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Helsinki, October 2007

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Tiivistelmä: Tässä työpaperissa analysoidaan ensimmäistä kertaa Suomen yrityssektorin aineettomat investoinnit vuosina 1975–2005 käyttäen Corrado, Hulten ja Sichelin (2005, 2006) luomaa perinteistä laajempaa aineettomien investointien määritelmää. BKT ja investoinnit ovat muuttuneet painottomammiksi, kun sekä tieteellisten innovaatioiden että ns. taloudellisten kyvykkyyksien merkitys on kasvanut. Vuonna 2005 yrityssektorin aineettomat investoinnit olivat 14,2 miljardia euroa, eli 9 prosenttia suhteessa korjaamattomaan bruttokansantuotteeseen. Tulostemme mukaan investointiaste on korkeampi ja työn tulo-osuus alhaisempi kuin aiemmin on luultu. Kasvutilinpitolaskelmamme osoittivat, että työn tuottavuuden keskikasvu oli 0,48 prosenttiyksikköä korkeampi vuosina 1995–2000 ja 0,06 prosenttiyksikköä korkeampi vuosina 2000–2005 verrattuna nykyisen kansantalouden tilinpidon lukuihin. Aineettomien investointien käsittely investointeina korotti kokonaistuottavuuden keskikasvua 0,12 prosenttiyksikköä vuosina 1995–2000 ja 0,45 prosenttiyksikköä vuosina 2000–2005. On tapahtunut siirtymä uusiin, aineettomiin, korkeamman rajatuottavuuden omaaviin investointitavaroihin. Enää ei pelkästään ole kyse siitä kuinka paljon investoidaan, vaan siitä mihin yritykset investoivat.
Avainsanat: *aineeton pääoma, kasvutilinpito, tuottavuus.*

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Abstract: This paper is the first effort to analyze the intangible investments of the Finnish non-financial business sector in 1975–2005 with a heretofore unseen scope of intangible investments in line with the definition of Corrado, Hulten and Sichel (2005, 2006). Not only GDP but also investments have become more weightless as the importance of scientific innovative property and economic competencies has increased. In 2005 Finnish business intangible investments amounted to 14.2 billion euro, which was 9 per cent in relation to (unrevised) GDP. Our results imply higher investments rates and lower labor shares than traditionally thought. Comparing our new results with SNA93-type growth decompositions we found that our revision increased the average growth rate of labor productivity by 0.48 percentage points in 1995–2000 and 0.06 percentage points in 2000–2005. Capitalizing intangible investments decreased the measure of our ignorance by 0.12 percentage points in 1995–2000 and 0.45 in 2000–2005. A shift to new, intangible, investments with higher marginal products than traditional capital has taken place. It is not any longer solely a matter of how much is invested, but what it is firms invest in.
Keywords: *intangible capital, growth accounting, productivity.*

CONTENTS

YHTEENVETO

Taloudellisessa toiminnassa on tapahtunut valtava rakennemuutos, kun käsin kosketeltavien tavaroiden osuus bruttokansantuotteesta on pienentynyt palveluiden hyväksi, eli taloutemme on muuttunut yhä painottomammaksi. Harvemmin tulee ajatelleeksi, että myös yritysten investoinnit ovat muuttuneet painottomammiksi, sillä perinteiset kiinteät investoinnit rakennuksiin, koneisiin ja kuljetusvälineisiin eivät enää riitä.

Tässä artikkelissa tarkastelemme Suomen yrityssektorin aineettomia investointeja vuosina 1975–2005. Mitä ovat aineettomat investoinnit? Tästä voidaan olla montaa mieltä. Voitaneen kuitenkin sanoa, että ainakin on kyse digitalisoidusta informaatiosta, eli tietokoneohjelmistoista ja tietokannoista. Lisäksi on kyse innovaatioinvestoinneista kuten tutkimus- ja kehitystoiminta, kirjallisuuden ja viihteen alkuperäisteokset sekä suunnittelupalvelut (kuten arkkitehti- ja konesuunnittelupalvelut). Osittain on myös kyse investoinneista tuotteen brändiin, investoinneista yrityskohtaiseen inhimilliseen pääomaan (kuten esimerkiksi työnantajan maksama atk-kurssi) sekä organisaation parantamisesta. Käyttämämme aineettoman pääoman luokitus on Corrado, Hulten ja Sichelin (2005, 2006) luoma ja on itse asiassa ensimmäinen kerta kun tällaiset laskelmat tehdään Suomelle.

Kolmessakymmenessä vuodessa Suomen yrityssektorin aineettomien investointien osuus bruttokansantuotteesta on miltei kaksinkertaistunut, ollen vuonna 2005 noin 9 prosenttia, eli 14,2 miljardia euroa. Aineettomat investoinnit olivat jo suuremmat kuin aineelliset investoinnit Yhdysvaltojen markkinatoiminnassa 2000-luvulla. Näin on myös Suomen yrityssektorilla. Ei siis ole kyse mistään mitättömästä ilmiöstä; vaikka aineeton onkin. Tulostemme mukaan investointiaste on korkeampi ja työn tulo-osuus alhaisempi kuin aiemmin on luultu.

Kasvutilinpitolaskelmamme osoittivat, että työn tuottavuuden keskikasvu oli 0,48 prosenttiyksikköä korkeampi vuosina 1995–2000 ja 0,06 prosenttiyksikköä korkeampi vuosina 2000–2005 verrattuna nykyisen kansantalouden tilinpidon lukuihin. Aineettomien investointien käsittely investointeina korotti kokonaistuottavuuden keskikasvua 0,12 prosenttiyksikköä vuosina 1995–2000 ja 0,45 prosenttiyksikköä vuosina 2000–2005. On tapahtunut siirtymä uusiin, aineettomiin, investointitavaroihin. Enää ei pelkästään ole kyse siitä kuinka paljon investoidaan, vaan siitä mitä oikeastaan on se, mihin yritykset investoivat.

1. INTRODUCTION

It is well known that advanced economies have become more weightless (Quah, 2001) as the share of tangible goods in GDP has declined in favor of services. The inputs into production have also become more intangible. For an economy near the technology frontier it is not enough to just have an ample labor force and state-of-the-art machinery. Human capital matters a great deal and talented employees are sought after and hard to find (Economist, 2006). Less attention has, however, been given to the fact that fixed capital has become more weightless as well. The system of national accounts, SNA93, recognizes computer software and such nonscientific innovative property as entertainment and literary originals as investments. Unfortunately scientific innovations and economic competencies are excluded. Hill (1997) regrets that scientific originals were kept as current expenses and not treated as capital formation in the SNA93; the decision was purely pragmatic as it was contrary to most economists' and many national accountants' views. Hence, the somewhat ambivalent present situation where firms' research and development efforts or marketing expenditure are recorded in national accounts as current expenses, i.e., actually lowering calculated GDP. This omission is not insignificant and we know from experience that often the price paid for a firm vastly exceeds its book value. Corrado, Hulten and Sichel (2006) found that in the US business intangible estimates approximately equaled tangible investments in 1999.

Neoclassical growth accounting enables us to differentiate between the quantity and quality of the inputs as sources of growth. Jorgenson, Ho and Stiroh (2005) demonstrated the importance of ICT to recent US economic growth. Jalava and Pohjola (2007) corroborated this result for Finland as well. Unfortunately omitting intangible capital from our accounting conventions means that the residual, our measure of ignorance, remains that much larger. Furthermore, from a conceptual standpoint it can also be argued that intangible capital should be capitalized. Hulten (2006) defined capital as such expenditure that is made in order to increase or maintain future consumption in contrast with current consumption; this is clearly the case with intangible capital.

While it is rather easy to agree with the need to capitalize the expenditure on intangibles, it is not obvious, in which way the data on these expenditures should be translated into the value of investment. The fact that the services of intangible assets can be used as inputs in the production of intangibles is taken into account in the production function e.g. by Corrado, Hulten and Sichel (2006). However, the fact that the value of these services used as input in the own account production of the intangible assets should be included in the value of these assets, seems generally to be overlooked., This is, because of the lack of data, the case in our calculations as well. Likewise, the fact that the services of the intangibles can also be exported seems usually to be ignored in the calculations. Since we do not include any of the services of the intangibles in the value of output of the industries, again because of the lack of suitable data, the exports of intangibles

consist also in our calculations merely of assets or parts of them.

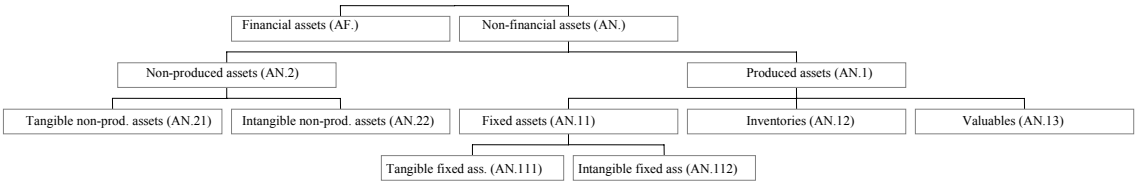
In this paper our aim is to quantify intangible capital expenditure for the Finnish business sector, treat it as investments, and account for the growth and productivity impacts of intangible capital in the tradition of Corrado, Hulten and Sichel (2005, 2006). It is in fact the first time such an exercise has been carried out for Finland. In the next section we describe which intangible expenditures are included and capitalized in the CHS-framework. Section 3 outlines a consistent accounting framework in the supply and use table type of environment which covers both the production and the use of both intangible assets and their services. Section 4 displays the Finnish business intangible investments, investment ratios and labor shares. The penultimate section contains the growth accounting results and the ultimate section concludes.

2. FROM INTANGIBLE EXPENDITURE TO INVESTMENT

The currently valid national accounts' classification of assets (figure 1) only includes assets that are subject to ownership rights and from which economic benefits can be gained by holding them or using them in economic activity, thus e.g. human capital, culture and natural resources (that are not owned) are excluded. Non-financial assets are either produced, i.e. they are outputs from production processes that are themselves used in production for more than one year, or non-produced, i.e. they occur in nature (tangible) or are legal or accounting constructs (intangible). Gross fixed capital formation, which is the national accounting terminology for investments, can by definition only belong to the fixed assets group. Of the fixed assets mineral exploration, computer software and entertainment, literary or artistic originals are classified as intangible. Scientific originals and economic competencies are not included although SNA93 does have asset type AN.1129 Other intangible fixed assets which it characterizes as: "new information, specialized knowledge, etc., not elsewhere classified, whose use in production is restricted to the units that have established ownership rights over them or to other units licensed by the latter."

While the present national accounts' classification of assets is logical it is incomplete with regard to intangible investments, which presently lack a comprehensive and detailed internationally agreed compilation standard. This is why we chose to use the taxonomy of Corrado, Hulten and Sichel (2005, 2006), who present a convincing argument and their methodology has already been applied in many country studies which enables international comparison (Haskel and Marrano, 2007; Marrano, Haskel and Wallis, 2007; Fukao, Hamagata, Miyagawa and Tonogi, 2007; van Rooijen-Horsten, van den Bergen and Tanriseven, 2007).[2]

Figure 1 The classification of assets in national accounts



Sources: SNA93, XIII, Annex; ESA95, Appendix 7.1

Corrado, Hulten and Sichel (2006) divide intangible investments into three broad categories. The first group is computerized information, which broadly

[2] For more on intangible investments see Vosselman (1998) and van Ark (2003).

corresponds to national account's computer software investment (as well as an estimate for computerized databases). The second category is comprised of innovative property. The main component in innovative properties is scientific research and development (R&D). Innovative property can also be non-scientific such as mineral exploration and copyright and license costs. The third broad group of intangible investments is economic competencies, i.e. "…spending on strategic planning, spending on redesigning or reconfiguring existing products in existing markets, investments to retain or gain market share, and investments in brand names" (Corrado, Hulten and Sichel, 2006). Brand equity is the biggest sub-group of economic competencies. Another sub-group is firm specific human capital; either direct firm expenses or wage and salary costs of employee time. The final part of economic competencies is improvement of organizational structure, both purchased and own account.

3. A GENERAL ACCOUNTING FRAMEWORK FOR R&D PRODUCTION

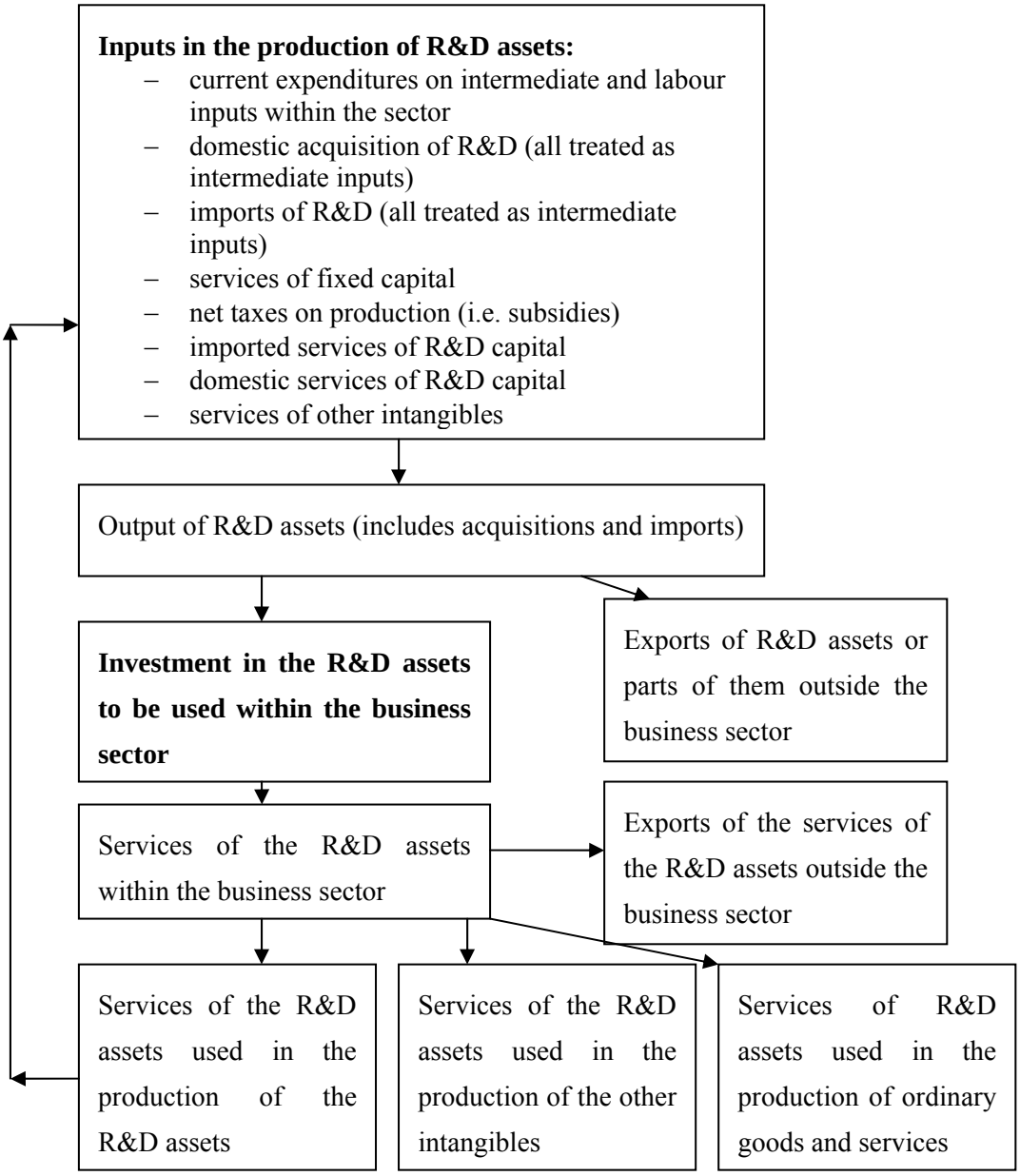
The aim of this paper is to estimate the investment in R&D, and in other intangibles. In this section we first outline a general accounting framework for R&D production. The availability of data, as well as the nature of the data that are available, imposes restrictions on the application of this general framework. We briefly discuss the data as well as the simplifying assumptions made by us because of these restrictions.

To begin with, it is important to remember that when R&D assets are treated as fixed capital they produce services of fixed, R&D, capital (this dual nature of R&D production is emphasized e.g. by Hill, 1997). A complete accounting framework for R&D production should therefore cover also the use of these services. When e.g. the exports of R&D are discussed, it should be specified whether they consist of R&D assets or of the services produced by using these assets or of both. As suggested by Hill (1997) scientific originals should be treated analogously to entertainment and literary originals. In this case scientific originals would be treated as R&D assets and "any payments received by the owner of asset would be conceptually equivalent to the rentals received by owners of tangible fixed assets who lease them out". They would be "treated as payments for services provided by the owner of the asset".

In outlining this framework we have already made several simplifying assumptions. Most importantly, all the acquisitions and imports of R&D assets, both finished assets and parts of them, are treated as intermediate inputs. This is because the borderline between a complete R&D asset and part of an R&D asset might be difficult to draw, at least in practice. And treating finished imported R&D assets as intermediate inputs only means that they are recorded first as output and then as investment, instead of being directly recorded as investment. We also assume that all the R&D assets are completed within a year and start producing services from the beginning of the next year.

The R&D assets produced within the sector can either remain within it or they can, as assets, be exported outside the sector. The services of the assets remaining within the sector can also be exported (payments for the services provided by the owner of the asset). The services that are not exported can be used to produce goods and services (in the SNA93 sense), R&D assets or other intangibles within sector. The figure 2 charts feedbacks from the services of R&D assets to the production cost of these assets. When this is the case the production cost of R&D assets can only be determined by successive iterations.

Figure 2 Full accounting framework for R&D



The availability of data does not allow us to use this full framework in our calculations. The framework, however, helps us discern the simplifying assumptions made by us and by others.

The starting point for calculations of the economy wide investment in R&D is normally GERD, which is defined in the Frascati–manual (OECD, 2002) as follows:

(1) GERD = gross domestic expenditure on R&D = total intramural

expenditure on R&D performed on the national territory during a given period. It includes R&D performed within the country and funded from abroad but excludes payments made abroad for R&D.

(2) Intramural expenditures = all the expenditures for R&D performed within a statistical unit or sector of the economy.

Our starting point for the business sector investment in R&D is BERD (business sector expenditures on R&D) defined analogously to GERD as follows:

(3) BERD = intramural expenditures of non-financial corporations on R&D.

BERD includes, besides current expenditure on intermediate inputs and labor, also investment in fixed capital (according to SNA93 definition). The latter has to be replaced by the value of the services of fixed capital (in the SNA 93 sense) not included in BERD (table 1). Neither are the services of R&D assets and rest of the intangible assets included in BERD. Since we do not know the allocation of the services of these assets between different uses, we assume that none of those services are used in the production of R&D assets. This is an assumption that seems to be, implicitly, rather generally made in the measurement of the investment intangibles or at least the fact that the services of R&D assets produced within the sector could contribute to production cost of these very assets is not explicitly discussed.[3]

Also the fact that the services of R&D capital (or more exactly the R&D services produced by using the services of R&D capital as inputs, i.e. payments for the services provided by the owner of the asset) can be exported outside the business sector seems to be overlooked e.g. by CHS (2006). This is obvious from their equations (2a)-(2c), which do not include output of R&D services produced by means of the services of R&D assets. In this paper, we have, again due to the lack of suitable data, adopted also this convention.

[3] As a matter fact Corrado, Hulten and Sichel (2006) do assume, in their equation (2a) that services of R&D assets are used as input in the production of these assets. However, they do not seem to explain, whether the value of these services is taken into account, when the value of investment in R&D assets is calculated. Neither is e.g. Gysting (2006) quite clear on this issue. Table 3.1, from GERD to NA, includes consumption of fixed capital, but not consumption of R&D capital. On the other hand net return on R&D capital is assumed to be included in the mark-up, which is the basis of the calculation of overall net return. Marrano, Haskel and Wallis (2007) do not seem to pay any attention to this issue. Neither Carson (1994), nor Fraumeni and Okubo (2002), Okubo, Robbins, Moylan, Sliker, Schulz and Mataloni (2006) and Robbins (2006) are very explicit on the possible inclusion of the cost of the services of R&D assets in the estimated value of these same assets.

4. INTANGIBLE INVESTMENTS IN FINNISH BUSINESS

Corrado, Hulten and Sichel (2006) divide intangible investments into three broad categories. The first group is computerized information. This is in the Finnish case national accounts' computer software series for the non-financial business sector.

The second category is innovative property. The main component in innovative properties is scientific research and development (R&D). R&D expenditure is compiled in accordance with the Frascati-manual's guidelines (OECD, 2002).[4] Business expenditure on R&D (BERD) cannot directly be used as investments. To avoid double counting and in order to adhere to national accounts definitions a bridge table (which is illustrated for year 2005 in table 1) was used for each year in our observation period, i.e. only after several economic transactions is BERD transformed into R&D investments for the Finnish business sector.[5] The BERD data is biennial until 1997 from which year onwards it is annual.[6] Innovative property can also be non-scientific. Mineral exploration is directly taken from Finnish national accounts. This is the case also with copyright and license costs (albeit it is called entertainment, literary and artistic originals by SNA93). New architectural and engineering designs are already included in tangible investments but for the purposes of this paper are transferred over to intangible investments.[7]

[4] There is a long tradition in the OECD on guidelines for compiling statistics on R&D expenditure. The first recommendation is from 1963 (OECD, 1963) and the currently valid Frascati-manual (OECD, 2002) is already the sixth incarnation. Finland has compiled statistics along Frascati guidelines starting from the statistical year 1971.

[5] When computing consumption of fixed capital for tangible gross fixed capital formation included in BERD the perpetual inventory method with a geometric 15 per cent depreciation ratio was used and the deflator was the implicit investment deflator for the non-financial business sector. The return on fixed tangible investment included in BERD was computed by using the smoothed (applying the Hodrick and Prescott (1997) filter with λ=6.25) rate of return of the business sector times the current price net capital stock of tangible investments in BERD.

[6] The missing years are interpolated by simple averages. I.e., for instance BERD in 1996 is computed as the average of BERD in 1995 and 1997.

[7] Computed 2000-2004 as 50 per cent of TOL 2002 (the Finnish NACE 2002 version) industry 742 Architectural and engineering activities and related technical consultancy gross output (excluding products 72 Computer and related services, 741 Legal, accounting, book-keeping and auditing activities; tax consultancy; market research, etc. and 744 Advertising services). In years 1975-1999 and 2005 as 50 per cent of industry 742 Architectural and engineering activities and related technical consultancy gross output.

Table 1 Bridge table from Frascati to SNA

S111 Non-financial corporations	Y:2005, mio euro
BERD (FM)	**3876.9**
+	
Acquisition of R&D	**204.8**
+	
Imports	**404.0**
-	
Fixed investment included in BERD	**225.2**
+	
COFC on fixed investment	**198.8**
+	
Return on fixed investment	**222.0**
+	
Other taxes less other subsidies on production	**-132.0**
-	
Software	**0.0**
-	
Exports	**274.0**
=	
R&D investments (SNA)	**4275.4**

Source: Authors' calculations

The third broad group of intangible investments is economic competencies (see Appendix 1 for more detail on compilation methods). Brand equity is the biggest sub-group of economic competencies and it is made up of businesses' advertising expenses (of which 60 per cent were capitalized). Another sub-group is firm specific human capital; either direct firm expenses or wage and salary costs of employee time. The final part of economic competencies is improvement of organizational structure, both purchased and own account.

Table 2 shows the non-financial business sector's intangible investments by asset type at certain benchmark years. In 2005 business intangible investments totalled 14.2 billion euro. This amounted to 9 per cent of (unrevised) gross domestic product at market prices. In the mid-1970s the intangible assets to GDP ratio had been approximately 5 per cent. Intangible investments also gained ground on tangible investments. For every billion euro spent on buildings, machinery etc. only 300 million were spent on economic competencies, innovative property and computerized information back in 1975. This ratio was one-to-one in the year 2000 and intangible investments outnumbered tangible investments by a ratio of 1.2 to 1 in 2005.

The capitalization of intangibles increases the level of business sector value added. It has to be kept in mind though, that several of the items outlined in table 2 are already counted as investments by existing practice (computerized information, mineral exploration and other innovative property). In fact, nominal business value added computed according to current conventions amounted to 89 per cent of our revised estimates in 2005 (the US ratio in 2000-2003 was also 0.89; Corrado, Hulten and Sichel, 2006), at the same time as total intangible

investments in relation to unrevised business gross value added was as much as 16.4 per cent (this proportion had been 9 per cent thirty years earlier). Therefore the net impact of new intangible investments was 10.6 billion euro (and not 14.2 billion euro); i.e., the sum of scientific R&D and economic competencies.

Table 2 Business intangible investments in Finland

EUR millions	1975	1980	1985	1990	1995	2000	2005
1. Computerized information	**26**	**76**	**180**	**518**	**612**	**1007**	**1591**
2. Innovative property	**190**	**446**	**1020**	**2071**	**2663**	**4901**	**6269**
a) R&D incl. social sciences and humanities	84	212	561	1038	1522	3452	4275
b) Mineral exploration and evaluation	2	5	11	25	31	35	59
c) Other innovative property	104	230	448	1008	1110	1414	1935
Copyright and license costs	30	70	108	168	175	202	220
New architectural & engineering designs	74	160	340	840	935	1212	1715
3. Economic competencies	**713**	**1352**	**2405**	**3643**	**3129**	**5248**	**6370**
a) Brand equity	276	603	1131	1601	1147	2323	2724
b) Firm specific human capital	266	454	761	1189	1079	1506	1853
Direct firm expenses	183	312	523	817	742	1035	1274
Wage and salary costs of employee time	83	142	238	372	337	471	579
c) Organizational structure	171	295	514	852	904	1419	1793
Purchased	6	14	43	116	236	487	646
Own account	165	281	471	736	668	932	1147
Total	**929**	**1874**	**3605**	**6231**	**6404**	**11156**	**14230**
Per cent of existing GDP at mp	**5.2**	**5.6**	**6.3**	**6.9**	**6.7**	**8.4**	**9.1**
Ratio to tangible investments	**0.3**	**0.5**	**0.5**	**0.5**	**0.9**	**1.0**	**1.2**
Ratio of unrevised gross value added to revised	**0.93**	**0.92**	**0.91**	**0.91**	**0.92**	**0.89**	**0.89**

Source: Authors' calculations

Corrado, Hulten and Sichel's (2006) results for the US are on a higher level than the Finnish ones. Their unrevised GDP to total nonfarm business intangible investments ratio was 11.7 per cent already 1998-2000. Their intangible to tangible investments ratio was 1.2 in the same period. Haskel and Marrano (2007) computed UK private sector intangible investments to amount to 10.1 per cent of GDP in 2004, with an intangible/tangible ratio of 1.1. van Rooijen-Horsten, van den Bergen and Tanriseven (2007) came to the result the intangible investments to Dutch GDP ratio was 7.5 per cent. Fukao, Hamagata, Miyagawa, and Tonogi (2007) found that in Japan in 1995-2002 the intangible investments to GDP ratio was 7.6 per cent. The Japanese intangible to tangible investment ratio was as low as 0.3.

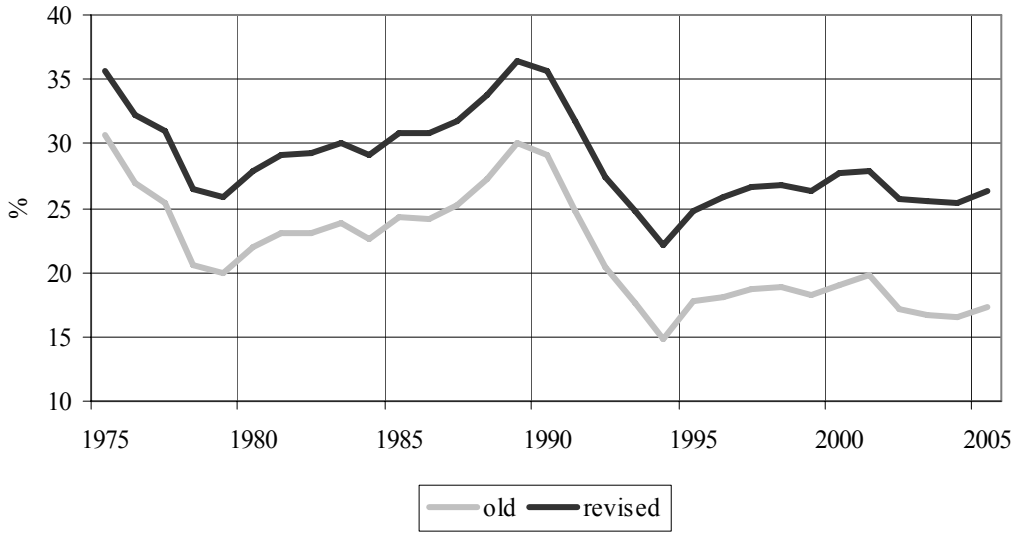
The investment ratios in Finland declined drastically during the early 1990s recession and have to date not regained their traditionally high levels.[8] The unrevised share of investments in gross value added averaged 25 per cent in 1975-90; but dropped by 7 percentage points 1995-2005. The revised[9] investment

[8] Finland was a staunch believer in capital fundamentalism (i.e. in the view that growth can be generated through investments in physical capital) in the post-Second World War period. The era of high investments began in 1948 when the investment ratio exceeded the 20 per cent level and continued until the early 1990s recession. During that time on average a quarter of GDP was invested in fixed capital.

[9] Revised gross value added at current prices is non-financial business sector's gross value added at current prices plus scientific R&D plus economic competencies, both at current prices. Later in section 5

ratio averaged 31 per cent in 1975-90, it declined by 5 percentage points in 1995-2005. Year 2005 the difference between the two ratios was 9 percentage points in the revised estimates favor. Even though the new investment ratios are higher than the old ones; the fact remains that the investment rate seems to have reached a plateau that is on a lower level than earlier (figure 3).

Figure 3 Investment ratios (per cent of business gross value added)



Source: Authors' calculations

Figure 4 shows the intangible investments by asset type in relation to revised gross value added in 1975-2005. Knowing Finland's R&D-expenditure to GDP ratio to have been the even by international comparison steep 3.48 per cent in 2005 (of which expenditure nearly 71 per cent stemmed from businesses) it is no surprise that investment in scientific R&D increased the most in relative terms from 1975 to 2005. The step-up was 3.6 percentage points. Digitalized information increased its share by 1.4 percentage points and non-scientific R&D by 1.1 percentage points. The shares of brand equity and organizational structure escalated both by 0.3 percentage points but firm-specific human capital decreased by 0.5 percentage points. At the end of our observation period the intangible investment ratio was 14.6 per cent; scientific R&D and economic competencies were three quarters of this figure (with scientific R&D 30 per cent, brand equity 19 per cent, non-scientific R&D 14 per cent, firm-specific human

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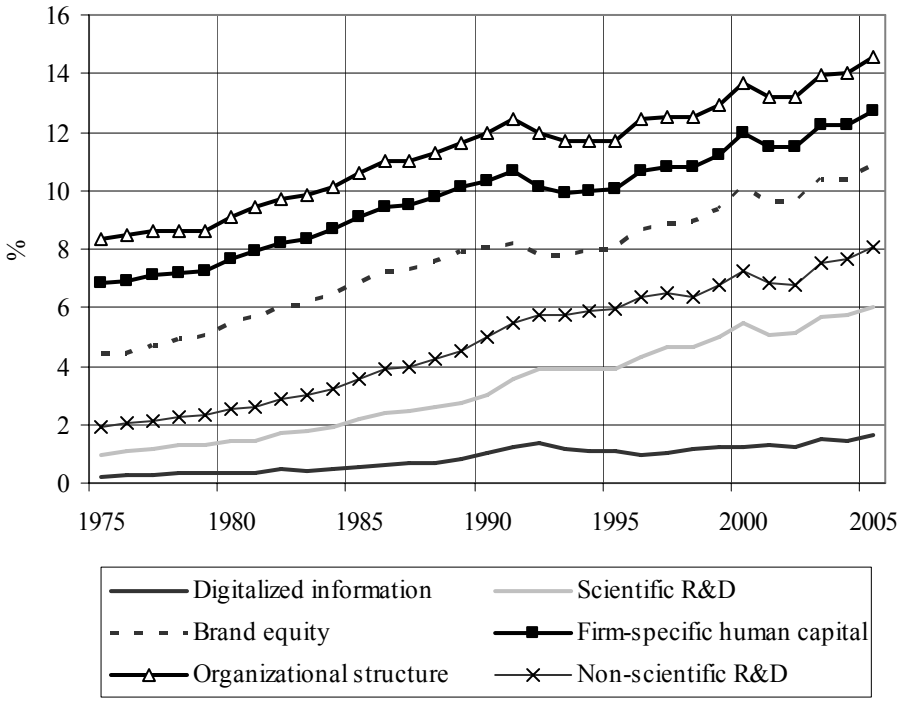
when calculating revised gross value added growth the chain-linked volume figures are made additive by switching to additive previous years prices and after summing business gross value added with scientific R&D and economic competencies (by asset type) and thereafter switching back to chain-linked volumes. Finnish national accounts uses a Laspeyres type volume index at previous years prices in accordance with Eurostat's recommendation

capital and organizational structure respectively 13 per cent and digitalized information 11 per cent of total intangible investments in 2005).

Figure 4 Intangible investments (per cent of revised business gross value added)



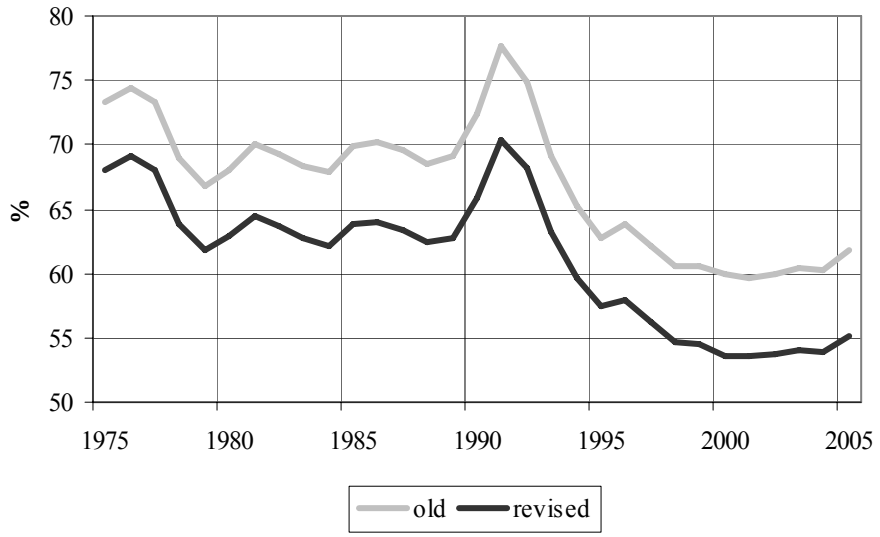
Source: Authors' calculations

Not only the investment ratios but also the labour shares plunged during the 1990s recession. This picture is not alleviated by the capitalization of intangibles; on the contrary, the decline in labour shares is actually exacerbated due to the fact that an increased part of value added goes to capital. The labour shares equal the compensation of employees in the non-financial business sector plus an imputed share for the self-employed (the average hourly salary of business sector employees times hours worked by self-employed). The revised labour share is at an approximately 6 percentage points lower level than the unrevised one. On average the unrevised and new labour shares were 70 per cent and 64 per cent respectively in 1975-1990 and 61 and 55 per cent respectively in 1995-2005. At the end of our observation period the difference is almost 7 percentage points (figure 5).

This dramatic drop in labour shares is of course closely related to the massive unemployment induced by the recession. The unemployment rate (as a share of the labour force) plummeted from a moderate 3.2 per cent in 1990 to 16.6 per

cent in 1994. Thereafter the unemployment rate slowly decreased, although it still exhibited double-digit figures in 1999, reaching 8.4 per cent in 2005. The high unemployment rate was by definition a massive reallocation of labour. When analyzing the manufacturing sector using micro-level data Kyyrä and Maliranta (2006) found that a considerable part of the story was the reallocation of resources between firms and that capital and labour shares in fact were rather stable at the firm level.

Figure 5 Labour shares (per cent of business gross value added)



Source: Authors' calculations

5. GROWTH ACCOUNTING

Having successfully capitalized intangible investments it is time to look at its impact on the proximate sources of growth of the Finnish non-financial business sector for the first time. Previous research has shown that the low investment shares in the post-recession period combined with a booming economy certainly gave rise to flattering capital productivity growth figures (see Aulin-Ahmavaara and Jalava, 2003) and the post-recession era has been heralded as a time of innovation-driven growth in contrast to prior investment-driven growth (Asplund and Maliranta, 2006).[10]

To assess the proximate sources of labour productivity growth, the number of hours worked are denoted by H(t) and labour productivity by Y(t)/H(t).

$$\Delta \ln Y - \Delta \ln H = v_T(\Delta \ln K_T - \Delta \ln H) + v_I(\Delta \ln K_I - \Delta \ln H) + v_L(\Delta \ln L - \Delta \ln H) + \Delta \ln A \quad (4)$$

There are four sources of labour productivity growth. The first one is tangible capital deepening, i.e. the income share weighted increase of tangible capital services per hour worked. The second source is the income share weighted increase of intangible capital services per hour worked. The third component is the improvement in labour quality which is defined as the difference between the growth rates of labour services and hours worked multiplied by labour's income share.[11] The fourth source is a general advance in multi-factor productivity (MFP) which increases labour productivity point for point.

Table 3 contains the growth decompositions in the case where the capitalization of intangibles is taken into account both on the input and output side. The volume of gross value added grew rapidly (7.36 per cent on annual average) in 1995-2000.[12] Labour input increased by 3.24 per cent and labour productivity by 4.12

[10] The favorable capital productivity picture 1995-2000 is softened when the new intangible investments are taken into account and vanishes 2000-2005 as economic growth notably slowed down 2000-2005 vs. 1995-2000 (see tables 3 and 5). We do not report the capital productivities explicitly; but keep in mind that MFP growth is the geometric average of labour and capital productivity growth.

[11] The labor composition is by age (15–29 yrs., 30–49 yrs., and more than 50 yrs.) and education (low-skilled, medium-skilled, and high-skilled) for the total economy from the EUKLEMS March 2007 release (www.euklems.net) as computed by Huovari and Jalava (2007). The total economy structure of labour composition is assumed to apply also to the non-financial business sector but the income share is changed in accordance with our revised (/unrevised for SNA93-type computations but using applying the income shares for the non-financial business sector and not the total economy) estimates. The contribution of labour composition change could not be calculated for 2005 due to lack of data; the 1996-2004 arithmetic average was used. See Appendix 2 for more on labour quality.

[12] To compare 1995-2000 with 2000-2005 is not ideal as cyclical effects from exiting the early 1990s recession are still visible in the figures of the mid-1990s. This is why Pohjola (2007) started the periodization from 1999 in his computations. We duly note the danger in comparing productivity figures from different stages of economic growth (i.e. not peak-to-peak figures). However, looking at the graphs in Appendix 3 we find that this concern is more serious for gross value added growth than labour productivity growth.

per cent. Investments into tangible capital were scarce, which is why its capital deepening was actually negative, the contribution of intangible capital deepening (0.64 percentage points) barely kept total capital deepening's contribution positive; 0.13 percentage points. The contribution of labour quality increase was also only just positive, 0.06 percentage points, which is why most of the labour productivity growth is explained by MFP change.

In the period 2000-2005 the business sector's economic growth is less than half of what it was in the earlier period. The increase in hours worked slowed down to 0.62 percentage points per annum and labour productivity growth was 2.90 per cent. In this period the contribution of capital deepening was the largest one, 1.47 percentage points, as both tangible capital and intangible capital chipped in (0.60 and 0.87 percentage points respectively). As much as 30 per cent of labour productivity growth in 2000-2005 stems from intangible capital deepening! The change in labour composition contributed 0.19 percentage points and the residual was 1.23 percentage points.[13]

Table 3 Annual change in business sector labour productivity (revised)

	1995-2000	2000-2005	2000-2005 vs 1995-2000
Gross value added	**7.36**	**3.52**	**-3.84**
Hours worked	**3.24**	**0.62**	**-2.62**
Labour productivity	**4.12**	**2.90**	**-1.22**
Contribution of components:			
Capital deepening	**0.13**	**1.47**	**1.35**
Tangible capital	**-0.51**	**0.60**	**1.11**
Intangible capital	**0.64**	**0.87**	**0.23**
Labour composition	**0.06**	**0.19**	**0.13**
MFP	**3.93**	**1.23**	**-2.70**
Addendum:			
Contribution of deepening of tangible capital quantity	**-0.55**	**0.74**	**1.29**
Contribution of deepening of intangible capital quantity	**0.32**	**0.52**	**0.19**

Source: Authors' calculations. May not sum to totals due to rounding and averages.

The contribution of intangible capital deepening is further decomposed by asset type in table 4. The impact of mineral exploration and copyright and license costs is negligible in both periods. Firm specific human capital and own account organizational structure contribute zero in 1995-2000 but 0.08 and 0.05 percentage points respectively in 2000-2005. Purchased organizational structure

[13] In the period 1995-2005 labour productivity in the business sector grew annually by 3.51 per cent. The contribution of capital deepening was 0.80 percentage points (of which intangible stood for 0.75 percentage points). The contribution of labour quality was 0.13 percentage points and MFP grew by 2.58 per cent.

bestowed 0.04 and brand equity 0.14 percentage points; the total for economic competencies was 0.31 in 2000-2005. Computerized information contributed 0.09 percentage points, new architectural and engineering designs 0.10, and scientific R&D 0.36 percentage points. The combined scientific R&D and economic competencies, our new investments, together contributed three quarters or 0.67 percentage points of the total 0.87 percentage points intangible capital deepening contribution.

Table 4 Contribution of intangible capital deepening to business sector labour productivity growth

	1995-2000	2000-2005	2000-2005 vs 1995-2000
Intangible capital	**0.64**	**0.87**	**0.23**
1. Computerized information	**0.05**	**0.09**	**0.05**
2. Innovative property	**0.31**	**0.47**	**0.16**
a) R&D incl. social sciences and humanities	**0.29**	**0.36**	**0.07**
b) Mineral exploration and evaluation	**0.00**	**0.00**	**0.00**
c) Other innovative property	**0.02**	**0.10**	**0.08**
Copyright and license costs	**-0.01**	**0.00**	**0.01**
New architectural & engineering designs	**0.03**	**0.10**	**0.07**
3. Economic competencies	**0.27**	**0.31**	**0.04**
a) Brand equity	**0.21**	**0.14**	**-0.07**
b) Firm specific human capital	**0.01**	**0.08**	**0.08**
Direct firm expenses	**0.00**	**0.06**	**0.05**
Wage and salary costs of employee time	**0.00**	**0.03**	**0.02**
c) Organizational structure	**0.05**	**0.09**	**0.03**
Purchased	**0.05**	**0.04**	**-0.01**
Own account	**0.00**	**0.05**	**0.05**

Source: Authors' calculations. May not sum to totals due to rounding and averages.

Table 5 contains similar decompositions as table 3 with the difference that the inputs and outputs adhere to SNA93. The volume of gross value added grew rapidly (6.88 per cent on annual average) in 1995-2000. Labour input increased by 3.24 per cent and labour productivity by 3.64 per cent (our revision increased the average growth rate of labour productivity by 0.48 percentage points). Investments into tangible capital were still limited, which is why its capital deepening was actually negative, as the contribution of software capital deepening (0.05 percentage points) was not enough to keep total capital deepening's contribution positive. It was -0.48 percentage points. The contribution of labour quality increase was also barely positive, 0.07 percentage points. Thus most of the labour productivity growth is explained by MFP change. Interestingly MFP grows even faster than labour productivity. Capitalizing intangible investments decreased the measure of our ignorance by 0.12 percentage points in 1995-2000.

In the period 2000-2005 the business sector's economic growth is half of what it

was in the earlier period. The increase in hours worked slowed down to 0.62 percentage points per annum and labour productivity growth was 2.84 per cent (our revision increased the average growth rate of labour productivity by 0.06 percentage points). In this period the contribution of capital deepening was 0.95 percentage points, including a contribution of software of 0.12 percentage points. The change in labour composition contributed 0.22 percentage points and the residual was 1.68 percentage points. Capitalizing intangible investments decreased the residual by as much as 0.45 percentage points in 2000-2005.

Table 5 Annual change in business sector labour productivity (old)

	1995-2000	2000-2005	2000-2005 vs 1995-2000
Gross value added	**6.88**	**3.47**	**-3.41**
Hours worked	**3.24**	**0.62**	**-2.62**
Labour productivity	**3.64**	**2.84**	**-0.79**
Contribution of components:			
Capital deepening	**-0.48**	**0.95**	**1.43**
Fixed capital	**-0.48**	**0.95**	**1.43**
of which software	**0.05**	**0.12**	**0.07**
Labour composition	**0.07**	**0.22**	**0.15**
MFP	**4.05**	**1.68**	**-2.37**
Addendum:			
Contribution of deepening of fixed capital quantity	**-0.45**	**0.92**	**1.37**

Source: Authors' calculations. May not sum to totals due to rounding and averages.

Table 3 gives much food for thought also to the discussion of appropriate investment ratios needed to sustain economic growth. It could be seen in figure 3 that part of the story is that the SNA93 definition of investments does not capitalize much of the intangible expenditure crucial for firms in developed countries near the technology frontier. The second part of the puzzle can be observed in table 3 in the difference between the contributions of the deepening of (the quality adjusted) capital services and the deepening of capital quantity. It is not solely a question of how much is invested, but in what kind of assets the investments are made. As there has been a shift to new (intangible) investments with higher marginal products than traditional (tangible) capital the contribution of capital quality is high.[14]

[14] Jalava and Pohjola (2007) contain the figures for ICT-capital quantity and quality in 1995-2005.

6. CONCLUSIONS

This paper took a quantitative look at intangible investments in the Finnish non-residential business sector in 1975-2005. Not only GDP but also investments have become more weightless as the importance of scientific innovative property and economic competencies has increased. In 2005 Finnish business intangible investments amounted to 14.2 billion euro, which was 9 per cent in relation to (unrevised) GDP. Our effort is a pioneering one as it includes a heretofore unseen scope of intangible investments for the Finnish business sector. This is useful also in view of the upcoming revision of SNA93 where R&D expenditure is to be capitalized.

Both outputs and inputs were corrected for the broader concept of intangible investments. We found that the investment ratios plunged during the 1990s recession but that the new total tangible plus intangible investment ratio was 9 percentage points higher than the old one in 2005. Intangible investments were 14.6 percentage points of the total 26.3 per cent investment ratio in 2005. Not only the investment ratios but also the labor shares fell during the 1990s recession. At the end of our observation period the difference was 7 percentage points in the old labor share's favor.

We calculated the proximate sources of growth of the Finnish non-financial business sector for the first time taking into account the broader, Corrado, Hulten and Sichel (2006)-type, intangible capital definition. Revised labor productivity increased 1995-2000 by 4.12 per cent. Tangible capital deepening contributed 0.13 percentage points and intangible capital deepening 0.64 percentage points. The contribution of labor quality increase was 0.06 percentage points, which is why most of the labor productivity growth was explained by MFP change.

In the period 2000-2005 labor productivity growth was 2.90 per cent. In this period the contribution of capital deepening was the largest one, 1.47 percentage points, as both tangible capital and intangible capital chipped in (0.60 and 0.87 percentage points respectively). As much as 30 per cent of labour productivity growth in 2000-2005 stemmed proximately from intangible capital deepening! The change in labour composition contributed 0.19 percentage points and the residual was 1.23 percentage points.

Comparing our new results with SNA93-type growth decompositions we found that our revision increased the average growth rate of labor productivity by 0.48 percentage points in 1995-2000 and 0.06 percentage points in 2000-2005. Capitalizing intangible investments decreased the measure of our ignorance by 0.12 percentage points in 1995-2000 and 0.45 in 2000-2005. Furthermore, our results show that the Finnish business sector was close to steady-state growth in 2000-5; this is a new result compared to previous research.

Our results also have implications for economic policy, especially vis-à-vis the

discussion of appropriate investment ratios needed to sustain economic growth in advanced countries. Intangible capital is increasingly important for firms in developed countries. A shift to new, intangible, investments with higher marginal products than traditional tangible capital has taken place; this is manifested through a high contribution of capital quality (and quantity). It is not any longer solely a matter of how much is invested, but what it is firms invest in.

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APPENDIX 1

Compilation methods for investments in economic competencies, 1975-2005:

Brand equity: Purchased marketing expenditures have been calculated from the business register data (total population level, not a survey) for years 1999-2005. The share of marketing expenditures of turnover was approximately 1.4 per cent by industry (with large inter-industry variations). Outside purchases of advertisement expenditure are included in the marketing expenditures. The time series was made by using an index of expenditure on outside purchases of advertisements of TOL 2002 (the Finnish NACE 2002 version) industry 744 Advertising. 60 per cent of the expenditures were capitalized.

Firm specific human capital:

Direct firm expenses: Total costs are estimated for year 1999 using the Continuing Vocational Training Survey (CVTS) which included total vocational educational costs only in course form; this amounted to 2.401 per cent of total personnel costs. The CVTS covers almost all business industries, except those with less than 10 employee units. The relative education costs in small enterprises are scarcer when compared to bigger enterprises. However, the inclusion of vocational education other than course form has an upward effect. After the estimation of these two corrections the total expenditure is 2.577 per cent of all employee costs (of this the costs of outside purchases were 0.84 (i.e. 2.577*0.325) per cent of total personnel costs according to the CVTS data). Time series were compiled by the In-service training statistics surveys made from 1982.

Wage and salary costs of employee time: From the CVTS data the share of compensation of employees was 45.48 per cent of total educational costs; therefore 1.17202 per cent of compensation of employees was added (i.e. 2.577*0.4548).[15]

Organizational structure:

Purchased: Computed using the development of nominal gross output of TOL 2002 (the Finnish NACE 2002 version) industry 74140 Business and management consultancy activities in the years 1995-2005. In years 1975-1995 development of nominal gross output in total business services used.

Own account: Computed using occupation data from Statistics Finland's Structure of Earnings statistics in the years 1995-2005. Included is management personnel; their share of business sector compensation of employees was approximately 11.6 per cent. Corrado, Hulten and Sichel (2005)

[15] The use of an opportunity cost as an investment item slightly puzzles the authors; to enable comparison it was included.

assumed that 20 per cent of managers' time was used on organizational improvement. One-fifth of 11.6 per cent is 2.32 per cent. This ratio was applied on business sector compensation of employees.

APPENDIX 2

Labor input has often in growth accounting been measured by simply summing the hours worked. The problem with this approach is of course that all hours are not equal with respect to their contribution to economic production. For instance, a high-school dropout and someone with a bachelor's degree rarely enjoy similar wages. This is usually also the case for a new coworker and an employee with several decades of experience. In the KLEMS-methodology (Jorgenson, Ho and Stiroh, 2005) this problem is solved by dividing labour into as many homogeneous groups as possible. The changes in quantity by quality group are weighed with the respective groups' share in total remuneration.

The volume index of labor services is defined as:

$$(A.1) \qquad l_{it} = \frac{L_{it}}{L_{i(t-1)}} = \prod_m \left(\frac{L_{imt}}{L_{im(t-1)}} \right)^{v_{imt}} ,$$

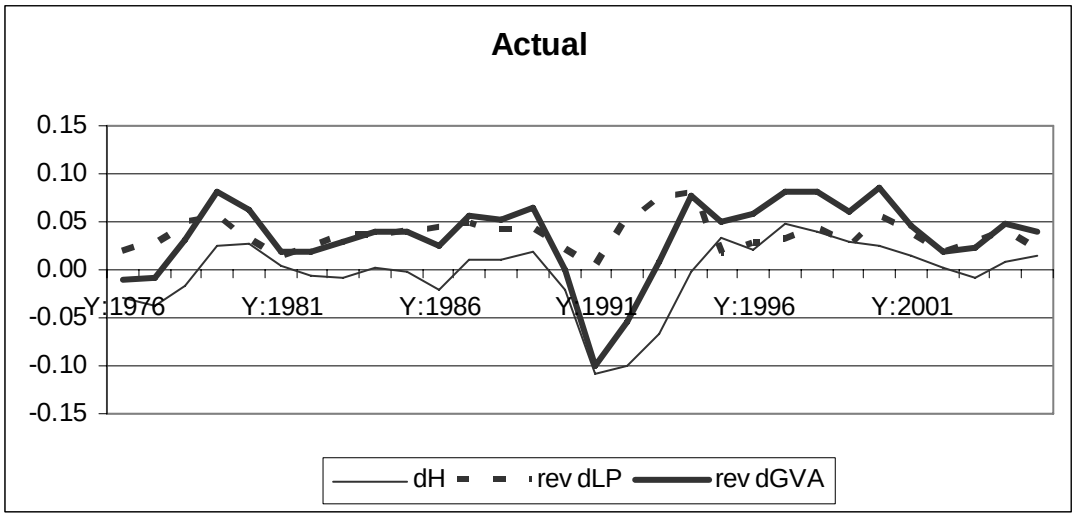
where i is industry, t is time, l is the volume index of labor services, m is quality group and v is a weight. The weights v are calculated as:

$$(A.2) \qquad v_{imt} = \left(\frac{p_{imt} L_{imt}}{\sum_i p_{imt} L_{imt}} + \frac{p_{im(t-1)} L_{im(t-1)}}{\sum_i p_{im(t-1)} L_{im(t-1)}} \right) / 2 ,$$

where p_m depicts compensation of employees of quality group m. There are nine quality groups of labor: three age groups (15–29 yrs., 30–49 yrs., and more than 50 yrs.) and three educational groups: low-skilled (lower secondary level education or education unknown), medium-skilled (upper secondary level education), and high-skilled (tertiary level education).

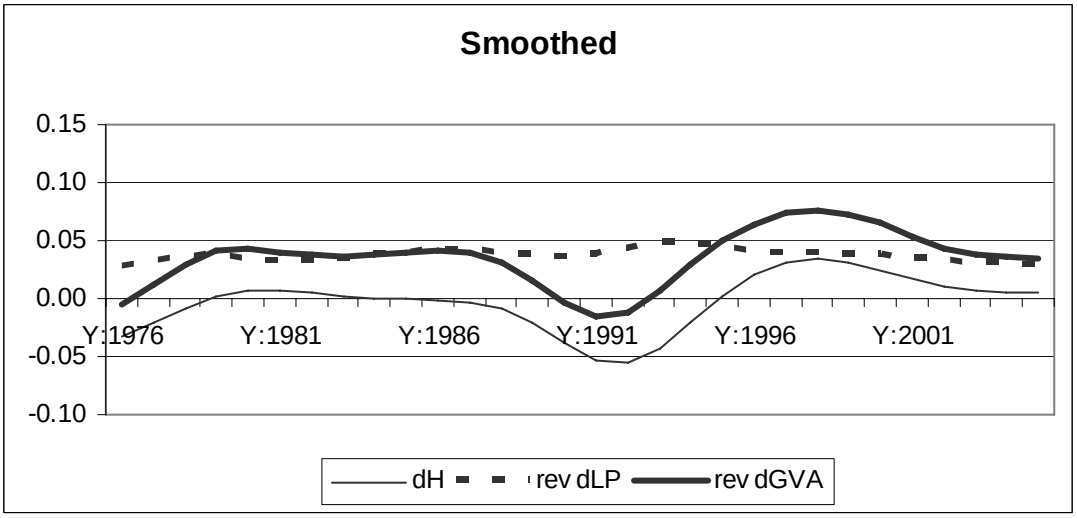
APPENDIX 3

Figure A1 Actual revised Finnish business sector gross value added, hours worked and labor productivity growth, 1976-2005.



Source: Authors' calculations

Figure A2 Smoothed[16] revised Finnish business sector gross value added, hours worked and labor productivity growth, 1976-2005.



Source: Authors' calculations

[16] Smoothed with the Hodrick and Prescott (1997) filter using λ=6.25.

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