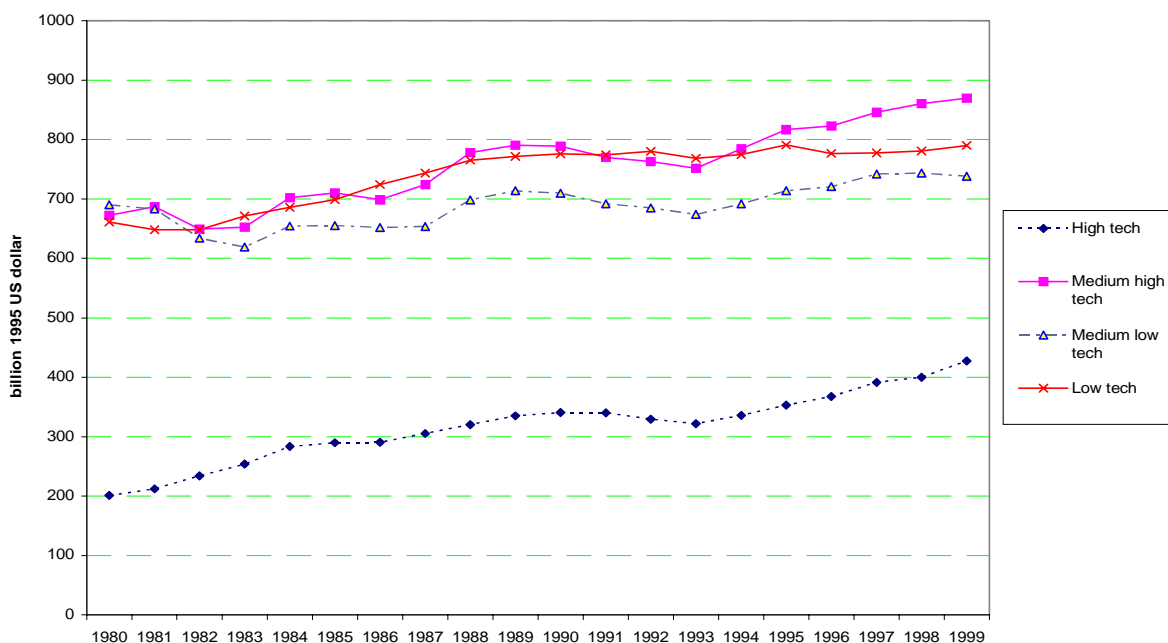
### 3.2 Structural change in OECD manufacturing

Constant-price manufacturing value added has risen, although with cyclical fluctuations, across the OECD over the past twenty years in all technology sectors. As we see in Figure 2 and 4,

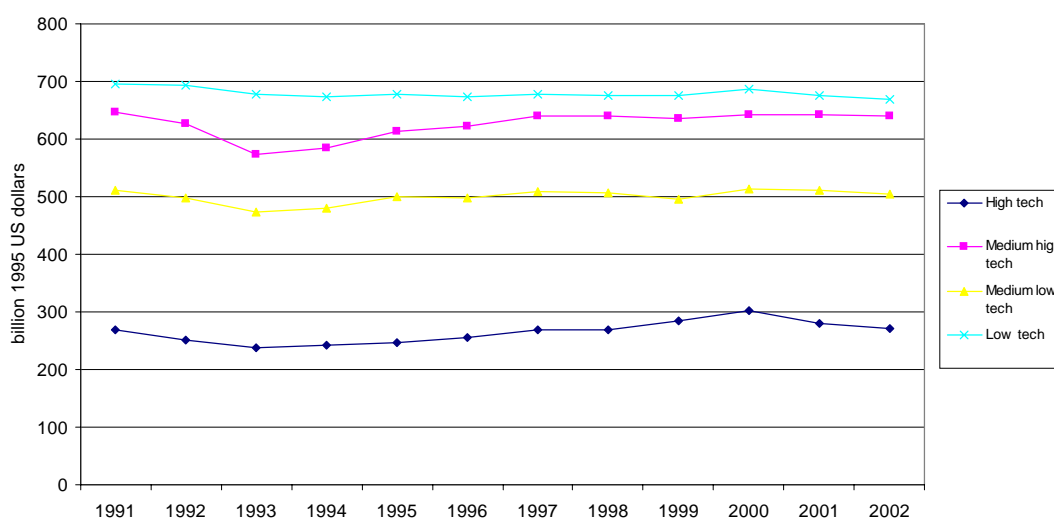
between 1981 and 1999, total value added in manufacturing as a whole for the eleven countries mentioned above combined grew by 26.4 per cent, implying a compound annual growth rate (CAGR) of 1.4 per cent per year. The Figures 3 and 5 extend the time series with three more years 2000, 2001 and 2002.

The high tech industries have by far the highest growth: 88.3 per cent (CAGR 3.8 per cent per year). High growth in high tech in part reflects a much lower starting point than the medium or low tech categories (the absolute increments to output in high and medium high tech sectors are roughly the same).

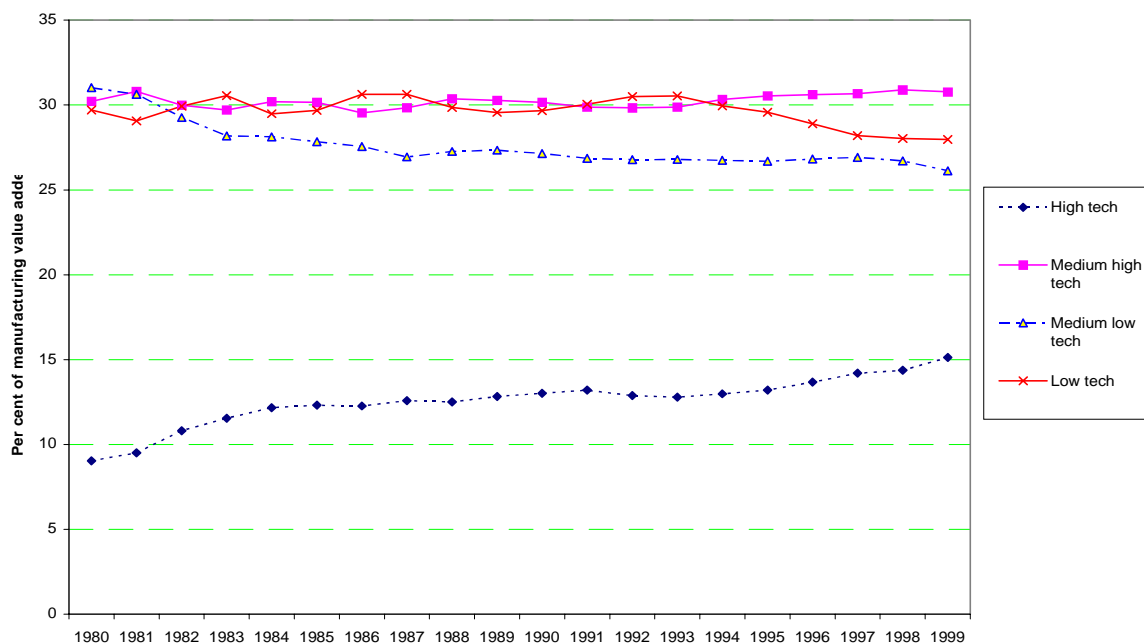
**Figure 2: Value added in billion 1995 US dollars, 11 countries combined. 1980-1999**



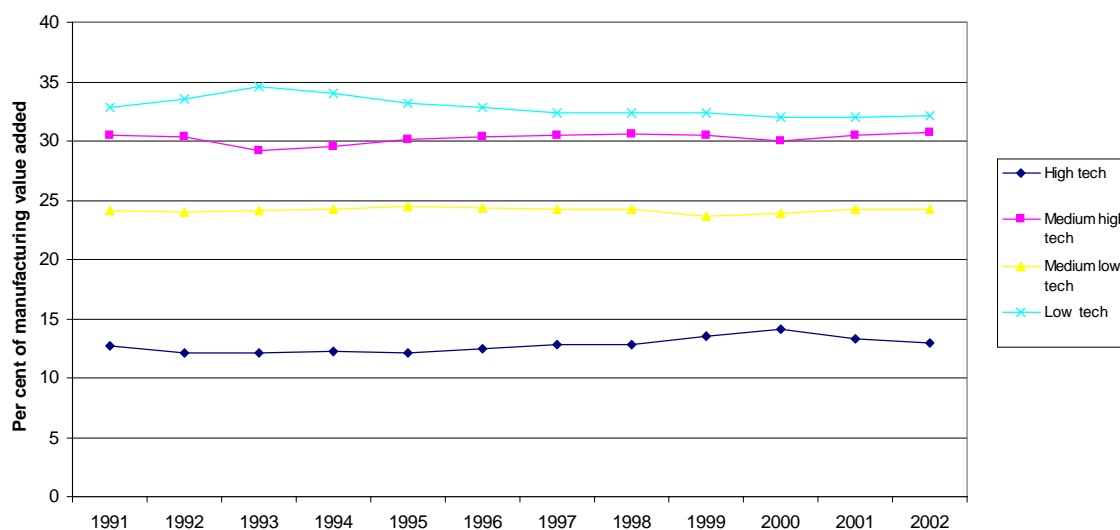
**Figure 3: Value added in billion 1995 US dollars, 13 countries combined. 1991-2002**



**Figure 4: Share of value added in manufacturing, four industry groups. 1980-1999. 11 countries combined**



**Figure 5: Share of value added in manufacturing, four industry groups. 1991-2002. 13 countries combined**



The medium high tech category saw growth about equal to manufacturing as a whole with 28.2 per cent (CAGR 1.5 per cent per year). The two low tech categories have growth of value added below manufacturing as a whole. Medium low tech has 10.8 per cent growth (CAGR 0.6 per cent per year), and low tech 20.0 per cent (CAGR 1.1 per cent per year).

These growth rate differentials mean that the high tech industries' share of manufacturing value added grows steadily up until 1998 (Figure 4), while the shares of the two low tech categories decline. Figure 4 shows a rise in the share of high tech in the early 1980s, followed by a decade of roughly stable share, followed by another rise after 1995. Figure 5 shows, however,

that the year 2000 represents a turning point for high tech industries' share of manufacturing value added.

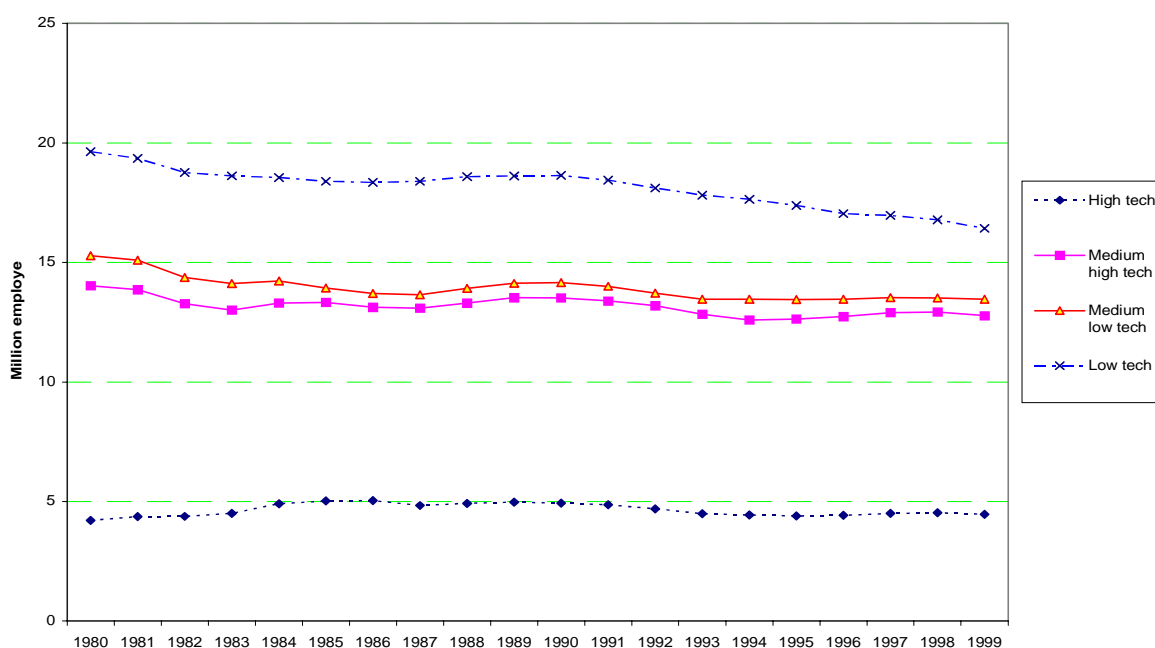
This way the share of the high tech industries in manufacturing value added rises from 9.8 per cent to 14.6 per cent in the course of the period up until 1998, but is thereafter down to below 13 per cent in 2002. There is little change in the shares of the medium-high tech sector, in the medium-low and low tech sectors. They largely remain stable.

From a 59.9 per cent in 1981, the two low tech categories together still accounted for 54.7 per cent of manufacturing value added in 1998. Between 1998 and 2002 the two low tech categories remain stable in terms of share of manufacturing value added. The compound rate of decline in the share of these low tech sectors is 0.5% per year between 1981 and 1998); the CAGR of the high tech share is 2.2% per year (also 1981-1998).

These trends are of course open to interpretation, and the power of compound change over long periods is well known, but we would argue that over a period of two decades, when economies are allegedly being reshaped by major high technology changes, these are not substantial structural shifts.

As noted above, it is important to bear in mind the wider structural changes taking place during this period, reflecting the growth of services sectors. The share of manufacturing as a whole in GDP in the countries studied decreases from 23.3 to 18.1 per cent. This means that the share of high tech manufacturing increases marginally, from 2.3 to 2.6 per cent of GDP. For the other three manufacturing categories the decline is substantial: the two low tech categories together see shares of GDP drop from 13.9 per cent in 1981 to 9.9 per cent in 1998.

**Figure 6: Number of persons engaged (in million employees). 1980-1998. 11 OECD countries combined**

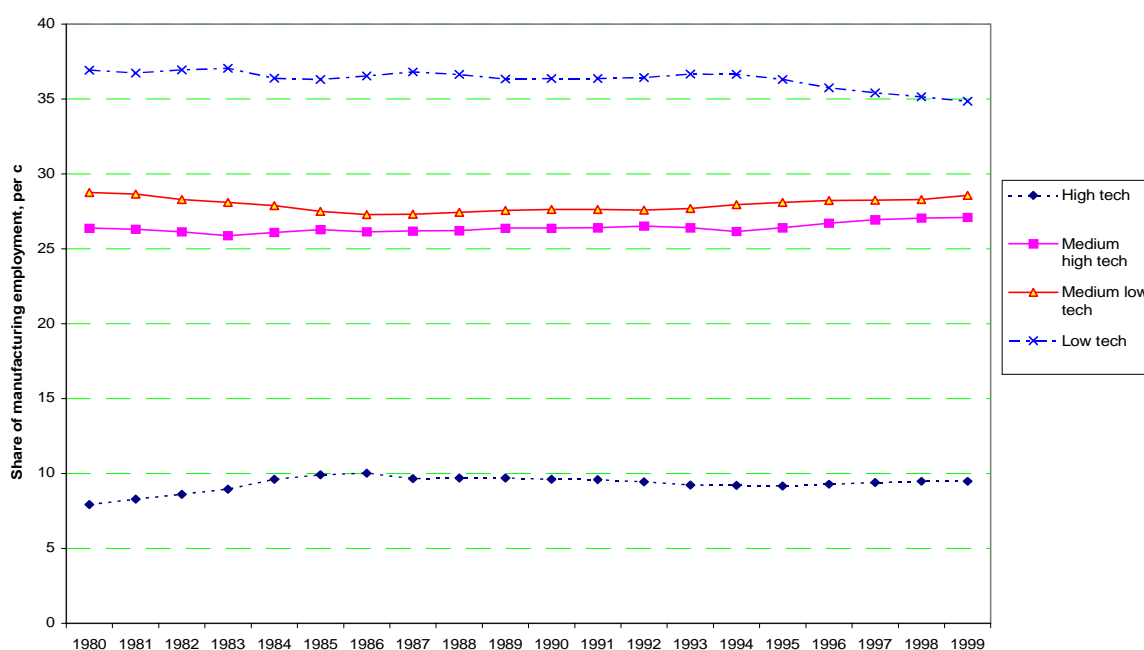


If we compare growth rates in productivity to growth rates in value added, we find that only for the high tech industries does the positive effect on employment from growth of production outweigh the negative effect on employment from the growth of productivity. This is shown in the figure below.

Figure 6 shows that the high tech industries have growth in employment during the period, but this growth is very small. The other three categories have decreases in employment, and the decreases are larger the lower the technological intensity.

For high tech industries we have altogether a growth in employment from 1981 to 1998 of 181,000 persons or 4.2 per cent, from 4.32 million to 4.50 million. The medium high tech industries have a decline of 850,000 persons or 6.2 per cent, from 13.7 million to 12.9 million. For the medium low tech industries employment decreases by 1.4 million persons or 9.5 per cent, from 14.9 million to 13.5 million employed. Finally, employment in the low tech industries decreases by 2.5 million persons or 13.1 per cent, from 19.2 million to 16.7 million. Altogether, employment in manufacturing decreases by 4.6 million persons or 8.8 per cent in these 11 countries, from 52.2 million to 47.6 million. Once again, however, we face questions about just how substantial these changes are, since the declines in employment are slow, and the employment levels are persistent, as Figure 7 below indicates.

**Figure 7: Shares of employment in total manufacturing. 1980-1999. 11 OECD countries combined**



In terms of shares, high tech industries increase their share of employment in manufacturing from 8.3 per cent in 1981 to 9.5 per cent in 1998. The low tech and medium low tech industries combined decreased their share of manufacturing employment from 65.4 per cent in 1981 to 63.5 per cent in 1998. Over a twenty year period, these are marginal differences in employment shares in manufacturing – so employment shares persist in such industries in the OECD.

However, while employment in manufacturing as a whole decreases by 8.8 per cent from 1981 to 1998, employment in the whole economy of the 11 countries combined increased by 50.2 million persons or 20.8 per cent, from 241.5 million to 291.7 million. This means that all four manufacturing categories decreased their share in total economy employment.

The main pattern emerging from this evidence is that in the medium low and low tech sectors we find slowly declining levels of employment; and – in the context of service sector growth – sharply falling shares of total employment. Furthermore, it is important to note that the persistent employment *levels* in both low tech and manufacturing as a whole suggest that structural change is not a replacement process: that is, as service activities grow, they increase their weight in the economy, but manufacturing is not replaced as an activity.

### 3.2 Identifying growth

The fact that high tech sectors are growing faster than medium or low tech sectors in manufacturing output does not necessarily mean that high tech contributes more to overall manufacturing growth. High tech sectors are small, so even high growth rates can have a relatively small overall impact. To gain a clearer picture of the sectoral composition of economic growth, we can start with the accounting point that the growth rate for any multi-sectoral economy is the weighted sum of the growth rates of the sectors, where the weights are the initial shares of each sector in output. For the overall economy, or for the manufacturing as a whole, therefore

$$g = \sum_{i=1}^n g_i s_i$$

where  $g$  is the overall growth rate and  $g_i$  and  $s_i$  are sectoral growth rates (i.e. sectoral CAGRs) and initial shares of output respectively. That is to say, in looking at how the overall growth rate is shaped, we need to consider first how the different sectors are growing, and then at how large those sectors are. If we do this over reasonable time periods we can get a picture of what kind of sectoral growth pattern is really driving aggregate economic growth. These sectoral contributions are calculated for the high, medium and low tech sectors in Table 4 below.

There is no significant difference in the contributions to growth from the high tech and medium high tech sectors: each contributes about 32.5 per cent of the growth in manufacturing value added between 1981 to 1998. Taken together, the low tech and the medium low sectors combined contributed about the same. So the slower growth of medium low and low tech sectors was offset by their much larger size, and they continue to contribute in an important way to manufacturing growth.

Although in PILOT we studied the structural diversity between the countries in question we shall not deal with this issue in this paper. However, the main results from this investigation are:

1. Considering the two low tech sectors together, there is quite substantial variation across the countries in the shares of these sectors in manufacturing value added, from about 50 per cent in Germany, USA and Sweden to about 80 and even 85 per cent in Portugal and Greece (country specific averages for 1997, 1998 and 1999).

2. Based on this evidence and on evidence from a more detailed study of the structural diversity between industrial structures at the beginning and end of the period (not shown here) we conclude that overall growth in the OECD is not accompanied by structural change – there is no lessening of structural diversity over time.

**Table 4: Contributions of the four sectors to the overall manufacturing growth between 1981 and 1998 (1981 = three year average 1980-1982; 1998 = three year average 1997-1999)**

	(1) Growth 1981-98	(2) Initial period share of VA	(3) Contribution to overall growth rate (1x2)	(4) Contribution to growth rate, per cent
High tech	88.3	0.097776	8.6	32.7
Medium high tech	28.2	0.303374	8.6	32.5
Medium low tech	10.8	0.303162	3.3	12.4
Low tech	17.0	0.295688	5.9	22.4
Total manufacturing	26.4	1	26.4	100

### 3.4 Does technological intensity account for economic growth?

Some economies are clearly more ‘high tech’ than others. Those countries which had a high share of high tech industries relative to other countries in the beginning of the period also tend to have a relatively high share in the end of the period.

However these points do not mean that the structural change hypothesis is wrong. It could be the case that despite comparative structural stability, OECD growth is concentrated in those countries that have high shares of high tech industries. So if the structural change approach to growth is correct, countries with higher shares of high tech in output ought to exhibit higher growth rates within the overall panel of countries. This section therefore asks whether economies which are characterized by a high share of high tech industries are also the economies which have the best growth performance. Conversely, do economies with a high share of low tech industries tend to have a weak growth performance?

High tech shares can be linked either to the level of income or to its rate of growth. Looking at income levels first, there is indeed a relationship between technological intensity and the level of income across national economies. Figure 7 below shows the relationship between the share of manufacturing value added accounted for by high tech industries in 1997 (or more precisely the average of 1996, 1997 and 1998), along the x-axis, and the level of GDP per inhabitant in 2001 (more precisely average of 2000, 2001 and 2002), along the y-axis.

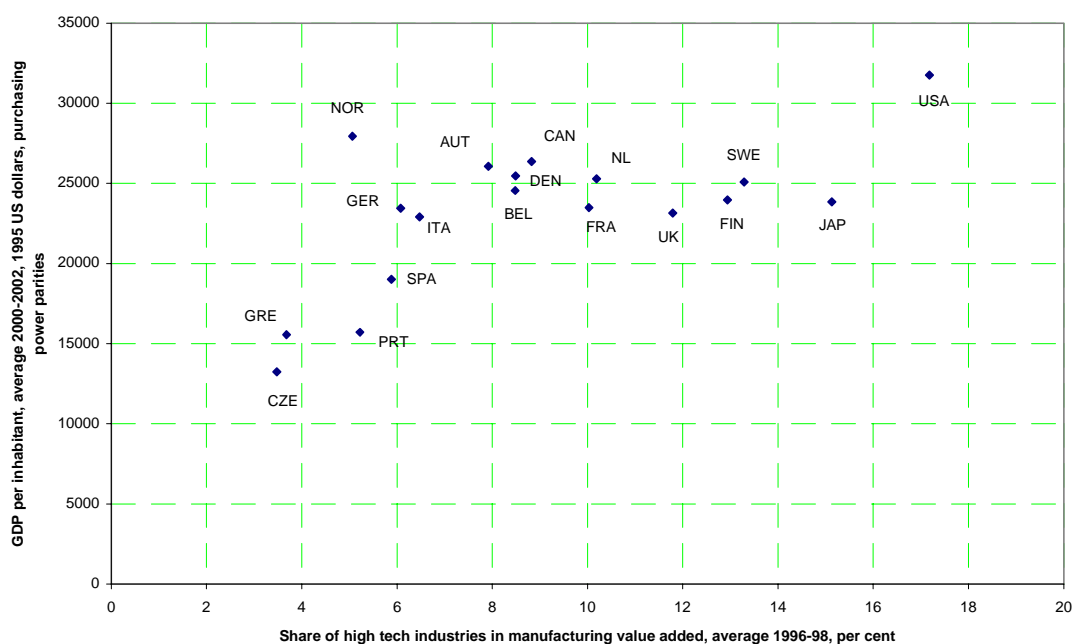
The (Pearson’s  $r$ ) correlation coefficient is here 0.65, significant at the 1 per cent level. Thus, the higher the share of high tech industries in manufacturing value added, the higher is GDP per inhabitant.

The fundamental question here is, however, which way the causality runs, since high tech industries (in particular aerospace, ICT, and pharmaceuticals) have in practice been created via substantial government support, and have invariably been initiated by substantial publicly-supported R&D infrastructures (Mowery and Rosenberg, 1989, and Bruland and Mowery, 2004 provide good overviews of this discussion). There may therefore be a pattern of causality that runs from high levels of income, to government budgetary positions, to the creation of industries – that is, some R&D-intensive industries may be a consequence of high income, not a cause of it.

Be that as it may, we do not find any positive relationship when we compare the high tech share in manufacturing value added with the rate of growth of GDP per inhabitant. This is illustrated in Figure 8.

Here, the correlation coefficient (Pearson's  $r$ ) for the whole period 1980-2001 is - 0.03 and not significant. We cannot conclude, therefore, that high tech economies are also the high growth economies.

**Figure 8: GDP per capita. Average 2000-2002, 1995 US dollars (y-axis); share of high tech industries in manufacturing value added. Average 1996-1998 (x-axis)**

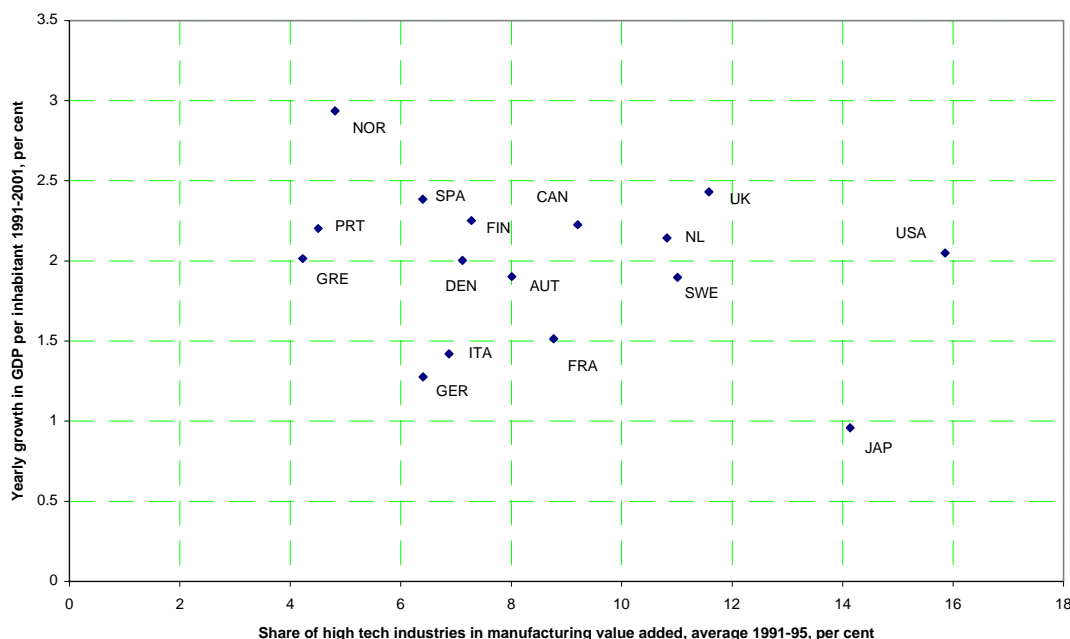


The linear relationship here is if anything positive, which would mean that the *low tech* countries have the best growth performance: Pearson's  $r$  is 0.43, but only significant at the 10 per cent level.

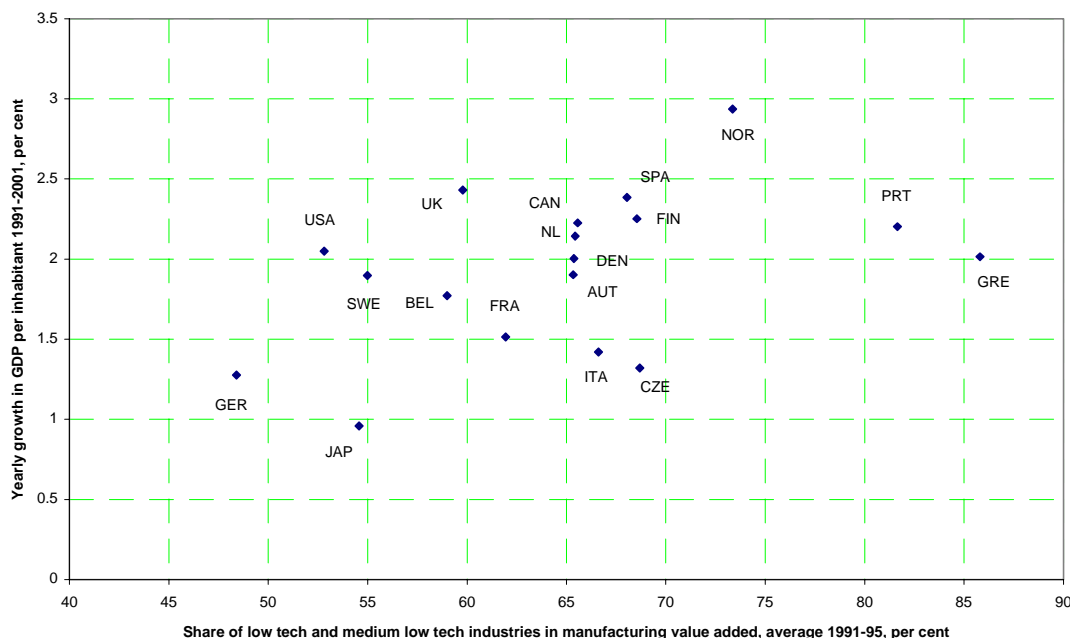
Looking at the linear relationship between annual compound growth rate of GDP per capita (1980-2001) and the shares of low tech and medium low tech value added combined in total manufacturing (average 1991-1995) we find again a correlation coefficient +0.08, but not significant. Thus, the important point here is the absence of any convincing evidence for a hypothesis that low tech economies are low growth economies. If anything, there is weak evi-

dence in the data that low tech economies are higher growth economies than the high tech economies.

**Figure 9: Annual compound growth rate in GDP per capita. 1991-2001. Percentages (y-axis); share of high tech industries in manufacturing. Value added. Average 1991-1995. Percentages (x-axis)**



**Figure 10: Annual compound rate in GDP per capita. 1991-2001. Percentages (y-axis); share of low tech and medium low tech industries combined in total manufacturing. Value added. Average 1991-1995. Percentages (x-axis)**



Conversely, Figure 10 above shows the relationship between growth in GDP per inhabitant from 1991 to 2001 and the share of low tech and medium low tech industries combined in manufacturing value added.

This evidence suggests that growth does not rest on the high tech driven structural change.

## **5. The importance of a domestic ICT sector**

A central question in this connection will be to what extent engaging in ICT producing sectors is important for economic growth, and to what extent the *utilization* of ICT in other sectors of the economy is what matters most. If engaging in ICT production on a large scale is essential, this would lend support to the more traditional high tech focus, implying reallocation towards the (high tech) ICT producing sectors from other sectors of the economy, and perhaps from low tech sectors in particular. However, if the utilization of ICT throughout the rest of the economy and not so much engaging in ICT production itself is what matters, this would be more compatible with continued involvement also in low tech industries, provided these industries are continuously transformed through the utilization of ICT. According to Boyer, intensity of ICT utilization seems to be the crucial factor here (Boyer, 2004: 2, 25), not ICT production. This is also the conclusion reached in an IMF working paper by Bayoumi and Haacker (2002).

We find no particular links between ICT output intensity and growth in national economies. Although we do not report the results here, we examined the correlation between the same economic growth variables and a number of indicators of ICT production and ICT use in different countries. These include share of the ICT sector in business sector value added, share of ICT sector in business sector employment, investment in ICT as a proportion of gross fixed capital formation, share of ICT employment in business sector services employment, ICT expenditures as a proportion to GDP 1999. Some of these variables are measured both in 1995 and 2000, which means that we also have a measure for the change in some of these magnitudes. We found at best a weak confirmation of a positive relationship at the national economy level between the intensity of ICT production and ICT utilization, on the one hand, and the growth variables, on the other. Most of the coefficients were weakly positive, but only a few were statistically significant.

## **6. Conclusions**

Advocates of high tech approaches to economic growth have often avoided even the most cursory reference to quantitative evidence, and so it is important to confront the claims of high tech approaches with the evidence. In the countries examined here there has been a clear tendency for the share of low tech industries in manufacturing to decline during the period 1980-1999, while the share of high tech industries has increased. The data between 1998 and 2002 illustrates the high tech crisis initiated in 2000: high tech declines while the other three tech categories by and large remain stable. This applies to both production (whether value added or gross production) and employment. We conclude that among the OECD countries studied here, structural change within manufacturing is not the direct cause of the growth process in advanced OECD-economies.

However, there has been structural change at the level of the economy as a whole, with a sustained rise in the share of services (both public and private). Of course, this change does not

support the high tech argument, since by and large services tend to be considerably less R&D intensive than high tech manufacturing.

There is no evidence supporting the argument that the high tech economies are also the high growth economies. This suggests that different economies can follow different paths of economic growth. Countries play different roles in the differentiated international economic system with clear patterns of division of labour among the highly developed economies.

Based on these conclusions we would hypothesize that growth is primarily rooted not on the creation of new sectors but on the internal transformation of sectors which already exist and/or are growing, such as, the service sector. Overemphasizing the role of the high tech sectors seen as isolated contributors to growth ignores this major dimension of change due to transformation in advanced economies.

Such oversimplifications are rooted in fundamental assumptions supporting modern research and innovation policies, which by overemphasising the role of R&D in economic growth they often underestimate processes of change and needs in those sectors of the economy with low R&D-investments.

## References

- Amable, B.; Petit, P. 2003, The diversity of social systems of innovation and production during the 1990s. In: *Institutions, Innovation and Growth*, ed.J.-P. Touffut, Cheltenham, UK: Edward Elgar.
- Bayoumi, T.; Haacker, M. 2002, It's not what you make, it's how you use IT: Measuring the welfare benefits of the IT revolution across countries. *IMF Working Paper* WP/02/117.
- Boyer, R. 2004, New growth regimes, but still institutional diversity. *Socio-Economic Review*, vol. 2 (1), 1-32.
- Bruland, K., and Mowery, D., (2004) 'Innovation through time' in J.Fagerberg, D. Mowery and R. Nelson (eds) *The Oxford Handbook of Innovation* (Oxford: OUP)
- Hatzichronoglou, T. 1997, Revision of the high technology sector and product classification. *STI Working Papers*, 1997/2, OECD.
- Mowery, D., and Rosenberg, N., *Technology and the Pursuit of Economic Growth* (Cambridge: CUP)
- OECD, 1986, *OECD Science and Technology Indicators, No 2: R&D, Innovation and Competitiveness*, (OECD:Paris)
- OECD, 2001, *The New Economy. Beyond the Hype. The OECD Growth Project* (OECD: Paris)
- Pilat, D.; Devlin, A. 2004, The diffusion of ICT in OECD economies, in *The economic impact of ICT*, ed.ECD, Paris: OECD.

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