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Abstract

Low aggregate investment in Finland has been argued to merely reflect structural change to an innovation economy, with high R&D levels adequately compensating for reduced physical investment. This paper briefly reviews the issues and discusses the severity and persistence of the shortage. Immaterialization of investment clearly plays a role and outward FDI crowds out domestic investment to some extent. Yet, we find no obvious explanation to low investment in the real economy relative to other western economies, since Finland fares rather well in multi-factor productivity and country risk and the supply of capital abode before the onset of the global crisis. We conclude that if investment was low when capital flew abundantly to any potentially high return end, it will most certainly be seriously damaged by the repercussions of the present global financial crisis. R&D and other intangible investment may not be able to compensate, if other factors, such as exchange rate policies, act against them and long-term growth prospects are generally bleak.

Key words: Investment, R&D, productivity, structural change, high-technology

JEL codes: E22, F21, H50, O38

Tiivistelmä

T&K, investoinnit ja rakennemuutos Suomessa: Onko investointien alhaisuus ongelma?

Suomen alhaisen investointiasteen on väitetty heijastavan talouden rakennemuutosta korkean teknologian innovaatiotaloudeksi, korkeiden T&K menojen kompensoidessa alentuneita fyysisiä investointeja. Raportissa tarkastellaan seikkoja, jotka puoltavat investointiongelman olemassaoloa tai olemattomuutta, sen vakavuutta ja pysyvyyttä. Kokonaistuottavuuden ja maariskin suhteen Suomen pitäisi olla varsin kilpailukykyinen. Pääomien tarjonta ei ole rajoittanut investointeja ennen nykyistä talouskriisiä, päinvastoin. Aineettomat ja ulkomaiset investoinnit osittain syrjäyttävät kotimaisia fyysisiä investointeja, mutta kokonaisuutena investointien alhaisuudelle suhteessa Länsi-Euroopan maihin ei ole selvää selitystä. Jos investoinnit olivat alhaiset jo ennen nykyistä talouskriisiä, on selvää että investointinäkymät ovat vain heikentyneet entisestään. T&K ja muut aineettomat investoinnit eivät pysty kompensoimaan, jos muut tekijät, kuten esim. valuuttakurssit, heikentävät pitkän aikavälin kasvuodotuksia entisestään.

Asiasanat: Investoinnit, T&K, tuottavuus, rakennemuutos, korkea teknologia.

JEL-luokat: E22, F21, H50, O38

Contents

1 Introduction

Physical investment is necessary to upgrade productive capacities, and to maintain capital embodied technological progress as well as economic growth in general. Ever since the early 1990's, Finland's investment levels relative to GDP have hovered at historically low levels. The share of gross investment (excl. housing buildings) in fixed priced value-added declined from around 20 % in the 1980's to about 15 % in recent years. Since the 1960's, Finland has fallen from top to bottom among OECD countries in terms of gross fixed capital formation in the private sector per GDP (Figure 1). In services, investment per value added has dropped from 35 % in 1976-1987 to 25 % in 1995–2003.

In 2006, ETLA (Sorjonen, 2006) suggested that there are no grounds for concern, as current levels merely reflect a shift from a resource-based economy to the information age, i.e., structural change from physical capital-intensive to R&D-intensive sectors in the economy. Finland has been argued to have approached the technology frontier and to have moved from extensive towards quality oriented intensive growth (Pekkarinen, 2007). When on the frontier, innovation is necessary to maintain a lead – hence R&D investments are critical. When a country lags well behind in an industry, copying and catch-up through capital embodied technological progress by means of physical investment is expected to dominate resource allocation. Hence, a leading technology country would invest more in R&D than in physical capital relative to a lagging country.

With hindsight Finnish investors seem to have been merely cautious in their fixed investments, and strong growth over 2006 and early 2007 attenuated fears, and investment rebounded in 2007. The rebound was short lived, however, as contagion effects from the US subprime housing loan crisis and the following global credit crunch set in, nibbling away confidence and investment expectations.

Frontier technology provides an intuitive explanation to Finland's reduced level of physical capital investment, but only in those Finnish industries that indeed dominate global frontiers. In several important sectors (e.g., in the paper industry and trade), investment has for long fallen short of replacement needs to cover the economic depreciation of capital. The capital base appears therefore to have contracted. At the same time, corporations are investing heavily abroad in locations such as China and India, where labour costs can be a fraction of those in Finland and market size and growth far beyond comparison.

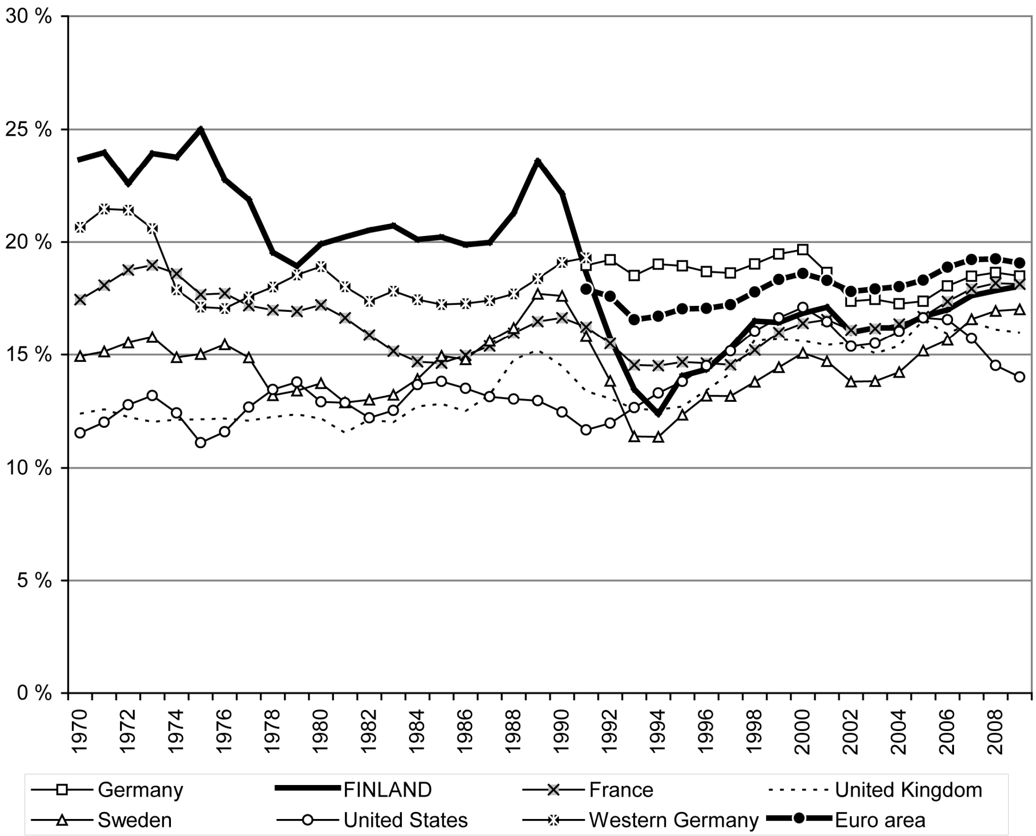

Figure 1. *Evolution of GFCF (private sector, volume) per GDP (volume, market prices) in selected OECD countries (197–02008) and the Euro area average (1991–2008). Source: OECD Economic Outlook.*

Moreover, in recent year exports, R&D intensive industries, e.g. ICT manufacturing, are giving way to medium technology industries as well as raw material production, pulled particularly by rising Chinese needs for capital goods and material inputs. At times, it would appear that Finland's comparative advantage relative to China has been reversed, with Finnish firms exporting medium and low value-added goods to China, and off-shoring high-tech production and establishing R&D centres there, while importing final goods. Physical investment abroad has complemented domestic production through high demand for investment and intermediate goods in the machinery, equipment and metal industries, which has helped maintain also domestic investment in physical capital. Despite extensive investments in R&D and education, and liberalisation of markets indications from other old EU Member countries also hint of losing high-technology manufacturing abroad. In any case, the present global initially financial, now economic crisis has proved the investment deficiency very real indeed.

This paper briefly reviews these issues and discusses the severity and persistence of the shortage. We find no obvious explanation to low investment in the real economy relative to other western economies, since Finland fares rather well in multi-factor productivity and country risk. We conclude that if investment was low when capital flew abundantly to any potentially high return end, it will most certainly be seriously damaged by the present global financial crisis. R&D and other intangible investment may not be able to compensate, if other factors, such as exchange rate policies, act against them. If the ultimate underlying cause is expectations with regard to growth prospects, the challenge is complex.

2 Capital flows, investment and growth in theory and policy

2.1 Factors behind productivity growth

In neoclassical growth theory, investment is the key growth policy instrument given natural resources and population growth. Hence, capital accumulation as in the so-called AK model was for long perceived as the critical ingredient in labour productivity growth, although already Solow (1956, 1957) suggested otherwise. It took decades for investment promotion to remove itself from policy prescriptions and design (Easterly, 2001).

The AK model was not entirely without empirical support. Almost all cross-country regressions on growth show that growth of capital per worker (K/L) has a strong robust relation to growth (Levine and Revelt, Sali-I-Martin). Among them, Arcelus and Arozena (1999) found capital-intensive growth to be the engine of growth in 1970's and 1980's. Also Färe, Grosskopf and Margaritis (JPA, 2006) found for 1965–1998 that EU labour productivity growth originated mainly from capital accumulation, although the inclusion of human capital slashed the impact of capital accumulation. Persistent productivity divergence among countries as found, e.g., by Bernard and Jones (AER, 1996)[1] has underscored a need for a more refined approach taking into account the efficiency of investment. Relative to the US, Börsh-Supan (1998) found Germany and Japan to waste physical and human resources due to poor management and capital market functioning, as well as lack of product market competition.

Specialization, technological progress and ICT, i.e., the general purpose technology (GPT) breakthrough of the 20th century, are perhaps the most important growth elements today. A cross-country effort by Fagerberg (2000) found that countries that specialized in electronics, the technologically most progressive manufacturing industry of the period studied, enjoyed higher labor productivity growth. Shao and Shu (2004) found information technology industries in 14 OECD countries over 1978–1990 to demonstrate highly varying performance patterns by country, with technological progress being the most important engine of productivity growth.

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[1] They were criticized by Sorensen (AER, 2001) for using inappropriate conversion factor-expenditure PPP's for total GDP.

2.2 The allocation of capital

In neo-classical theory, resources are invested until their marginal return equals their marginal cost. Since markets and competition are assumed to be perfect, the allocation of resources is always optimal. In a simple closed economy model, investment equals savings and labour supply depends on population growth. In an open economy, capital is in unlimited supply and in the long-term investment settles to the rate at which returns equal the cost of capital, i.e., investments are made until the marginal productivity of capital declines to the international interest level (Cooper and Sachs, 1985).

In practice, capital flows do not behave according to standard economic theory. According to Feldstein and Horioka (1980) even in open OECD economies, domestic investments and savings rates are highly correlated. In contrast to highly liquid international short-term capital, institutional rigidities and portfolio preferences reduce the use of long-term capital flows to eliminate cross-country differentials in yields. In contrast, similarly with Dornbusch's overshooting theory of real exchange rates, Ghosh (1995) found international capital flows to be excessively large in that they are more directed by speculative calculations than economic fundamentals. The herd instinct of international investors, well known in portfolio investment, is also present among more stable and long-term oriented FDI. E.g., Wheeler and Mody (1992) found FDI to be attracted by the mere size of FDI inflows, which is consistent with e.g., Bhasin et al. (1994) and Morrissey and Rai (1995) who have found that the size of the home country market and growth prospects in potential host markets are important in relocation decisions. Even when capital flows aim at exploiting differences in the marginal productivity of capita, capital inflows are often more drawn in by past growth rates, i.e., ex post realised returns and growth leads to investment rather than vice versa.

The euro fix has stabilised economies and reduced speculative flows to the extent that resource allocation can be expected to have improved in regard to capital. Consequently, the unlimited supply of capital enabled by the euro fix should have set the investment rate at the point were its marginal productivity equals its cost, completely irrespective of the pull effect of economic growth in China or the deficit needs of the US. Yet in practice, investments (at least) in Finland have continued to be predominantly financed cautiously from firm revenue and domestic savings (ETLA, 2006).

2.3 Inefficient use of capital in the past and a shift in the policy regime

Prior to the early 90's depression in Finland, investment was encouraged by all possible means, including low, often negative, real interest rates, recurring devaluations, and tax incentives favouring investment at the expense of showing profits or dividend distribution. Regulated and undeveloped capital markets suffered from a constant shortage of alternative investment opportunities. With the shift towards supply-side economics in the 1980's involving deregulation and liberalization, market determined prices began to reveal the misallocation of resources investment promotion policies had introduced. At the same time, the partiality of the liberalization created new distortions in resource allocation, and investments were fuelled by a flood of foreign capital. These market distortions led to overinvestment and rising capital inefficiencies, which culminated in its negative contribution to productivity growth in 1990-1994 as capacities were dismantled during the depression (Pohjola, 1996, Table 18).

The depression further exposed the shortcomings of the prior government-led model. Finland lagged other western markets in the evolution of its economy. Average value-added was low and capital- and energy intensive industries dominated exports. Finland opened fully to foreign capital inflows by 1993 when FDI was liberalised, and entry into the European Union in 1995 further enhanced competition (see e.g., Kiander *et al*. (2002). According to Huovari and Jalava (2007), a rapid rebound in capital productivity took place around 1994 and, apart from the brief and lesser downturn of 2001–2002, the marginal productivity of capital has been positive ever since.

A shift in the policy regime supported the rebound. In the 1980's, innovation economics gained in clout across the world with the advent of New Growth theory and revival of Schumpeterian theories in the Evolutionary Economics approach. In the 1990's many governments quickly adopted features of innovation and human capital-based growth strategies, requiring a reallocation of resources to education and R&D. Also Finland adopted this stance towards the end of the 1980's, though it truly settled in with the early 1990's depression. Finland emerged from the depression with a decisive shift in the policy regime from an investment-led to a knowledge-based growth strategy and to reliance on R&D and human capital from conventional investment.

Viewed against this background, concern for low investment appears a policy relic of the past. Today, science, education, innovation and technology policies govern the rhetoric scene, and Finland is said to feature among the foremost so-called "information societies". The industrial structure is more diversified and high-tech. R&D expenditure hovered above 3 % of GDP, highest in the world for years, mainly due to private sector innovation. Intangible investment, separate from R&D, has gradually increased to 10 % of total investment[2].

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[2] R&D has contributed to only a small share of intangible capital, being closely linked to labour input and its quality. In the late 1990's US intangibles were estimated to mount to 1 trillion US dollars, roughly equal to tangible investment and enough to boost GDP by 10 %. (Sichel, 11.12.2006). Jalava, Aulin-Ahmavaara and Alanen (2007) estimate intangible investment to have risen to 9 % of GDP, and to have

3 Causes and effects in recent trends in investment

3.1 Investment relative to other countries

It has been argued that there are no grounds for concern, since the investment rate has converged with more general trends in developed economies, such as that of the US, Germany, France and Sweden, being only a little lower than in the Euro area on average (Sorjonen, 2006). These countries are claimed, however, also to suffer from an investment squeeze, even during times of excess liquidity in the global economy. Figure 1 shows private investment with respect to GDP in these countries, Finland and the Euro area. Figure 2 shows Finland and the Euro area compared to most other OECD economies. As they reveal, the "it's the same elsewhere" argument applies only selectively, i.e., Finland's investment rate is among the lowest even more persistently than that of most other OECD countries since 1994.

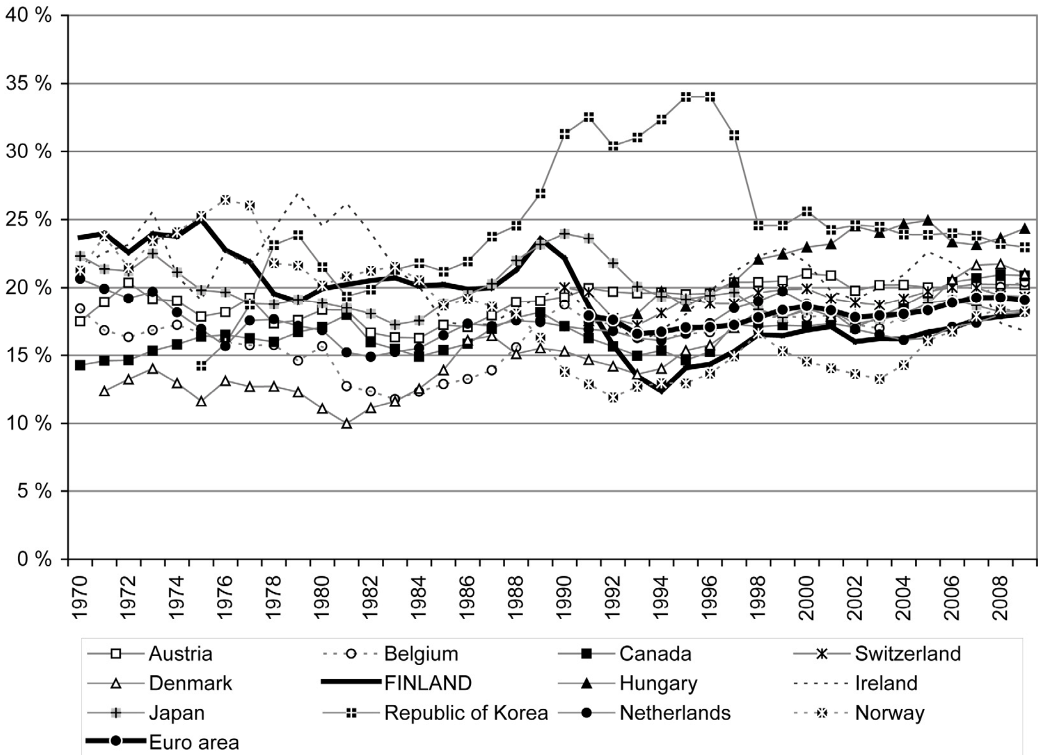

Figure 2. Evolution of gross fixed capital formation (private sector, volume) per gross domestic product (volume, market prices) in most other OECD countries (1970–2008) and the Euro area average (1991–2008). Source: OECD Economic Outlook.

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increased the marginal productivity of capital significantly. Intangible investment may have overtaken traditional investment, but data shortages prevent us from exploring its further.

3.2 The shift from physical capital to R&D investment

If R&D investments are included in the investment calculation, Finland's outlook improves greatly in comparison to other OECD economies (Figure 3). Apart from Sweden and Israel, relative to GDP no other country's private sector has invested equally heavily in R&D. Investment and R&D combined, Finland approximates the western European average. Overall, R&D intensity has increased greatly both relatively and absolutely to other countries and regardless of whether one compares R&D to employees, value-added or turnover.

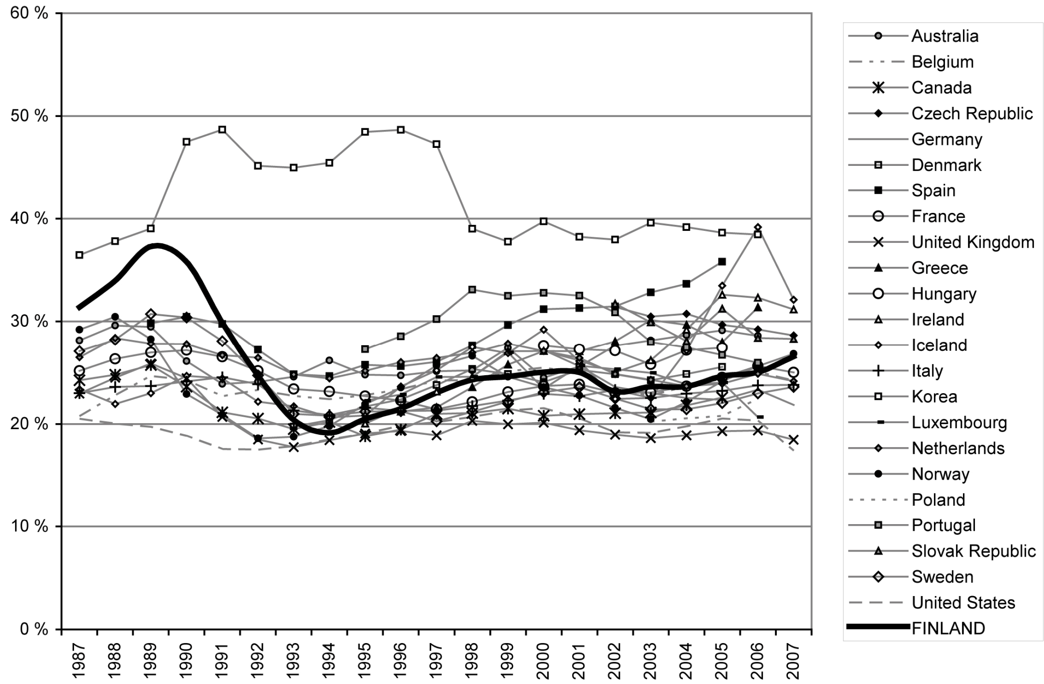

Figure 3. The sum of business enterprise R&D (BERD) and gross fixed capital formation (GFCF) per Value-Added in manufacturing and services in most OECD countries, 1987–2007. Source: Calculated from STAN indicators, OECD

Yet, the inclusion of private R&D places Finland only in the midst of EU countries, which are also claimed to lack investment. Many competitors, such as Japan and Korea have maintained above 20 % investment rates providing them with a strong lead even if R&D is included (Figure 3).

3.3 Frontier technology and the electronics industry

Frontier technology provides an intuitive explanation to Finland's reduced level of physical capital investment. More R&D is needed to substitute for investment to produce the same output as before (see e.g. Acemoglu et al., 2006). In principle R&D may generate private and social returns in innovation that compensate by far for any loss in physical structures. But are there industries in Finland that generate high returns to R&D? Are these industries large enough to compensate for a general lack of investment at the aggregate level, even if there are no significant inter-industry spillovers? Are these industries at the global frontier, and hence does R&D dominate physical investment?

The combined investment rate of R&D and physical capital is high in the R&D intensive chemical industry (EK, 2007). Relative to other countries, Finland enjoys relatively high R&D intensities also in basic and fabricated metals, along with Japan, and in the wood and wood products sector among EU countries. Yet, the sustainability of high R&D investment and productivity growth continues to rest crucially on future trends in the electronics industry. The gravity of the investment drought is dependent on the compensatory effects of electronics R&D relative to investment in other industries, which are either too small or too old.

What pulled Finland out of the early 90's depression was the emergence of a new technology and with it a new industry, the mobile phone industry. It was, and still is headed by the Nokia Corporation, whose pull effect generated almost the entire electronics industry. Contrary to past dominances, the electronics industry is high-tech, R&D-intensive, high value-added and has enjoyed rapid technological change. Though spillover impacts are somewhat disputed, Finland is a case example of success in the ICT industry with demonstrated productivity impacts on the aggregate economy.

Though its capital base tripled between 1990 and 2005, the industry lies far behind largest investors in fixed capital intensity relative to value-added or machinery and equipment per personnel (Figure 4). Hence resulting aggregate investment relative to value-added has been rather low, while the combined R&D and fixed capital investment rate has increased from 20 % in mid 1970's to 35 % in recent years.

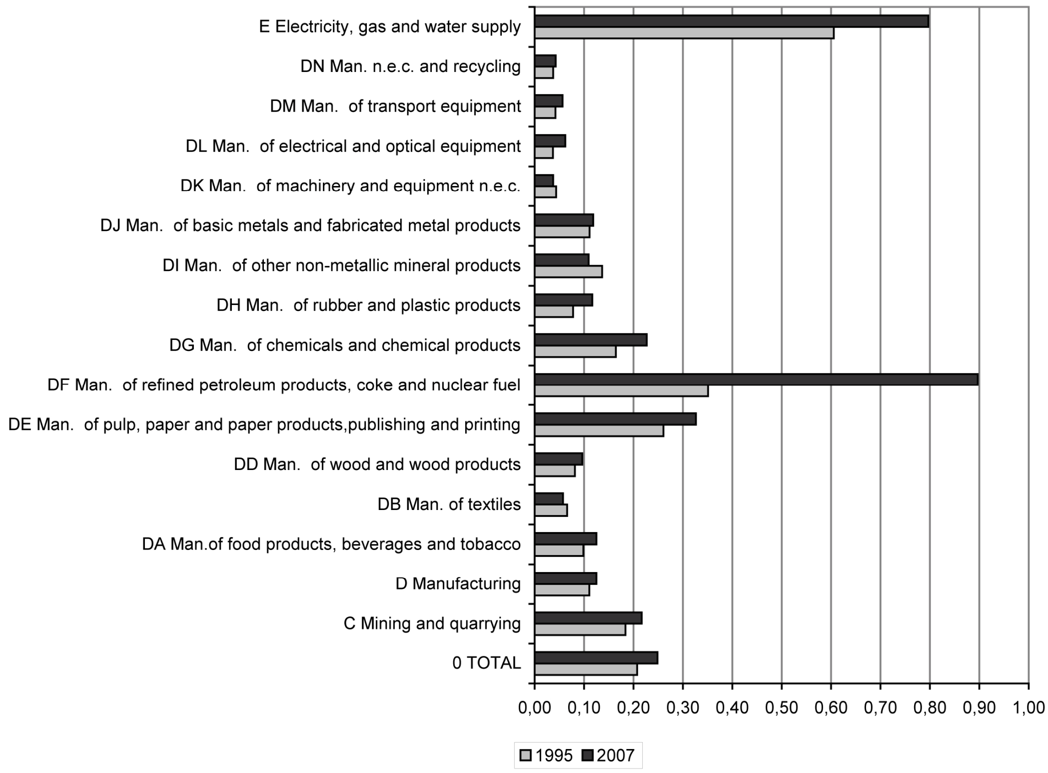

Figure 4. Machinery and equipment per total personnel in manufacturing, 1995 and 2007. Source: Statistics Finland.

Thus, at the core of the electronics success lies the mobile phone industry. As Figure 5 shows, peak R&D investment relative to value-added in the mobile phone industry took place in 1991. Ever since, R&D intensity levels have gradually approached other high-tech industries. Despite equally massive investments (relative to value-added) into pharmaceuticals and office, accounting and computing machinery at the turn of the millennium (GFCF categorised as R&D in 2000), as well as railroad equipment and transport equipment n.e.c. in the 90's, high returns continue to let themselves wait. In absolute terms and with respect to total business enterprise R&D (BERD) these other investments have been small, but the same can be said for the mobile phone industry in 1991 when it was about to take off. In recent years, total private R&D in the electronics industry and overall has grown at a reduced rate (Statistics Finland, 2007). In consequence, compensatory effects of the entire electronics industry are gradually fading.

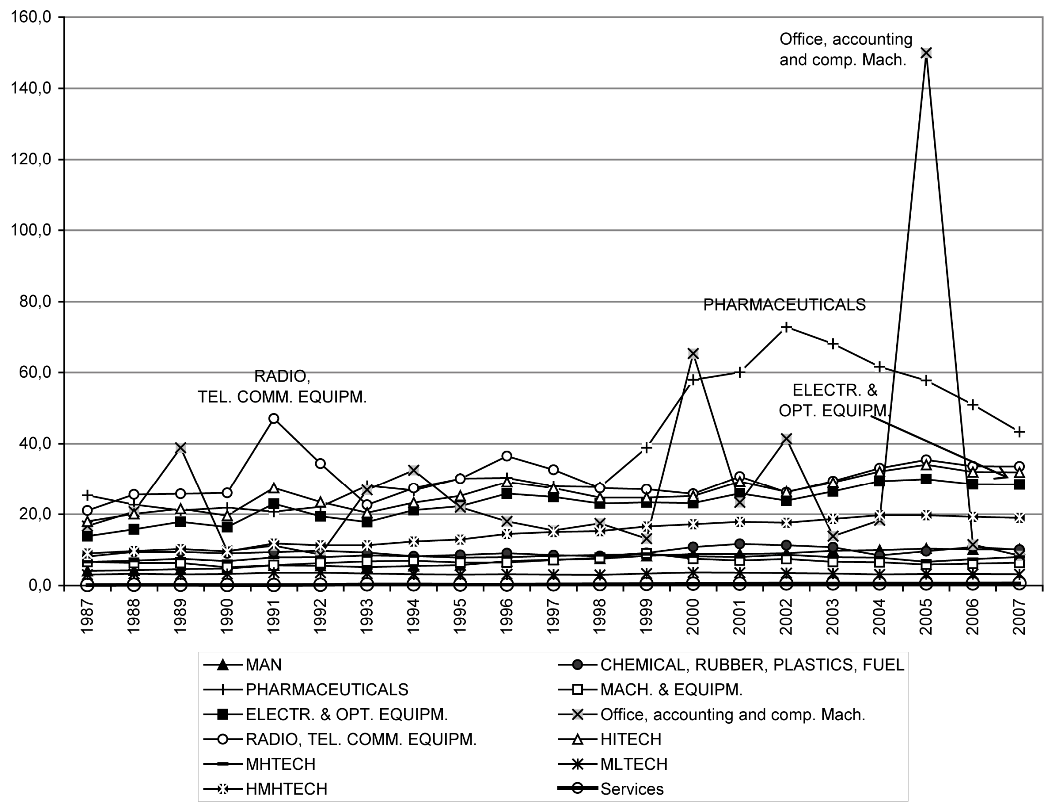

Figure 5. R&D per Value-Added in R&D intensive industries in Finland (%). Source: OECD, STAN Indicators, 2009.

3.4 Frontier comparison based on MFP levels

Data constraints on international comparisons are notorious. The recent KLEMS and complemented GGDC (Groningen Growth and Development Centre) databases were constructed to resolve this impediment (Inklaar and Timmer, 2008), and in the absence of better measures, below we compare their multi-factor productivity (MFP) levels. At least, TFP/ MFP levels offer a better signal of productive conditions than labour productivity, which obscures capital productivity entirely. Returns to capital may naturally differ greatly from TFP, if for instance the profit stream is necessary to pay for high wages, but such aspects are beyond the scope of this paper.

Provided that some stringent assumptions can be assumed, multi-factor productivity (MFP) levels provide an indication of relative efficiencies of input use between countries. These assumptions include an identical production function, constant returns to scale, competitive markets and technical and allocative efficiency. In addition, input measures must sufficiently reflect differences in adjustment costs cyclical effects and input quality between countries (see Schreyer 2001). In addition revenue maximization or cost minimization is required of the firm, which at the industry or aggregate economy level, requires even more stringent assumptions. Provided that these assumptions hold, MFP levels account for many inputs in the production process, though R&D is typically not included. In the interpretation of these figures, capital embodied technology cannot be accounted for, as well as other factors causing differences in the shape of production functions between countries, i.e., other than mere level differences. Otherwise, differences in MFP levels can be interpreted as differences in technology, i.e., very narrowly defined.[3] As is obvious, these MFP levels can only approximate distances from the technology frontier and varyingly for different industries.

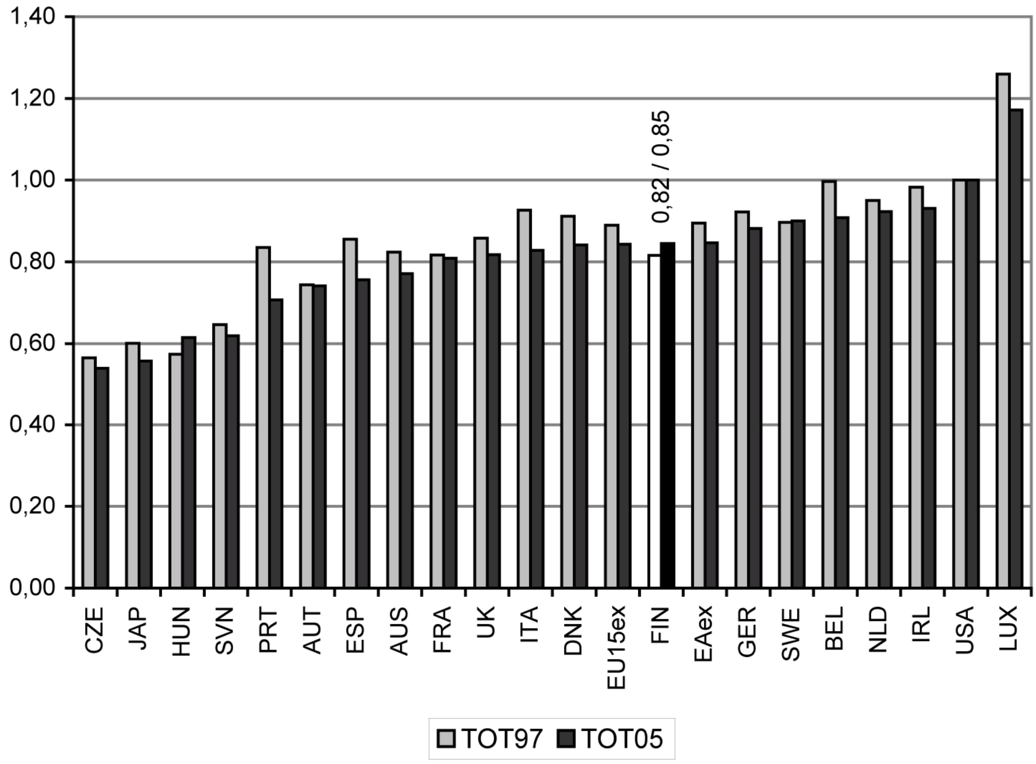

Figure 6. Multi-factor productivity index (double deflated, USA=100) in total economy in 1997 and 2005. Source: "Inklaar, R. and Timmer, M.P. (2008). 'GGDC Productivity Level Database: International Comparisons of Output, Inputs and Productivity at the Industry Level', Groningen Growth and Development Centre Research Memorandum GD-104, Groningen: University of Groningen, September 2008"

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[3] As technological change often affects all inputs, and not only the primary factor inputs labour and capital, gross output-based MFP levels better reflect differences in technology than value added-based ones. From the producer's perspective there is no inherent difference in the primary inputs (labour and capital) and intermediate inputs (materials, energy and service inputs). Production decisions are made for all inputs simultaneously and substitution between all inputs can take place, making them non-separable. Instead, value added-based MFP measures provide only an indication of the importance of the productivity differences in factor inputs (capital and labour) for the economy as a whole. The value added-based measure was obtained by independent comparisons of gross output and intermediate inputs with their own PPPs (so-called "double deflation").

A comparison of these MFP indices at the total economy level places Finland in the EU average, with an 85 percent productivity level relative to that of the US (Figure 6). Exclusion of the non-market economy raises Finland to 90 % of the US level, implying that the large public sector imposes a small tax on productivity.

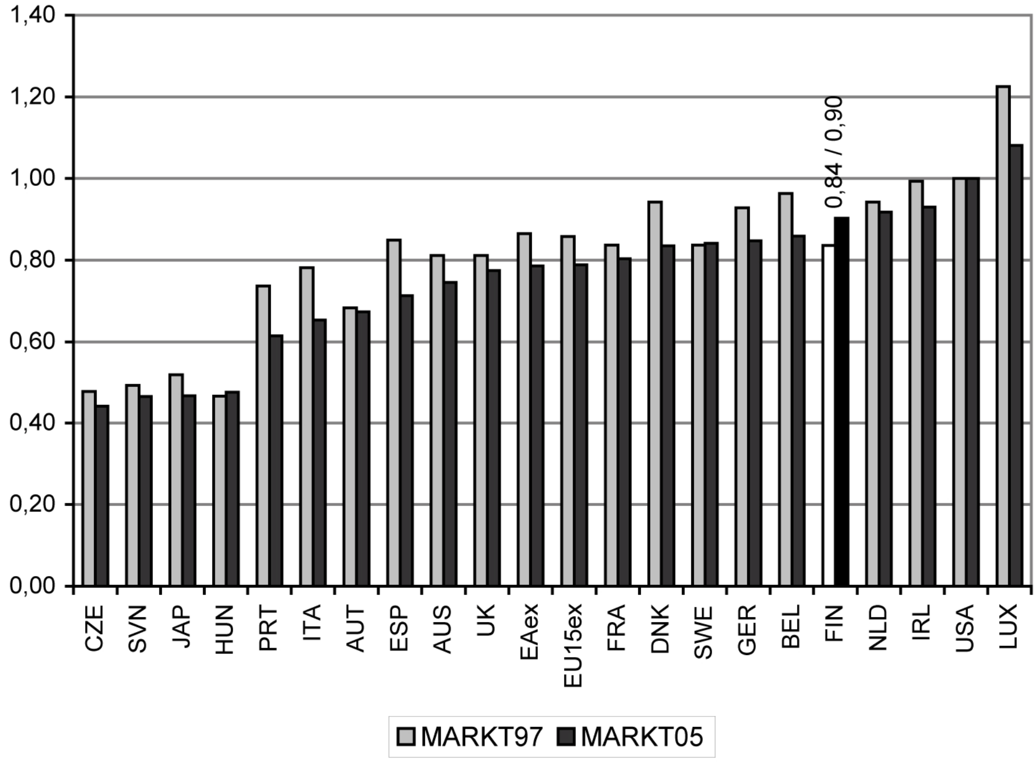

Figure 7. Multi-factor productivity index (double deflated, USA=100) in market economy in 1997 and 2005. Source: Ibid.

Figures 6–7, suggest that MFP differences are rather small at the total economy level for Western economies, apart from Japan and Luxemburg at the other end. Since underlying sectoral differences are much larger, countries appear to have employed their resources rather well according to their comparative advantage. Yet, differences in MFP seem to have increased from 1997 to 2005, suggesting that technological diffusion has not kept pace with innovation in leading economies. This implies that some economies need to restructure towards other industries and/or accelerate technological diffusion to catch-up. Finland managed to narrow the productivity gap slightly in goods production.

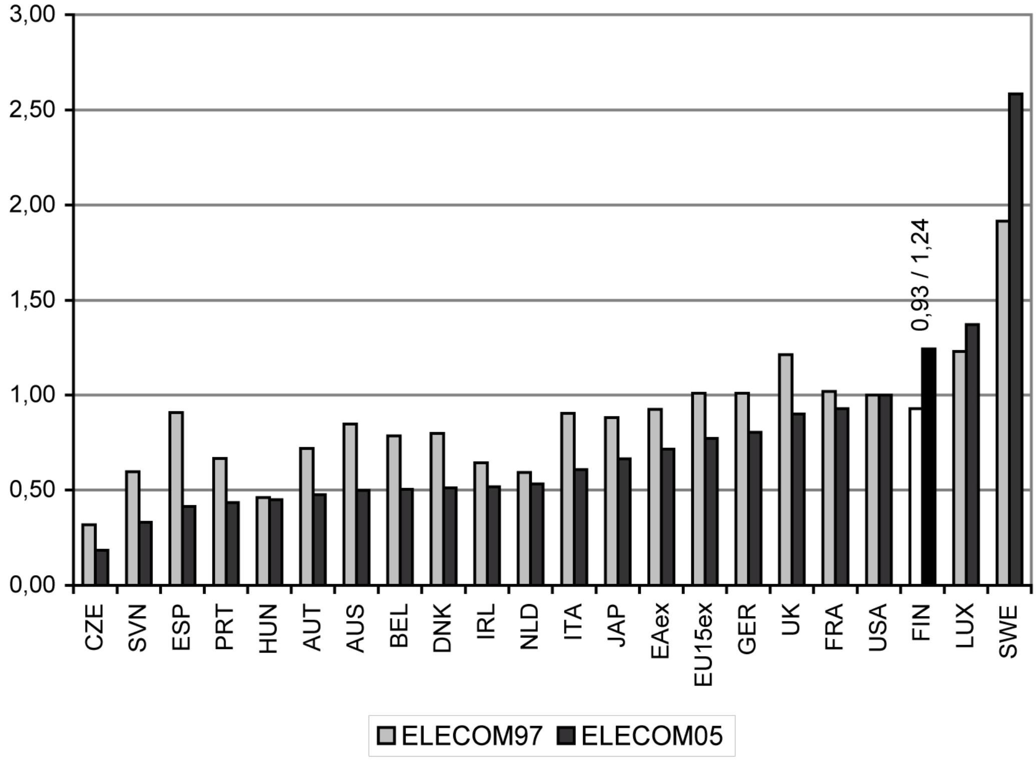

Figure 8. Multi-factor productivity index (double deflated, USA=100) in electrical machinery, post and communication services (Elecom) in 1997 and 2005. Source: Ibid.

In electrical machinery, post and telecommunication services, Finland fared much better than the US with a 124 % score in 2005, although Sweden beat it by far with a 258 % score (Figure 8). In manufacturing, excluding electrical machinery, Finland reached 107 % of US MFP level in 2005, with only Belgium (109 %) and Ireland (154 %) faring better[4] (Figure 9).

[4] ELECOM figures for Ireland placed it surprisingly low at just over 50 % of the US level in 2005. In goods producing, excluding electrical machinery, Ireland competes for the frontier with Belgium ahead of the US, revealing that its ICT production appears to be categorised somehow differently.

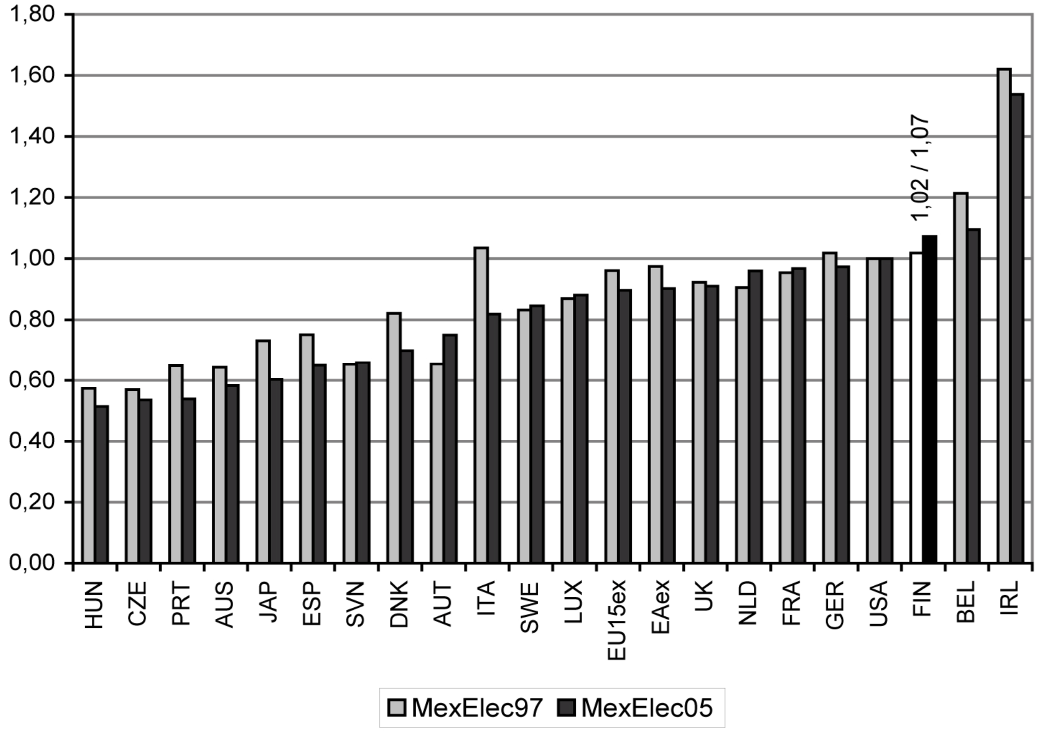

Figure 9. *Multi-factor productivity index (double deflated, USA=100) in total manufacturing, excluding electrical in 1997 and 2005. Source: Ibid.*

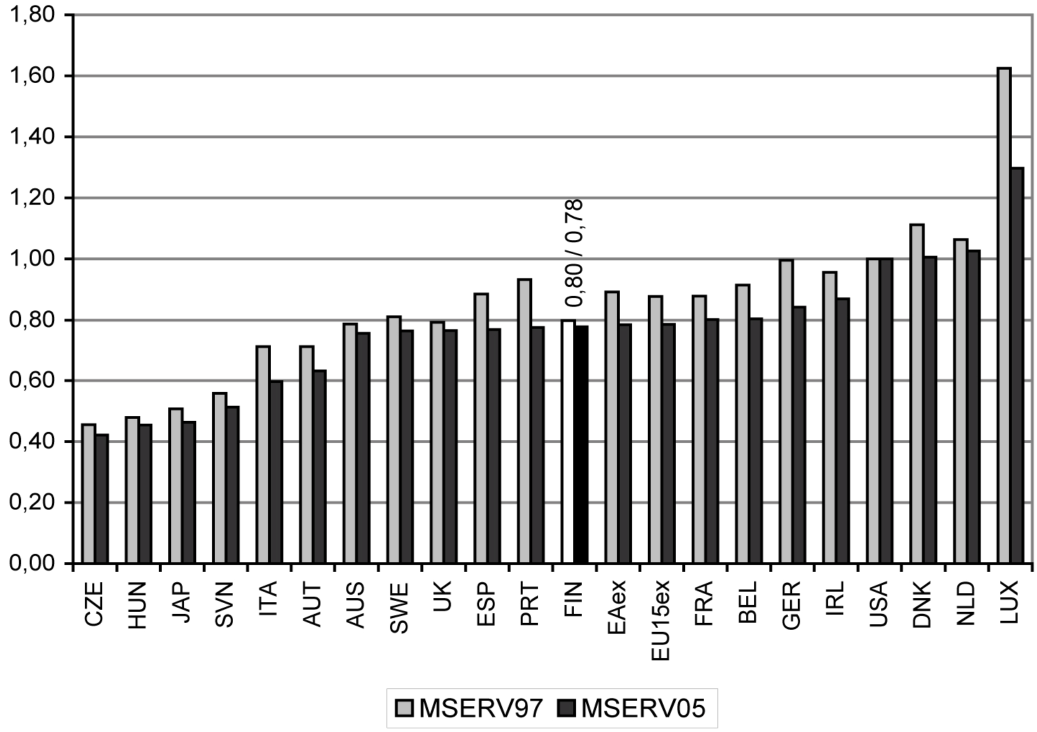

Figure 10. *Multi-factor productivity index (double deflated, USA=100) in market services, excluding post and telecommunications in 1997 and 2005. (Market services include distribution (trade and transport), finance and business, except real estate and personal services). Source: Ibid.*

Finland's competitiveness in manufacturing and electrical machinery is counterbalanced by only EU average MFP (78 %) in market services (Figure 10). This drop is not due to trade, in which Finland reached a commendable score of 147 % in 2005 second highest in 2005 after Denmark (Figure 11).

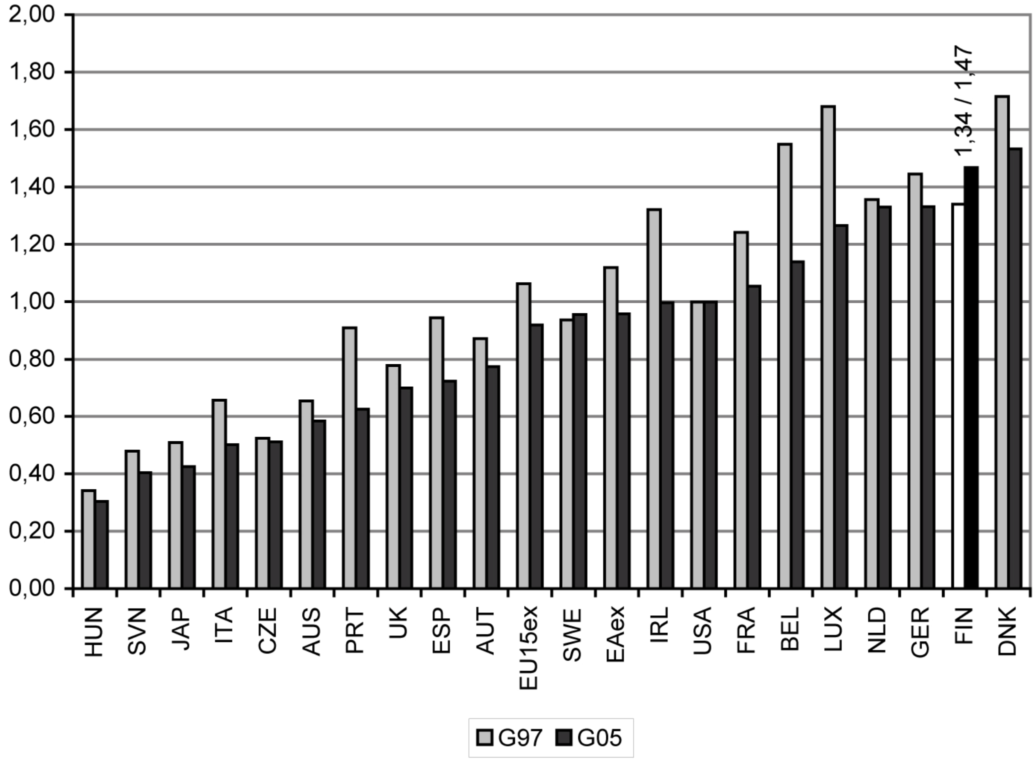

Figure 11. Multi-factor productivity index (double deflated, USA=100) in trade in 1997 and 2005. Source: Ibid.

Instead, in personal services, Finland is the fourth worst with only 49 % MFP of the US level in 2005 (Figure 12). Personal services may, however, be subject to high regulation, and consequently the stringent conditions placed on MFP are most unlikely to hold. Nevertheless, MFP figures suggest that private investment is unlikely to close the personal services gap, since it has only widened from 1997 to 2005. Assuming that the Finnish economy does not differ that greatly from the rest of the EU and that these MFP figures can at all approximate efficiency, public investment could yield high catch-up related returns in personal services.

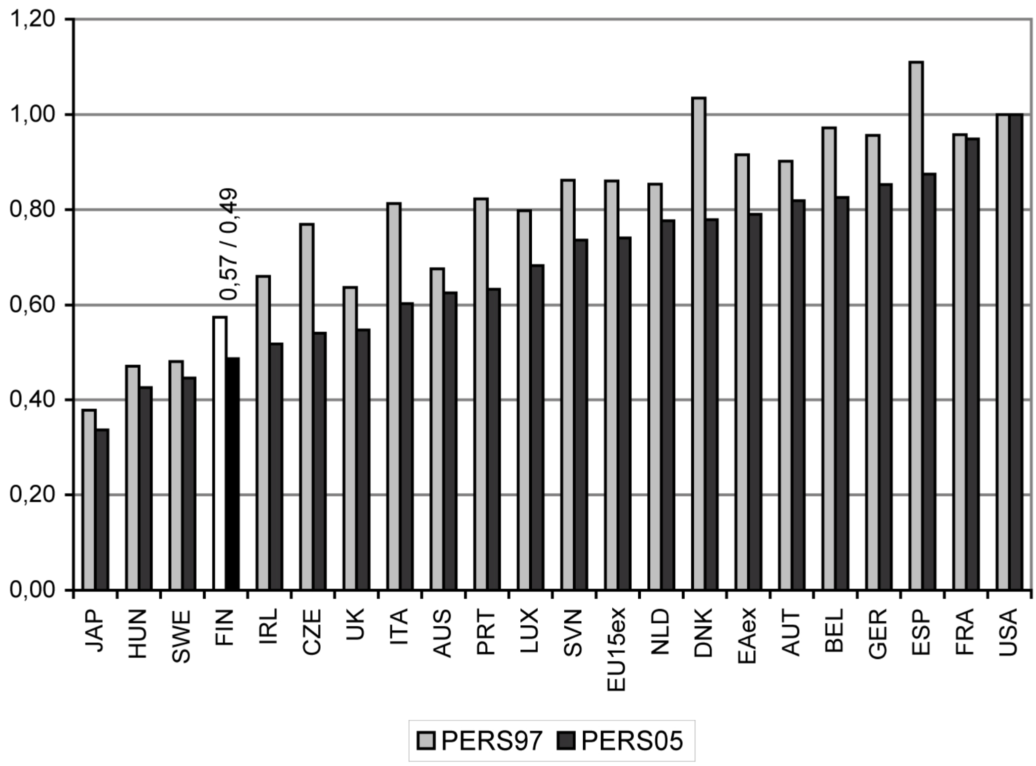

Figure 12. Multi-factor productivity index (double deflated, USA=100) in personal services in 1997 and 2005. (Personal services include hotels and restaurants, other community, social and personal services, Private households with employed persons.) Source: Ibid.

Overall, MFP figures do suggest that Finland is indeed on the frontier in the electronics industry at large. Yet, by 2008, Finnish ICT manufacturing had largely fled to lower labour cost and/or larger market countries. This applies also to most of the EU (apart from e.g., Romania). Problems related to competitiveness in investment in this industry may stem from ICT producing Asian countries, such as China, India, Korea and Taiwan for which data was unavailable for comparison. Consequently, the global frontier in electronics cannot be determined by the MFP results of Figure 8 above.

Moreover, the MFP figures above lacked R&D input data. In consequence, R&D intensive industries and countries may show high productivity growth, while in reality they have relied on extensive growth, based on additional R&D inputs. As long as the productivity of R&D remains high, capital productivities may score as well as MFP figures above suggest. Once returns to R&D decline, there is a real risk of inefficiency originating from overinvestment as with physical capital in the past. As Finland features among top R&D investors in the world, it is not clear that inefficiency in investment has not shifted from conventional fixed capital investment to R&D. It is entirely possible that Finland has moved from inefficient capital investment to inefficient investments in knowledge. It may be just as difficult to "push" growth with knowledge accumulation, as it was with physical capital accumulation. It is possible that R&D crowds out investment in a critical bottleneck, or that increases in R&D demand increase only wages and costs, without a respective supply increase. Duplicate R&D is wasteful. Or, an increase in supply leads to price/ wage declines which in turn reduce supply in the long term. Particularly in boom phases of the business cycle, excessive public R&D investment may crowd out more private investment than it generates in multiplier effects. In principle, large size, an abundance of human capital, and a sizable knowledge base contribute to a country's competitiveness in research. While R&D subsidies can change the course of a human-capital endowed country with a short history in research, they may also crowd out R&D in high-tech manufacturing if there are limits to complementing the human capital stock from abroad. (Grossman & Helpman, 1997, p. 338, 339). In any case, R&D investment has not been able to barrier production outflow.

Hence, frontier technology in electronics may explain Finland's reduced level of physical capital investment, but better data is needed to definitely establish the case. Electronics R&D may generate returns in innovation that compensate for any loss in physical structures, being large enough to compensate for a general lack of investment at the aggregate level. Nevertheless, the outflow of ICT production as well as of some R&D from Finland does not envisage sustainability to this (already past) state of affairs. Even frontier technology and knowledge does not seem to guarantee future investment.

3.5 Productive capacity

Figure 13 shows that the total economy capital stock relative to GDP rose in the depression as GDP fell, but has declined gradually prior levels. Since capital stocks have accumulated more rapidly in most other OECD economies, Finland's is now among the lowest. This raises concerns about productive capacity and the sustainability of economic growth. In the paper industry, as well as in trade, investment has for long fallen short of replacement needs to cover the economic depreciation of capital, and the capital base appears to have contracted.

Yet, according to ETLA's calculations (Sorjonen, 2006), productive capacities continued rise at least until 2006. Considering output and capacity utilisation, productive capacity in manufacturing increased by about 60 % from 1995 to 2006. In forestry, productive capacity increased by 35 %, in technology industries (metals and electronics primarily) by 115 %, and 15 % in other manufacturing industries. Productive capacities have not suffered due to outsourcing and renting, which is increasingly common place and the machinery ever better.

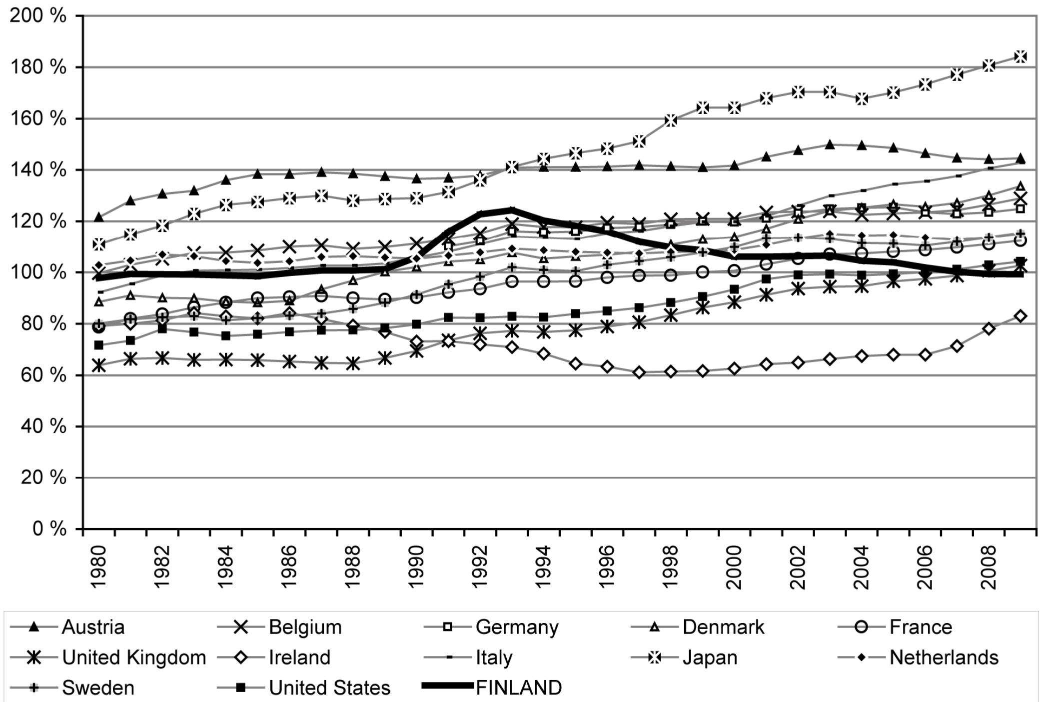

Figure 13. Capital stock volume (total economy), per GDP volume, market prices in some OECD economies, 1980–2009. Source: OECD Economic Outlook.

3.6 Capital embodied technical change

Capital-embodied technical change is directly reflected either in the productive capacity of capital goods or their price. Particularly when technological progress is rapid, net investment and capital do not appear accurate measures of productive capacity. Less capital investment is needed to obtain the same productive capacity and it is only natural that investment rates decline. In contrast to high-tech sectors, corporate R&D is generally less effective in low-tech sectors, which in turn are more dependent on capital embodied technological progress. (Ortega-Argilés et al., 2009)

Hence, productive capacities can continue to rise as investment falters, but there are limits to the compensatory extent of technological progress and R&D. Capital embodied technology imports are typically central to the upgrading of productive capacities in small countries, including Finland, regardless of their own R&D and innovation. Even if human capital and knowledge were at the frontier, one needs frontier production equipment to enjoy frontier productivity. R&D and physical investments may appear as substitutes at the aggregate level and in the long run, but at the micro level it would be extremely inefficient if technologies were not imitated, copied or simply acquired from abroad. Re-inventing everything in the presence of severe resource constraints would no doubt lead to falling behind from the technology frontier. Domestic innovation cannot substitute for technological diffusion from abroad.

Thus R&D and physical capital can substitute for each other, but are also necessarily complements. Even if there is some substitutability between factors of production, it is rarely perfect and may require a long time to emerge. It is the complementary feature which is so apprehending. In the era of globalisation, outsourcing and the ICT revolution, technological progress is very much about capital embodiment.

3.7 Outsourcing and off-shoring

Balance sheets have been alleviated from the risky load of heavy capital investments, as across the world, buildings, machines, equipment and other capital goods can be rented from specialised companies e.g. in the real estate and business services sector. (Sorjonen, 2006). Similarly, outsourcing and off-shoring are global trends that have raised productivity while alleviating the need for heavy physical investments.

While renting, outsourcing and technological progress can overcome the investment dilemma, they raise the risk of outmigration of production and further erosion of productive capacity. Judging by Figure 13, after 1995, the shift towards lighter structures in terms of the share of business sector capital per GDP has been especially strong in Ireland (until 2006) and Finland. Though excess capacity may have continued to weigh on investment levels and reduced investment may be a healthy sign, production may also be more easily shifted abroad as a consequence.

Indeed, corporations have invested a great deal in locations such as China and India, where labour costs can be a fraction of those in Finland and market size and growth far beyond comparison. In addition to production costs, the saturation of OECD markets has left the greatest growth potential to be found among rapidly growing emerging markets. Furthermore, low investment may not be a temporary phenomenon, but may proclaim long term trends in production shifts to other areas. Current low investment levels may offer the first glimpses of a slow long-term adjustment to global market demand and supply conditions, eventually transforming the global division of labour.

3.8 The Past Global Savings Glut and Current Shortage

Finland’s country risk in terms of political upheavals, natural disasters, etc., is among the lowest in the world for a small open economy, as can be judged by government triple A-credit ratings. If risk-return relationships guide global capital flows, bottom risk levels with little attraction of inward FDI, cannot but insinuate modest expected returns to investment. Has Finland therefore lost out to competing locations in investment because of its lack of competitiveness in terms of the productivity of capital or other resources? MFP levels shown above, did not suggest it.

The paradox of low investment despite abundant savings and good risk-return opportunities – at least on the surface – was a hot topic of the international economic policy scene for years. The US drew in bond investments from central banks to finance its twin deficits, while its private sector net invested abroad directly and via portfolios. (IMF, 2005, and Weale, 2006). It was considered only natural for an aging and wealthy Europe to show a slight savings surplus, and to fund the US current account deficit along with most of the developing world. The excess supply (glut) of global savings (Bernanke, 2006) was embellished by liquidity boosting policies of major central banks, such as the Federal Reserve Board of the US. The supply of global capital was unusually abundant also because high oil prices had built up oil producer countries' surpluses. (Roubini, 2006). During the first oil crisis these surpluses were recycled through the global banking system to developing countries. The inefficiency of these investments has been well documented. This time surpluses were channelled among others to the US housing market with similar results.

Most of the world was already suffering from an investment drought following the burst of the technology bubble and 9/11 (Roubini, 2006). Their lot has only accentuated after global credit has been crunched by the US subprime loan crisis. Russia is one an oil producer, but has suffered from a relative shortage of investment into other than energy related sectors already before the global crisis. Even some of emerging Asia showed low investment relative to GDP and prior levels. At first, Europe and particularly the Finnish economy were not expected to suffer greatly. On the contrary, suddenly Europe was portrayed as dynamic and creative. That is or was, until the crisis truly set in.

3.9 The Business Cycle

In the first decade of the new millennium, investment followed the business cycle, but with a considerable lag. Economic growth was strong, private sector profitability good, leverage moderate and interest rates low for several years before investment finally caught up in 2007. Yet, productive and export capacities and employment did not deteriorate, quite the contrary. Finland fared better than neighbouring regions such as the Euro zone. During the 5-year period (2000–2004), Finland's GDP grew on average 2.8 % p.a., i.e., faster than in the US (2.6 %), EMU-12 (1.9 %) and Japan (1.5 %). Exports of goods rose by 6.5 % on average. Manufacturing output increased by 4 % and services output by 2.8 % p.a. Labour productivity rose by 2.4 % on average. Employment improved and hours worked increased by altogether 2.3 %. Private consumption grew strongly.

Only fixed investment rose slowly (1.3 %) raising the question of why productive capacities did not expand faster.

Judging by the heated debate, uncertainty related to energy production and measures to tackle climate change may have played a role in investment decisions. The uncertainty has, however, been mostly related to the ability of industry and other pressure groups to forestall energy price rises by over-allocation of allowances or some other way. The long term policy trend with respect to climate change is bound by international commitments, and has therefore been common knowledge all along. By 2009, industry's concerns proved misplaced, as energy prices had collapsed along with other inflation. In contrast, the sharp fall of emission right prices threaten to prolong the emergence of the EU Emission Trading System (ETS) as a fully functioning spot market that trades emissions credits like any other commodity at optimal efficiency and liquidity across the globe. In any case, the 2007 investment rebound has been entirely jeopardized by contagion effects from the US subprime loan crisis. Among plummeting exports, orders, inventories and sales, rising uncertainty and financial sector turmoil, little remains of investment enhancing confidence and economic stability.

3.10 The Savings Rate and Outward FDI

In Finland, the savings rate has changed little over the years. The Current Account was in surplus and prices relatively stable until global inflationary pressures set in around 2007. In contrast to a simple closed economy model in which investment equals savings, in an open economy investment is no longer dependent on domestic savings and firm revenue. Following liberalisation, capital was in abundant supply and interest rates low in the Euro area, even if the US swallowed enormous amounts of it. Thus it seems clear that there was no shortage of capital, but of investment.

Despite the textbook conditions for an advantageous investment climate, an amount equal to about 75 % of domestic investment was invested annually abroad (EK, 2006)[5], with manufacturing companies accounting for the major share. Oksanen (2006) has argued that the impact of outward FDI on domestic investment is positive when invested in developed countries, but moderately negative when invested in emerging markets by financially constrained firms. His 1998–2002 sample represents an unusual boom period, however, when crossborder M&A activity rose rapidly and financial constraints were rare. Circumstances with respect to important industries have changed greatly ever

[5] Contrary to domestic investment figures, FDI includes mergers and acquisitions (Elinkeinoelämän Keskusliitto, 2006).

since, and suggest that the negative effect on domestic investment of outward FDI to emerging economies is not limited to financially constrained firms.

Indeed, Sauramo (2008) carried out macroeconomic co-integration tests following Feldstein (1994), finding that outward FDI Granger-causes low investment in Finland. The effect was one to one, i.e., every euro invested abroad decreased domestic investment by the same amount. Thus, despite extensive liberalisation of international capital flows since 1980, the Feldstein & Horioka (1980) puzzle still holds. That is, domestic investment continues to be financed from domestic savings, or firm revenue to be specific, though with the exception that outward FDI has entered the investment equation.

Official outward investment has not increased as much as domestic investment has decreased since the early 90's depression. The aggregate savings rate has remained relatively stable while the investment rate has decreased. The gap can be explained by current account and savings surpluses. Therefore the benefits of outward FDI provide only a partial explanation to reduced domestic investment. There is no clear reason to why retained savings has increased.

Lagging inward FDI also provides some explanation to the investment gap. Inward FDI increased, but continued to be dominated by acquisitions into the services sector, particularly bank mergers. Unlike green-field investment, mergers and acquisitions do not directly raise domestic investment. Moreover, ever since full liberalisation in 1993, inward investment has failed to catch-up with outflows. Two episodes of asset seeking if not technology sourcing inward FDI took place at the height of the ICT boom in the end of the 1990's and 2003, but both were short-lived. Implicit barriers to the Finnish market may either be too high for potential foreign entrants or the market too small to interest them.

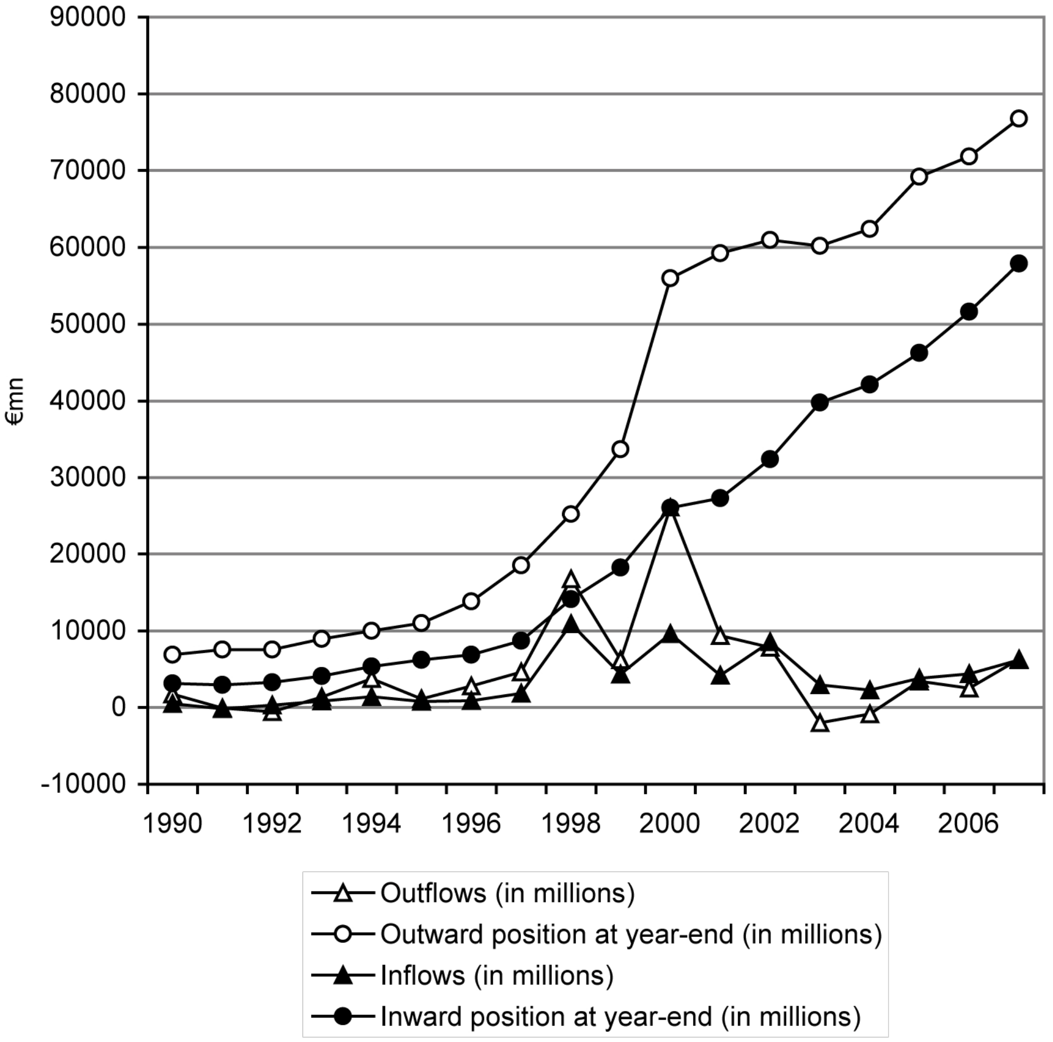

Figure 14. Inward and outward FDI flows and stock, € million. Source: OECD.

Though Figure 14 suggests net-inflows to Finland after 2003, official statistics may underestimate outbound investment. Official balance of payments (BoP) statistics collected by the Bank of Finland are based on financial flows to and from Finland. Hence investments financed from foreign sources do not appear at all in the data. For instance, Feldstein (1994) estimated that within the OECD, each dollar of cross-border external finance reduces domestic investment by one dollar. Approximately 20 % of existing U.S. foreign affiliate capital is financed by a cross-border flow of capital from the United States. 18 % comes from the retained earnings of the foreign affiliate, and 62 % from foreign debt and equity sources. Thus BoP statistics may record only as little as 20 % of investment abroad.

Naturally, technologies and competitive conditions have evolved and industry life cycles shifted priorities. Capital-intensive industries such as the paper industry, no longer enjoy incentives to invest in Nordic countries already suffering from excess capacity. The domestic market may be saturated and offer little scope for the expansion of productive capacity. Another explanation is Eastern Europe, which has enjoyed abundant FDI inflows particularly from neighboring Western Europe. Their problems have been more focused on supporting catch-up of indigenous industries with inward multinational investment, and over the years, their prices and wages have risen and competition for investment with other areas toughened.

3.11 The euro fix and high-tech exports

Finland's economic boom was associated not only with the ICT technology hype, but also the 1995 exchange rate fix to the EMU, which was favourable to exports until 2000. Thereafter the depreciation of the US dollar has removed these cost advantages on exports, and accentuated the aftermath of the bursting of the technology bubble. The erosion of cost competitiveness in terms of foreign exchange offers a significant explanation to the severity of the investment drought, only accentuated by the subsequent appreciation of the euro against the dollar and currencies attached to it, such as the Chinese renminbi.

Despite the Euro appreciation, Finnish manufacturing industry flourished in the golden age of globalization that lasted until 2007, particularly with regard to the production of investment goods and industrial intermediate goods in the machinery and metal industries. Strong growth in China and some other Asian countries pulled up raw material, intermediate and investment goods' prices, particularly energy prices. Meanwhile, inflation remained low for years thanks to the deflationary effect of cheap, particularly Chinese, labour (Salokoski, 2008). As inflation no longer eroded the real value of debt, investments in free markets needed to be productive, and consequently capital efficiency improved (Sorjonen, 2006).

During the 1990's, Finland's export specialisation structure approached that of South Korea and Hungary, with some similarities observable also with China, Taiwan, and Estonia. These similarities were mainly due to ICT production exports, partly generated by Finnish investments abroad.[6] A significant share of the subsequent decline in relative high-tech intensity of exports is hence also due to investments of Finnish firms (Kaitila, 2004, 2007).

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[6] VTT Intelligence Forum 2007. http://www.vtt.fi/inf/pdf/symposiums/2007/S250.pdf

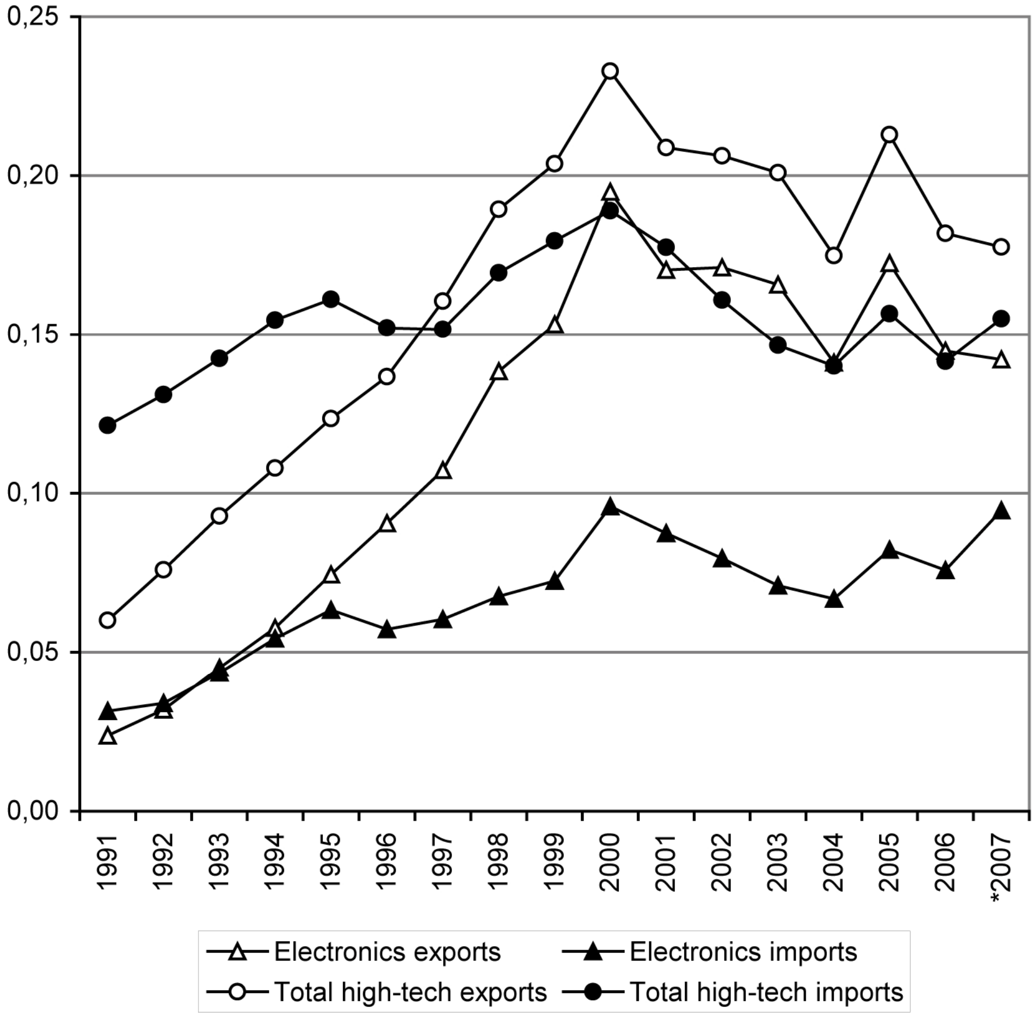

Figure 15: Shares of high tech imports and exports in Finland's foreign trade in 1991–2006. Source: Statistics Finland.

As figure 15 below shows, Finland's high tech exports peaked in 2000 at the height of the ICT hype, declining subsequently below 20 % of total exports. Imports from China grew by about 50 % p.a. for three years until 2006, while past levels in high-tech exports were mainly due to the high-tech flag ship, the electronics industry (80 %). The data shows that the high-tech balance of trade was still quite positive for Finland in 2006 (Figure 15-16). Since the electronics industry has witnessed plant closures one after another in recent years, one can expect high-tech shares in exports to plummet soon.

As Figure 16 shows, relative to other countries, Finland is actually far from the forefront in high-tech export intensity, which seems to be dominated by newly industrialized countries (NICs) or other middle-income economies. High-tech shares seem to have declined in general from 2000 to 2006. This may be due to the rising share of Chinese high tech exports, on which data is lacking.

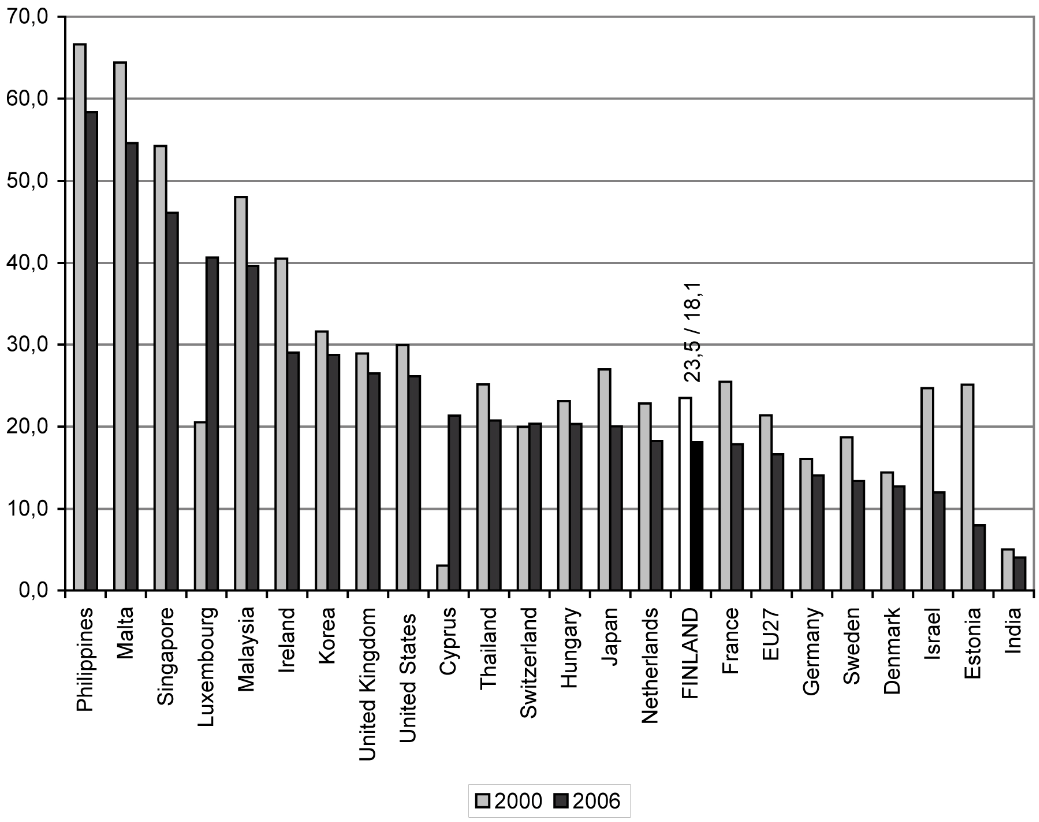

Figure 16: High technology exports as a share of total exports in 2000 and 2006 in high-tech exporting countries. Source: European Innovation Scoreboard 2008, Eurostat.

A collapse of high-tech exports does not signify a shift in comparative advantage despite terms of trade changes. Comparative advantage should not be dismissed lightly. Factors also work in the opposite direction. Wage increases and other classic equilibrating mechanisms are likely to accelerate in China, as is Eastern European countries. Moreover, international trade theory does not rule out trade patterns contrary to comparative advantage. Canada and the US gain from exporting primary products because they are very efficient at producing them. (Markusen et al., 1995, 73). Hence, Finland can gain from exporting intermediate and investment goods to China, while importing increasingly higher tech products.

Finnish industry used to be dominated by high energy and capital intensity, and these continue to be important, although Finland continues to lack in comparative advantage in either energy or capital intensive production. Relative to other EU countries, Finland enjoys an abundance of highly educated employees. The traditional Ricardo – Heckscher-Ohlin theory of comparative advantage places Finland among human capital intensive exporters. High-tech export intensity would probably be more prone to generate human capital intensive employment and high value-added. To some extent, similarly with Sweden, Germany and

Austria, Finland is comparatively specialised in technology or education intensive production, such as communications technology, paper and pulp industry and some metal industries, though apart from the first, the rest are typically regarded as capital intensive. As Figure 17 below shows, employment in medium-high and high-tech manufacturing was 7 % in 2007, i.e., is slightly above the EU average of 6.7 %.

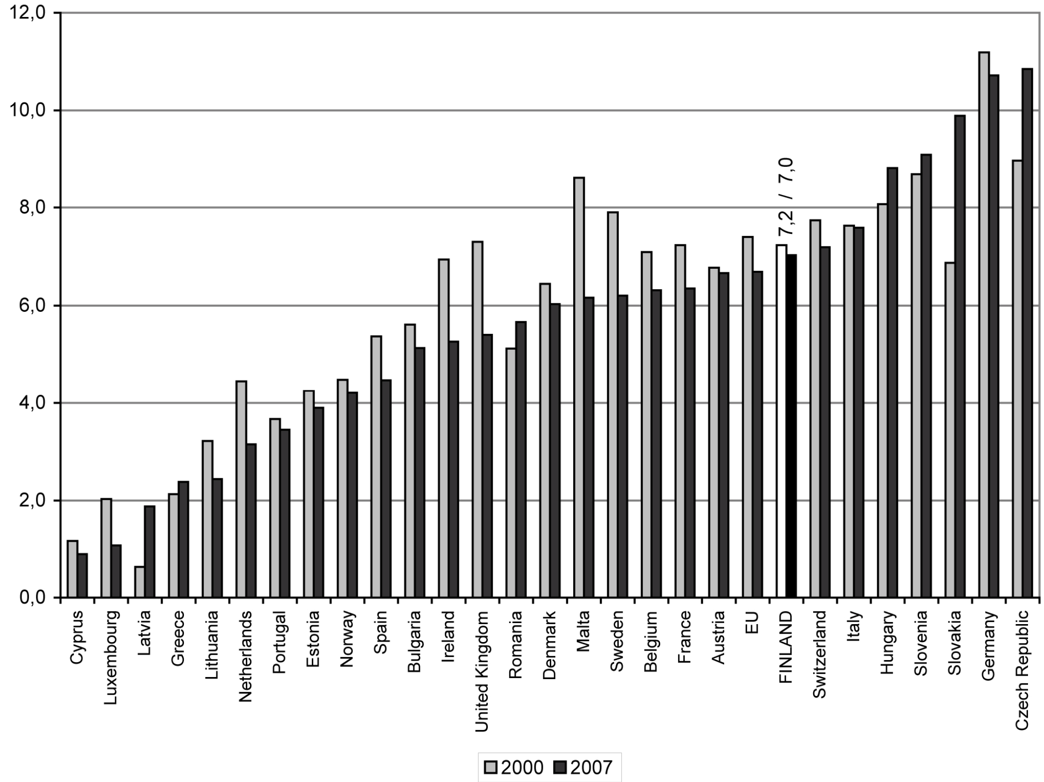

Figure 17: Employment in medium-high and high-tech manufacturing (% of workforce) in 2000 and 2007. Source: European Innovation Scoreboard 2008, Eurostat.

Developments could have been entirely different with different exchange rate regimes. Chinese national level predatory pricing in the form of “strategic exchange rate policy” to capture market share from foreign companies, may have been an important component behind problems encountered in attempts to raise the technology and R&D content of exports. Indeed, prior to the financial crisis Chinese mercantilist policies were reshaping world production and threatening it increasingly in the Euro zone (Salokoski, 2008). By 2006 China had overtaken the EU in terms of world share in high-tech exports. In electronics and telecom, China passed the EU already in 2004, and was expected to catch up with the US by 2007.

For countries participating in the Euro zone, devaluation is not an option. If cost advantages have been lost, little can be done to regain them. A variable exchange rate, as maintained in Sweden, could therefore have supplied policymakers with a more effective means of sustaining competitiveness and investment growth. Entering the Euro zone was argued for by low interest rates, abundant supply of capital, abolishment of exchange rate risks within the zone, investment promoting stability, as well as the need to raise the value-added content of exports. It seems a paradox that the abolishment of capital market constraints, reduced interest rates and increased productivity of investments has actually reduced investment.

3.12 Structural change

The decline in investment was not entirely due to structural change. After the 1980's, the investment rate declined in almost all sectors, with few exceptions (Figure 18). Services investment has proved sustainable at well over 20 % of value-added, with growth notably in construction, finance and business services, while in manufacturing the investment rate has generally declined. A disturbing exception is agriculture, forestry and fishing, one prime source of capital inefficiency in the past, with investment per value-added ratio extending even above 40 % in 2006.

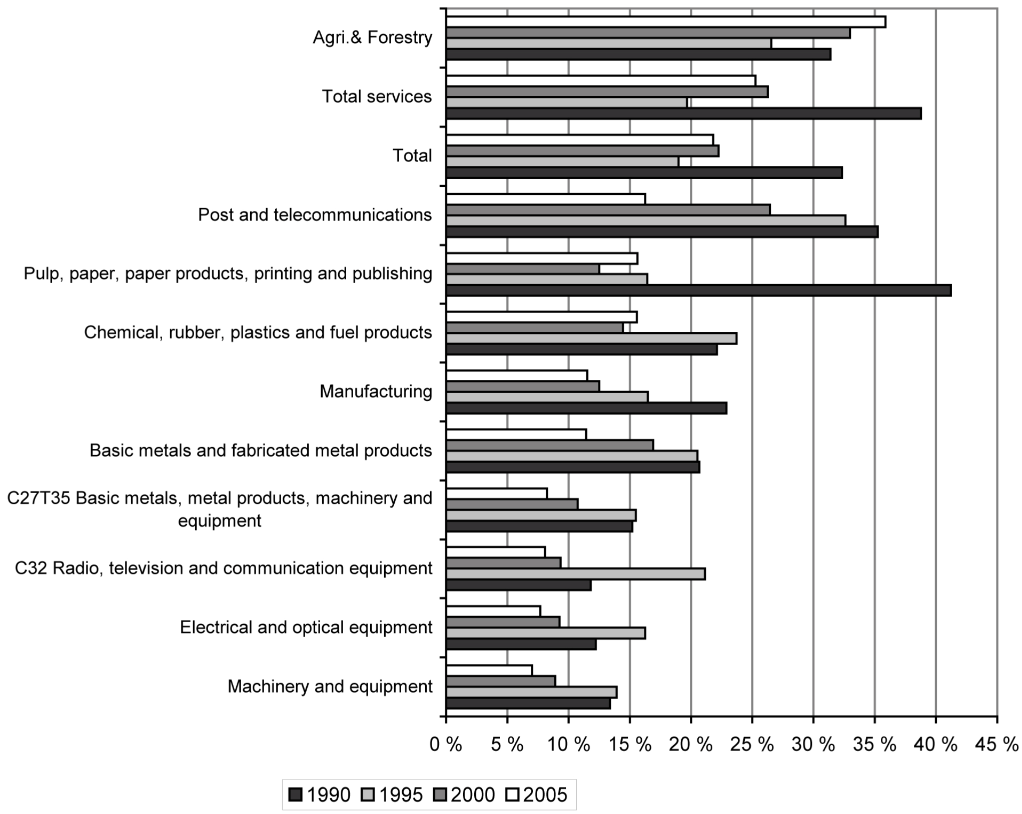

Figure 18. Investment intensities by sector, GFCF per Value-Added, 1990, 1995, 2000 and 2005. Source: OECD.

Even more disturbing is the fact that in manufacturing, the declining trend is strongest in high-tech industries (Figure 19), headed by radio, television and communication equipment (Figure 18). Even in telecommunications services, investment has gradually declined below 20 % of value-added. The 2007 rebound in investment appears to be more related to trend growth in mechanical engineering and metal industry exports, as well as some major investments, such as power plant buildings. Though categorised as technology industries, the metal and mechanical engineering industries represent more medium than high technology in terms of R&D intensity. Thus despite the education, innovation and high-tech rhetoric, as Figure 19 shows, the current trend appears to favour medium technology industries.

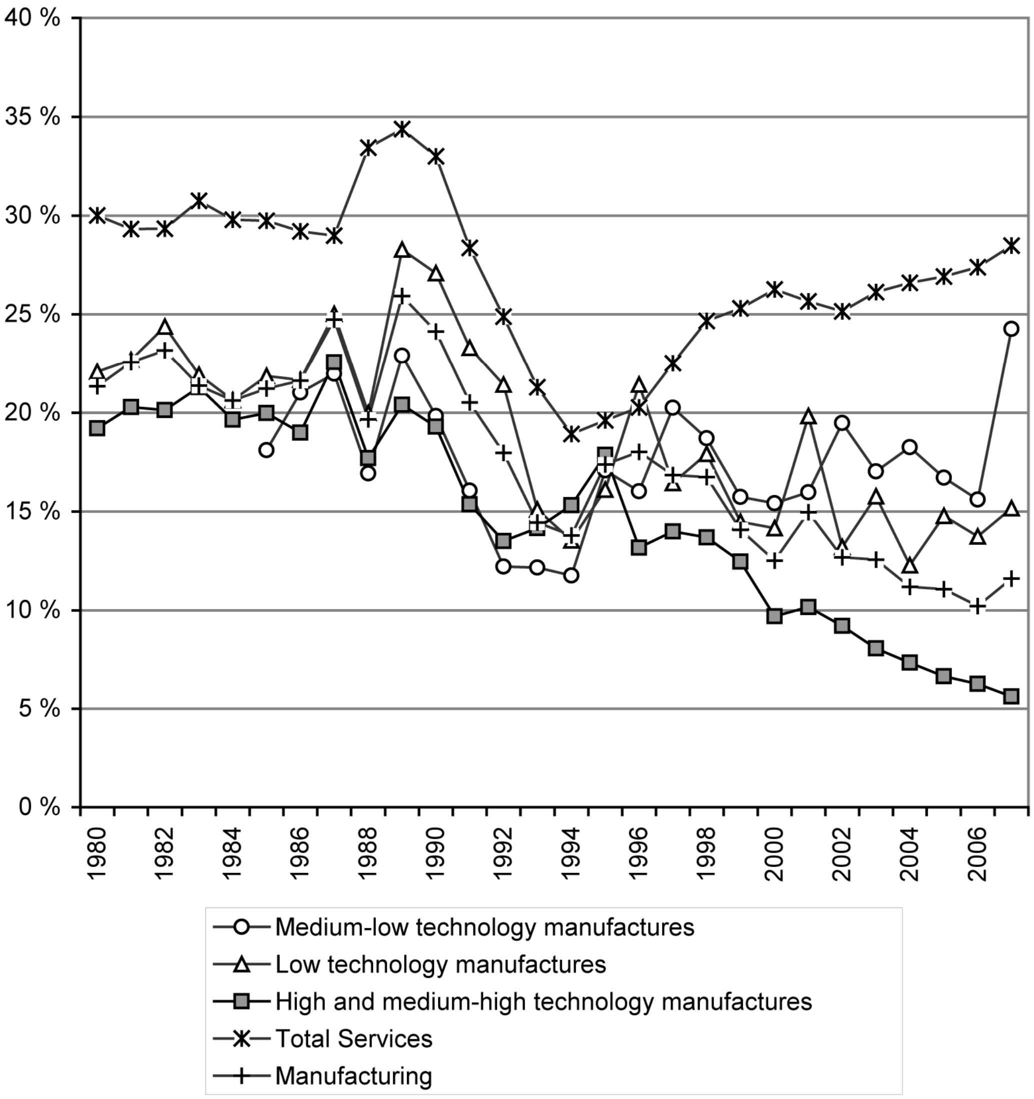

Figure 19. *Investment intensities by technology intensity, services and manufacturing industries, GFCF per Value-Added, Finland 1980–2007. Source: OECD.*

Since the high-tech base is narrow, relatively small R&D investments may represent important frontier knowledge inputs. But can R&D in some industry compensate for the lack of production in general? Can R&D levels and overall productivity growth be sustained if high-tech production moves increasingly abroad? As mentioned, corporate R&D is generally less effective in low-tech sectors. Hence, if the technology content of tradables is low or decreasing, productivity growth requires increasingly physical investment and capital embodied technological progress (Ortega-Argilés et al., 2009).

If Finland were to substitute physical investment by innovations and new technology, it would have to export patents, licenses, business services, etc. Expansion of R&D intensive services industries could indeed present such an alternative. Pure knowledge and human capital could perhaps be exported, but these services are still relatively undeveloped in Finland. So far, it has mainly materialised in the form of some, though little, brain drain. R&D intensive services are still small scale operations in general, although developments e.g. in the ICT services industry were promising at least before the outbreak of the global economic crisis. At the same time, publicly supported efforts to develop such industries question the very basis of public R&D support. This is because the sale of heavily subsidized innovations abroad channels the social returns, i.e., positive externalities that the innovators are unable to capture and prevent others from using, also abroad and away from domestic beneficiaries. It is possible to thrive on technology rather than product exports, there are plenty of such examples, but so far the returns have been modest in Finland.

The high-tech trend may indeed favour intangible services. As figure 20 shows, even with R&D included, investment would appear to be increasingly dependent on expansion in them. Investment in services dropped from 35 % in 1976–1987 to 25 % in 1995–2003 per GDP, and similarly relative to value-added (Figure 19), but is gradually rising. The relative growth of the tertiary sector has characterised structural change in most OECD countries, in which Finland has generally lagged behind. The challenge with services is that productivity growth can no longer be maintained by simply raising capital intensity, although ICT capital offers important untapped opportunities. On the other hand, labour productivity focused capital deepening policy was precisely the cause behind past capital inefficiencies and misallocation of resources. A broader productivity concept is more sensitive to the efficient allocation of resources.

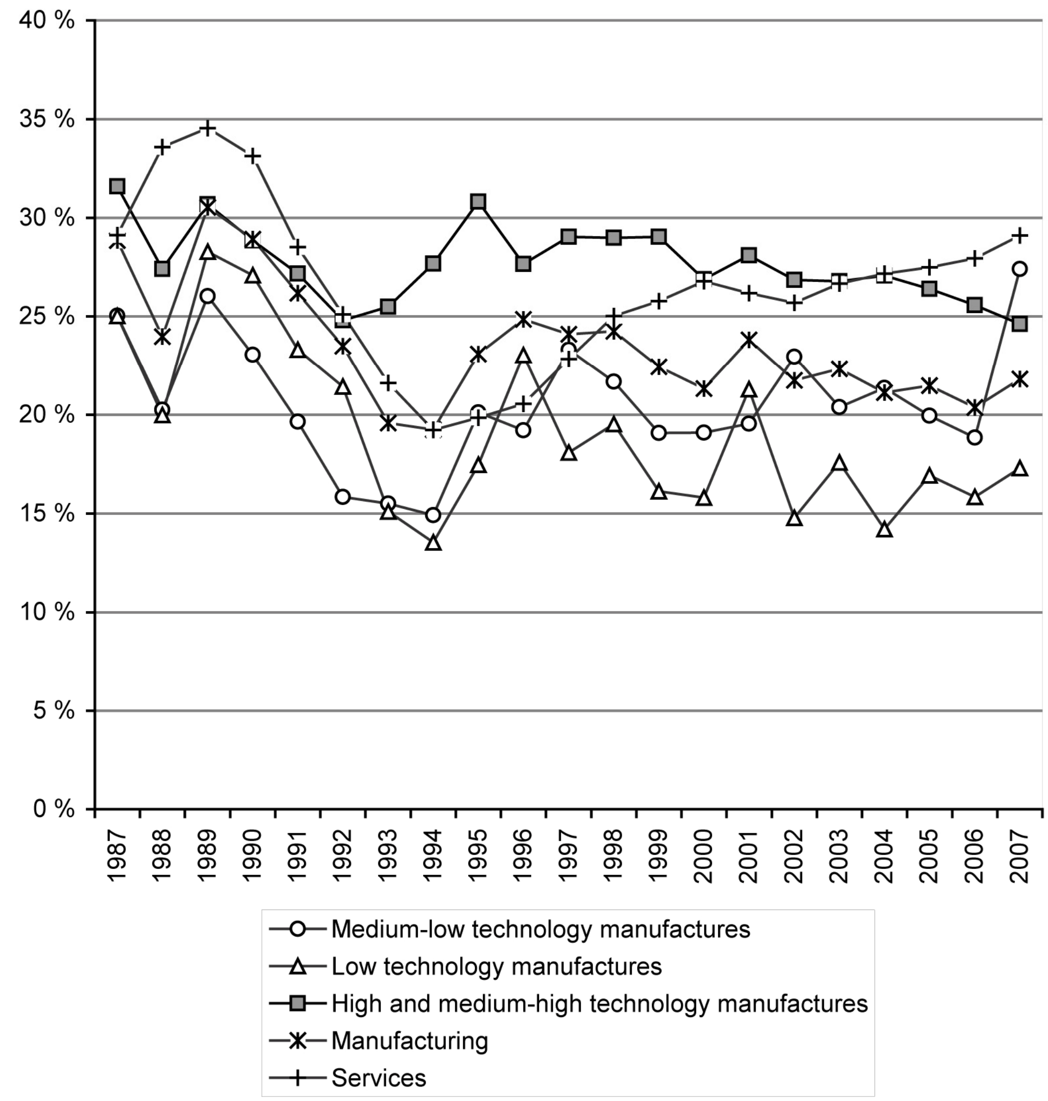

Figure 20. R&D and Gross Fixed Capital Formation per Value-Added (%), Finland 1987–2007. Source: OECD, STAN Indicators, 2009

3.13 The EU-US productivity gap

Growth accounting analyses of the EU KLEMS database have revealed that the big labour productivity gap between the EU and the US over 1995–2004 was mainly driven by total factor productivity (TFP)[7] and in few key industries, particularly in 2001–2004. Finland differs from most EU countries by faring exceptionally well in two of these sectors, trade and electronics. MFP measures are also more likely accurate in these industries.

[7] One should rather speak of multi-factor productivity (MFP) developments, since it is difficult to consider all factors of production, even if estimates for capital are improved.

The other key drivers of EU-US productivity differentials were other business services, financial intermediation and network industries. (Koszerek et al., 2007). The subsequent US sub-prime loan crisis has cast a shadow of doubt on the impacts of at least "other business services", which includes real estate, and financial intermediation. On the other hand, returns may have been high, only the risks were underestimated due to serious shortcomings in regulation, in an expansionary monetary policy climate. In financial intermediation, the contribution of ICT capital services to labor productivity growth has also been estimated to have been double that of the equivalent ICT effect for the EU.

The EU has outperformed the US in few industries after 1981. Among them Koszerek et al. (2007) mention particularly a so-called "network" industries, which include electricity, gas and water supply; transport, storage and communications; and post and telecommunications. The key driver of this advantage was TFP growth. (Koszerek et al., 2007). Public utilities are typically heavily regulated and potentially subsidized, however, which is likely to distort the results. Moreover, growth accounting exercises typically assume constant returns to scale and perfect competition in product and factor markets, which are inappropriate assumptions in regulated industries in the first place.

Up to 30 % of the total EU-US TFP gap was attributed to the electrical and optical equipment industry. Koszerek et al., (2007) perceive the superior US performance in ICT as a reflection of its outstanding innovation capacity that includes the commercialization of innovative technologies over the longer term. Meanwhile, the principle underlying explanation of productivity growth in the industry is "Moore's Law", i.e., the empirical observation that the number of transistors on an integrated circuit doubles approximately every two years, raising productivity particularly in the semiconductor industry.

Thus, Finland is highly competitive with respect to the US in the two industries in which the productivity gap is largest and undisputed. Yet, at the total economy level (Figure 6), Finland’s productivity gap with the US is as broad as the EU average. This suggests that there is considerable scope for productivity catch-up in the other industries particularly with respect to similar EU economies. The gap is especially wide in personal services. Though regulation may distort results in this field, catch-up related productivity growth opportunities seem highly promising.

4 Conclusions

Immaterialization

Considering Finland's past capital inefficiencies, concern for low investment appears a policy relic of the past. Despite sluggish investment, productive capacity has continued to improve due to outsourcing and renting, which is increasingly common place and the machinery ever better. Moreover, once R&D is added to physical investment, Finnish gross investment levels improve to the Western European average.

Multifactor productivity (MFP) levels do not suggest that Finland has lost out to competing locations in investment because of its lack of competitiveness. On the contrary, MFP levels place Finnish electronics at the OECD technology frontier, and Finnish manufacturing high among OECD economies. Due to the size of the industry, electronics R&D may generate returns in innovation that compensate for losses in physical structures even at the aggregate level. Hence, immaterialization of investment into R&D or intangible investment offers a comforting explanation to the mystery of the lost investment.

Evaporation

Even if credit did not constrain investment, investor caution in Finland during the past period of expansive monetary policies and resulting excess liquidity, does not promise bolder investment during the present credit crunch. Finland's peer group of Western European countries also suffered from an investment drought already well before the outbreak of the global crisis when liquidity was abundant.

Finland's country risk in terms of political upheavals, natural disasters, budgetary balances, etc., is among the lowest in the world for a small open economy, as can be judged by government triple A-credit ratings. Stability and risk conditions are as good as can be. Hence, if risk-return relationships guide global capital flows, as standard economic theory predicts, the lack of investment cannot but insinuate modest expected returns to it.

Moreover, MFP figures compare only labour and capital input use relative to OECD economies, leaving out R&D, intangible inputs and most newly industrialised countries (NICs). R&D intensive industries and countries may show high productivity growth, while in reality they have relied on extensive growth, based on additional R&D inputs. As Finland features among top R&D investors in the world, it is not clear that inefficiency in investment has not shifted from conventional fixed capital investment to inefficient investments in knowledge. It may be just as difficult to "push" growth with knowledge accumulation, as it was with physical capital accumulation if the knowledge is somehow inappropriate.

MFP comparisons also left out most high-tech exporters, which are increasingly middle-income NICs. Problems related to competitiveness in high-tech industries may stem from countries, such as China, India, Korea and Taiwan for which MFP data was unavailable for comparison. Considering the problems encountered in producing harmonised data for OECD economies, it is unlikely that NICs will provide harmonised time series for a while. Hence, one can only presume that leading OECD economies are close to the global frontier. Yet, if all inputs, including R&D, are adequately considered, NICs may well prove more cost-efficient in many respects.

Though frontier technology may have shifted the emphasis from physical to R&D investment, it is clear that R&D can substitute physical investment only up to a point: This point, i.e., the elasticity of substitution, increases with the time horizon and the share of high-tech in the industry, being positive in the ICT industry (Berghäll, 2006). Unfortunately, the dominant high-tech industry, i.e., ICT production, does not seem to be thriving in Finland. The ability of R&D to compensate for the lost physical capital is at best partial.

Outmigration

Indeed, frontier level R&D and productivity does not seem to guarantee future investment. Apart from ICT services, developments in the ICT industry and hence in Finnish high-tech in general, have been rather dismal, with ICT firms raising production abroad, while closing down operations in Finland. By 2008, Finnish ICT manufacturing had largely fled to lower labour cost and/or larger market countries. This applies also to most of the EU, apart from e.g., Romania so far.

The outflow of ICT production as well as of some R&D from Finland does not therefore envisage sustainability to the high-tech frontier state of affairs. As total private R&D in the electronics industry and overall has grown at a reduced rate, the compensatory effects of the entire electronics industry are gradually fading. Despite equally massive investments relative to value-added, as in the mobile phone industry in the early 90's, into pharmaceuticals and office, accounting and computing machinery, railroad equipment and transport equipment n.e.c. in some period, high returns continue to let themselves wait, giving no promise of new Nokia success stories in the near future.

Contrary to the survey findings of Oksanen (2006), empirical macro-economic evidence (Sauramo, 2008, applying Feldstein, 1994) proves outmigration an important factor in the investment gap, to the point of resulting in an adverse, one-to-one relationship between domestic and outward investment. That is, the Feldstein & Horioka (1980) puzzle still holds, but with the exception that outward FDI has entered the investment equation. Despite extensive liberalisation of international capital flows since 1980, domestic investment continues to be financed from domestic savings, or firm revenue to be specific, with the result that investments abroad crowd out domestic investments.

Thus the Feldstein & Horioka puzzle suggests that Finland has lost out as a location due to crowding out. Even if firms evaluate investments abroad on equal terms with domestic investments, and the home bias in investment has declined, the unexplained gap between domestic savings and investment remains wide. In view of standard economic theory, it would seem that expected returns have not been high enough to raise investment to prior levels, no matter how low the cost of capital. No doubt it can partially be explained by immaterialization and other factors reviewed above, but nevertheless the question remains: Why has the propensity to retain savings increased? Low investment offers no positive indication of creative destruction or structural change if the liberated resources are not re-employed elsewhere more productively. Does low physical capital investment reflect temporarily low returns to investment or is there a general lack of faith in long-term growth prospects?

ETLA suggests that the lack of human capital constrained output growth more than the lack of physical capital. In the 2000's, productivity improved, funding for successful firms abode and capacities were sufficient (Sorjonen, 2006), i.e., economic conditions would have permitted faster growth (before the global economic crisis). Human capital may provide a partial explanation, as there are rigidities in the labour market and some industries did report problems in finding appropriate employees. Yet, Finland's free education has subsidised human capital production, which should have led to excess consumption of education and an oversupply of the highly educated university graduates. At the graduate level, shortages have been limited to some highly specialized fields, while the oversupply has reduced graduate wages and encouraged brain drain. Considering that there is nothing that prevents firms from paying higher salaries and attracting strategic employees from abroad if they deem it worthwhile, the human capital explanation seems insignificant. On the other hand, it is entirely possible that the quality of education does not adequately meet the needs of industry.

Amidst the science, education, innovation, technology, and information society rhetoric, the public debate in Finland has evolved around the lack of entrepreneurship, small firms' reluctance to grow, and large companies' preference of outward FDI. Saturation of OECD markets has left the greatest potential to be found among rapidly growing poorer countries, accentuated by their cost competitiveness. This fits well into an image of a wealthy, aging, and conservative Europe, which prefers to sit back and watch its globally diversified portfolio of assets expand.

The Lisbon strategy has promoted increased R&D as the general answer to waning competitiveness and the widening productivity gap with the US. By now, it seems clear that R&D can provide a partial solution at best. Koszerek et al.,

(2007) speculate about a structural decline in the EU's overall innovation capacity and in the efficiency with which capital and labour are employed in its production systems. In this context, they mention an inflexible and outdated EU industrial structure, excessive concentration in low to medium technology industries and failure to fully exploit the direct and indirect productivity benefits from relatively new, leading technologies such as ICT.

On the European scale, does the crux of the problem lie in the lack of competition and associated market power of established firms on European markets? Deeper integration of EU markets might prove the best facilitator and one important step towards restoring dynamism to the Common Market. Larger market size was an important motive for many smaller European economies to integrate into the EU, to allow their consumers enjoy the benefits of intense competition and their firms to capture economies of scale and specialise in what the firm is most competitive in. Since European states are still far from the unification level of as the US as a market, it is no doubt an important factor behind the shortcomings in competition and the US-EU productivity gap. Although so far EU integration does not appear to have accelerated productivity growth very much[8], this may be precisely because of remaining barriers and distortions that misallocate resources and create market failures. Yet, in the end, all cultural and language barriers cannot be abolished, and US level of unification is probably beyond reach in any case.

Could animal spiritualization be the answer? At least, those that still storm forward driven by relentless animal spirits may prefer more dynamic business climates, in contrast to the sleepy self-content surroundings of the old continent. Despite years of conditions creating enabling policies, lack of dynamism and particularly ambitious growth oriented entrepreneurship seems to erode many business climates. Yet, entrepreneurship or related initiatives may offer little support if demand and growth are simply elsewhere. If low long-term expected returns lie beneath the surface as the ultimate cause to the production outflow, complex micro- and macropolicy combinations are necessary to remedy the situation.

At the macrolevel, considering the catastrophic effects of lax US policies, hindsight endorses European restraint and IMF's and ECBs's advice in balancing budgets. Thus populist policies and spend-drift populations would not appear to be what Europe needs to pull itself from the dire straits of welfare and leisure, once "normal circumstances" are restored. In the meantime – until that precious

[8] Van Ark et al., (2007) found labor productivity to have slowed down in older EU Member countries after 1995, when the EU enlarged to include Finland, Sweden and Austria. Average labour productivity growth in 1995–2004 barely exceeded that of 1980–1995 in EU Member countries. Even among the new entrants of 1995, Finland and Sweden gained greatly from the ICT revolution, irrespective of EU integration.

state of affairs is reinstated – it may be exactly what is needed, although volatility is likely to discourage investment in any case and for some time, as governments are resorting to inflationary money printing in their desperation.

Frontier technology or productivity does not seem able to prevent an exodus of R&D intensive production if other factors play against it. In particular, the erosion of cost competitiveness in terms of foreign exchange may be an important factor behind the severity of the Finnish investment drought after the ICT bubble, only accentuated by the appreciation of the euro against the dollar and currencies attached to it, such as the Chinese renminbi. Entering the Euro zone was argued for by low interest rates, abundant supply of capital, elimination of exchange rate risks within the zone and investment promoting stability. It seems a paradox that the removal of capital market constraints, combined with reduced interest rates and increased productivity of investments has actually reduced investment.

While one argument in favor of a fixed euro exchange rate was the need to raise the value-added content of Finnish exports and emerge from the vicious devaluation ridden circle of cost competition, the strong euro rate may actually have turned against R&D intensive production. As low-cost Asian countries have rapidly caught-up technologically, the strong euro has helped Asian countries to capture market share from foreign companies and drive them out of business. In 2006, Finland was already far from the forefront of high-tech exporters, dominated increasingly by NICs. A variable exchange rate, as maintained in Sweden, could have supplied policymakers with an effective means to counter-tackle distorting foreign policies. The rigidity of the current regime prevents rapid and effective responses, and may be an important un-mentioned component behind the problems encountered in attempts to raise the technology and R&D content of exports to sustainable levels. Developments with respect to high-tech production could have been entirely different in another exchange rate regime.

Is it necessary just to wait for the euro to depreciate eventually and turn the tide, or is there something that can be done at the macro-level? The outmigration of production should eventually cut average wages and consumption and consequently savings as jobs are lost, restoring balances, but the process is long, slow and very painful. While there is little that can be done about external competitiveness, other than cost cuts, public investment in necessary infrastructure, services and other demand creating measures can ease the pain, being sound countercyclical courses of action in downturns, as resources are vacated from the private sector and employment is dependent on domestic demand. MFP figures suggest that investment particularly in personal services could yield high returns. In their respect Finland's productivity gap with the US has only widened from 1997 to 2005, being is wide even with respect to similar EU economies, with the exception of Sweden. Since private investment has proved unlikely to close the gap, public investment could yield high catch-up related returns. While there is no system superior to the invisible hand in reallocating resources and restoring economic growth, this time the hand visibly trembles too much with the turmoil, and requires some holding and support.

References

Acemoglu, Daron – Philippe Aghion – Fabrizio Zilibotti (2006): Distance to Frontier, Selection, and Economic Growth. Journal of the European Economic Association, MIT Press, vol. 4(1), pages 37–74, 03.

Arcelus, F.J. – P. Arozena (1999): Measuring sectoral productivity across time and across countries. European Journal of Operational Research 199, 254–266.

Battese, G. E. – T. J. Coelli (1988): "Prediction of Firm-Level Technical Efficiencies with a Generalised Frontier Production Function and Panel Data." *Journal of Econometrics* 38, 387–399.

Battese, G. E. – T. J. Coelli (1995): "A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data." *Empirical Economics* 20, 325–32.

Kiander, Jaakko – Reino Hjerppe – Elina Berghäll – Tuomo Heikkilä – Juha Kilponen – Vladimir Lavrac – Peter Stanovnik (2002): The Role of Science and Technology Policy in Small Economies, VATT Research Reports 91, Government Institute for Economic Research (VATT).

Bernanke, Ben (2006): in http://www.rgemonitor.com/blog/roubini/ ...

Bernard, Andrew B. – Charles I. Jo *Review* 78(1), 135–146. nes (1996): Productivity Across Industries and Countries: Time Series Theory and Evidence, *The American Economic*

Bernstein, J.I. – T.P. Mamuneas (2006): R&D Depreciation, Stocks, User Costs and Productivity Growth for US R&D Intensive Industries. Structural Change and Economic Dynamics, 17, 70–98.

Bhasin, A. – Jun, K. – Economou, P. (1994): Assessing the sustainability of foreign direct investment flows. The World Bank, International Economics Department.

Bosworth, B. (1978): "The Rate of Obsolescence of Technical Knowledge – A Note." *Journal of Industrial Economics* 26(3), 273–279.

Bogetoft, Peter – Rolf Färe – Bǿrge Obel (2006): Allocative efficiency of technically inefficient production units. *European Journal of Operational Research* 168, 450–462.

Börsh-Supan, Axel (1998): Capital's Contribution to Productivity and the Nature of Competition, *Brookings Papers on Economic Activity. Microeconomics,* 1998, 205–248 with commentary by Paul Romer.

Carree, M.A. (2003): Technological progress, structural change and productivity growth: a comment. *Structural Change and Economic Dynamics* 14, 109–115.

Coelli, T. – D.S. Prasada Rao – G.E. Battese (1999): *An Introduction to Efficiency and Productivity Analysis*. Boston/ Dordrecht/London: Kluwer Academic Publishers.

Corrado, Carol A. – Hulten, Charles R. – Sichel, Daniel E., "Intangible Capital and Economic Growth" (January 2006). NBER Working Paper No. W11948 Available at SSRN: http://ssrn.com/abstract=877453

Cyert, R.M. – J. G. March (1963): *A Behavioral Theory of the Firm*. Prentice Hall, Englewood Cliffs, NJ.

EK (Elinkeinoelämän keskusliitto/ Confederation of Finnish Industries), Investointitiedustelu (Investment Survey), June 2007.

EK (Elinkeinoelämän keskusliitto/ Confederation of Finnish Industries), Investointitiedustelu (Investment Survey), 2006,

EU Klems data, November 2007 release. http://www.euklems.net/

Fagerberg, Jan (2000): Technological progress, structural change and productivity growth: a comparative study. *Structural Change and Economic Dynamics* 11, 393–411.

Feldstein, Martin – Horioka, Charles (1980): Domestic Savings and International Capital Flows, NBER Working Papers 0310, National Bureau of Economic Research, Inc.

Feldstein, Martin (1994): The Effects of Outbound Foreign Direct Investment on the Domestic Capital Stock, NBER Working Papers 4668, Cambridge, MA.

Freeman, Richard (2000): What Does Modern Growth Analysis Say About Government Policy Toward Growth? Economic growth and Government policy seminar: Papers presented at a HM Treasury seminar held at 11 Downing Street on 12th October 2000.

Färe, Rolf – Shawna Grosskopf – C.A. Knox Lovell (1984): *The Measurement of Efficiency of Production.* Kluwer Academic Publishers.

Färe, Rolf – Shawna Grosskopf – Mary Norris – Zhongyang Zhang (1994): Productivity Growth, Technical Progress, and Efficiency Change in Industrialised Countries, *The American Economic Review* 84(1), 66–83.

Färe, Rolf – Shawna Grosskopf – Dimitri Margaritis (2006): Productivity growth and convergence in the European Union. Journal of Productivity Analysis 25: 111–141.

Grossman, G.M. – E. Helpman (1991): Innovation and Growth in the Global Economy. Cambridge, MA: The MIT Press, p. 338, 339.

Hall, Bronwyn (2007): Measuring the Returns to R&D: The Depreciation Problem. NBER Working Paper 13473, Cambridge, MA.

Hanusch, Horst – Markus Hierl (1992): Productivity, Profitability and Innovative Behavior in West German Industries. Chapter in Entrepreneurship, Technological Innovation, and Economic Growth. Studies in the Schumpeterian Tradition. Edited by Frederic M. Scherer and Mark Perlman. Ann Arbor, The University of Michigan Press.

Hernández, J. A. – I. Mauleón (2002): Estimating the Capital Stock. Documento de Trabajo 2002-03. Fac. CC. Económicas y Empresariales, Universidad de La Laguna and Fac. CC. Económicas y Empresariales, Universidad de Las Palmas de Gran Canaria.

Huovari, Janne – Jukka Jalava (2007): Kansainvälinen ja vertaileva näkökulma Suomen tuottavuuskehitykseen. Pellervon taloudellisen tutkimuslaitoksen työpapereita n:o 96. ETLA, Keskusteluaiheita No. 1096.

IMF, 2005 in http://www.rgemonitor.com/blog/roubini/ ...

Inklaar, R. – Timmer, M.P. (2008): 'GGDC Productivity Level Database: International Comparisons of Output, Inputs and Productivity at the Industry Level.' GGDC Research Memorandum GD-104, Groningen: University of Groningen, September 2008.)

Jalava, Aulin-Ahmavaara – Alanen (2007): Intangible Capital in the Finnish business sector, 1975-2005. ETLA Discussion Papers No. 1103.

Kaitila, V. (2004): The Factor Intensity of Accession and EU15 Countries' Comparative Advantage in the Internal Market. ETLA Discussion Papers No. 926.

Kaitila, V. (2007): Teollisuusmaiden suhteellinen etu ja panosintensiivisyys. Elinkeinoelämän Tutkimuslaitos Keskusteluaiheita 1090.

Koszerek, Douglas – Karel Havik – Kieran Mc Morrow – Werner Röger – Frank Schönborn – European Commission, Directorate General for Economic and Financial Affairs (2007): An overview of the EU KLEMS Growth and Productivity Accounts EUROPEAN ECONOMY. ECONOMIC PAPERS. 290. October 2007. European Commission. Brussels. 107pp.

Levine, Ross – Davide Renelt (1992): A Sensitivity Analysis of Cross-Country Growth Regressions, *The American Economic Review* 82(4), 942–963.

Markusen, James R. – James Melvin – Keith Maskus – William Kaempfer 1995: International Trade: Theory and Evidence, New York, McGrawhill.

Morrissey, O. – Rai, Y. (1995): The GATT agreement on trade-related investment and their relationship with transactional corporations. Journal of Development Studies 31, 702–24.

Nadiri, M. Ishaq – Prucha, Ingmar R. (1997): "Estimation of the Depreciation Rate of Physical and R&D Capital in the U.S. Total Manufacturing Sector". NBER Working Paper No. W4591.

OECD data. http://www.oecd.org/statsportal/0,3352,en_2825_293564_1_1_1_1_1,00.html

Oksanen, Olli-Pekka (2006): Are foreign investments replacing domestic investments? – Evidence from Finnish Manufacturing. ETLA Discussion Papers No. 1001.

Ortega-Argilés, Raquel – Piva, Mariacristina – Potters, Lesley – Vivarelli, Marco (2009): Is Corporate R&D Investment in High-Tech Sectors More Effective? Some Guidelines for European Research Policy. IZA Discussion Paper No. 3945. Available at SSRN: http://ssrn.com/abstract=1332586.

Pakes, A. – M. Schankerman (1984): "Rates of Obsolescence of Knowledge, Research Gestation Lags, and the Private Rate of Research Resources." In Griliches, Z. (ed.), *R&D, Patents and Productivity*. Chicago: University of Chicago Press, 209–232.

Peters, T.J. – R.H. Waterman, Jr. (1982): In Search of Excellence: Lessons from America's Best Run Companies. New York: Harper and Row.

Pohjola, Matti (1996): Tehoton pääoma. Uusi näkökulma taloutemme ongelmiin WSOY.

Ritter, C. – L. Simar (1997): "Pitfalls of Normal-Gamma Stochastic Frontier Models." *Journal of Productivity Analysis* 8(2), 167–182.

Roubini, 2006 in http://www.rgemonitor.com/blog/roubini/ ...

Sali-I-Martin; Xavier (1997): I just ran two million regressions, American Economic Association Papers and Proceedings 87(2): 178–183.

Salokoski, Juuso (2008): Maailmantalouden ja -politiikan pohjavirtoja – euforiasta finanssikriisiin. Mediapinta.

Sauramo, Pekka (2008): Does outward foreign direct investment reduce domestic investment? Macro-evidence from Finland. Labour Institute for Economic Research, Discussion Papers 239.

Schreyer (2001): Chapter 2, for further discussion: Schreyer, P. (2001): Measuring Productivity – OECD Manual. Measurement of Aggregate and Industry-Level Productivity Growth, OECD, Paris.)

Shao, BBM – WS Shu (2004): Productivity breakdown of the information and computing technology industries accross countries. Journal of the Operational Research Society, 55, 23–33.

Sorensen, Anders (2001): Comparing Apples to Oranges: Productivity Convergence and Measurement Across Industries and Countries: Comment, *The American Economic Review* 91(4), 1160–1167.

Sorjonen, Pasi (2006): Investointien vähyys Suomessa. ETLA *Suhdanne* 2006:1.

Statistics Finland, Science and Technology Statistics and National Accounts, 2006-2008.

Timmer, M. – O'Mahony, M. – B. van Ark (2007): The EU Klems Growth and Productivity Accounts: An Overview.

van Ark, Bart – Robert Inklaar (2005): Catching Up or Getting Stuck? Europe's Problems to Exploit ICT's Productivity Potential. EU KLEMS Working Paper Series, nr.7.

van Ark, Bart – Mary O'Mahony – Gerard Ypma, eds. (2007): The EU Klems Productivity Report. An Overview of Results from the EU KLEMS Growth and Productivity Accounts for the European Union, EU Member States and Major Other Countries in the World, Issue no. 1, March 2007. Available online at www.euklems.net/index.html

Weale, Martin (2006): in http://www.rgemonitor.com/blog/roubini/ ...

Wheeler, D. – Mody, A. (1992): International investment location decision: The case of US firms. Journal of International Economics 33, 57–76.

The Economist, May 17th, 2007: Use IT or lose it. Economics Focus.

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