UNIVERSITY OF VAASA

DEPARTMENT OF ECONOMICS
WORKING PAPERS 15

Hannu Piekkola

Intangibles: Can They Explain the Unexplained?
Revised Version

VAASA 2010

UNIVERSITY OF VAASA

DEPARTMENT OF ECONOMICS

WORKING PAPERS 15

Hannu Piekkola

Intangibles: Can They Explain the Unexplained?

Revised Version

VAASA 2010

TABLE OF CONTENTS

ABSTRACT

Piekkola, Hannu* (2010). Intangibles: Can They Explain the Unexplained? Revised Version. University of Vaasa, Department of Economics Working Papers 15, 32 p.

Intangible capital is embedded in the firm to run the business and develop innovations, and evaluated here using occupational information regarding intangible capital-type work available in Finnish linked-employer-employee data. The value of organizational capital is doubled by using a performance rather than an expenditure-based approach. Intangible capital, i.e., organizational, informational, communications, and technology and R&D capital, is shown to increase the market value of firms beyond a level that can be explained by standard economic analysis. A 10% increase in such intangibles increases the firm's market value about 6% beyond that explained by a standard economic forecast.

JEL classification: M40, J30, O30, M12, J62
KEYWORDS: Intangible capital, R&D, market valuation, linked employer-employee data

---

* Department of Economics, University of Vaasa P.O. Box 700 FI-65101 Vaasa Finland
email: hannu.piekkola@uwasa.fi

** This paper is published as a working paper of the INNODRIVE project financed by the EU 7th Framework Programme, No. 214576, www.innodrive.org. I am thankful to Pekka Ilmakunnas, as well as to participants in INNODRIVE for their helpful comments and suggestions. I am solely responsible for any remaining errors and omissions.

1. Introduction

Innovative growth requires investment in intangibles, most of which are imprecisely valued in any balance of accounts. More and more of the expenditures on marketing and organizational investment need to be recognized as intangible investments that increase productivity over a longer period. Organizational capital is also more clearly firm-specific and owned by the firm than are other types of intangibles (Youndt, Subramaniam and Snell 2004; Subramaniam and Youndt 2005; Lev and Radhakrishnan 2003 and 2005). Organizational capital is less tradable and/or cannot be invested with only long-term goals, as is investment in R&D. R&D expenditures are in turn the first and only recognized type of intangible capital to be included in the satellite accounting of GDP by the OECD.

Ito and Krueger (1996) and Bresnahan and Greenstein (1999) suggest that organizational competence also complements investments in information and communications technology ICT and may well exceed the direct financial costs of the ICT investments themselves. ICT work thus needs to be analyzed in conjunction with organizational capital, because it is heavily concentrated in industries such as business services and finance. Indeed, Hitt and Yang (2002) argue that the reportedly large returns on ICT investments can be largely explained by a relationship between the utilization of ICT and skilled workers, on the one hand, and human resource management, on the other.

The basic idea here is to concentrate on producing intangible goods of the following types: (i) organizational capital, (ii) research and development and (iii) information, and communications technology, which complements organizational capital in market valuation. We adapt the methodology used in the INNODRIVE project and described in greater detail by Piekkola, Görzig and Riley (2010).[1] An important issue here is the fraction of workers engaged in the production of intangible goods. The remaining employees in organizational, R&D and ICT occupations are engaged in current production, which in the National Accounts means that the service life of the goods and services they produce is less than a year. In contrast to

---

[1] See the INNODRIVE project website, at http://www.innodrive.org.

Corrado, Hulten, and Sichel (CHS) (2006), we evaluate the value of the necessary intermediate and capital costs in own-account production of intangible capital goods.

The performance-based approach is also used to measure the relative productivity of organizational workers. We adapt this methodology from Hellerstein, Neumark, and Troske (1999) and from Ilmakunnas and Maliranta (2005). The production function includes the share of the organizational workers as a proxy for labor-augmenting productivity improvement We find our performance-based measure of organizational capital together with the other intangibles to yield a higher share of intangibles accounting for value added than what has been previously recorded. On average, intangibles account for about 60% of private sector value added. We also check the robustness of all our results using Olley and Pakes (1996) estimates with hiring as our control for productivity shocks. Intangibles are also shown to affect the valuation of the firm to an extent far beyond that explained by economic forecasts.

Section 2 of the paper discusses the composition of intangible capital and presents the data. The estimation and calculation of the intangible capital are presented in section 3. Section 4 incorporates intangible capital into a valuation model and shows the magnitude of intangibles relative to recorded balance sheets and market values. Section 5 provides the conclusions.

2. Intangible capital components and data

Organizational capital is at the core of the economic competence category in CHS. This category includes the competence of the top management and human resources as well as that of marketing and sales efforts. The organizational structure of a firm's own account in Corrado, Hulten, and Sichel (2005) is measured according to a predetermined share of management expenditures (20%) in the business sector. CHS also includes as firm-specific capital the training provided by the employer. Such information is provided by surveys. Market research activities are measured by the size of the marketing industry in the System of National Accounts; in a study set in the UK, Marrano and Haskel (2006) use private sources from media companies.

Scientific innovation capital is a category of its own in which our firm-level analysis can only cover R&D capital. For ICT capital, CHS includes software and hardware expenditures that are currently recorded in national statistics. National income accounting procedures frequently use ICT-related work expenditures as proxies for software and hardware, so our approach takes into account most of these expenditures. On the other hand, Brynjolfsson, Hitt, and Yang (2002) refer to case studies indicating that computers and software are just the tip of the iceberg of the actual implementation costs of ICT.

We use linked employer–employee data, which have been extensively utilized in the study of human capital formation beginning with Abowd, Kramarz, and Margolis (1999). These data are convenient for use in an analysis relying on the valuation of different tasks and occupations. The labor data are from the Confederation of Finnish Industry and Employers, with 7.9 million person-year and 87,972 firm-year observations for the years 1995–2008. The data include a rich set of variables covering compensation, education, and profession in the business sector. Non-production employees receive salaries, and production workers, 36% of all workers, receive an hourly wage. Employee compensation is evaluated based on monthly salaries (multiplied by 12.5 months) and using the average figure for social security taxes over the years (30%).

The occupational classification is specific to the data from the Confederation of Finnish Industries and is available for all employees in the firms considered here. The occupational codes can be transformed into ISCO-88 using additional information on education level (for qualifications) and industrial codes. Most importantly, the occupations in manufacturing and services are separated. Organizational compensation is obtained from occupations classified as relating to organizational capital: management, marketing, and administrative work done by those with a tertiary education. We end up with 41 non-production worker occupations, which are listed in Appendix A.

Employee data are linked to the financial statistics data provided by the Suomen Asiakastieto[2] and include information on profits, value added, and capital intensity (fixed assets). To eliminate firms with unreliable balance sheets, we include in the analysis only those firms that have real sales exceeding €1.5 million (in 2000 consumer prices). The final linked employer–employee data of 4.14 million person-year observations cover 2,933 firms with 20,115 firm-year observations after dropping the years 1995–97, which are used to build up organizational, R&D and ICT capital. The employee data in the sample cover 379,000 employees annually on average (the original employee data cover 580,000 employees in the respective period), that is, one-fourth of the entire workforce in the private sector industries. Later, we evaluate the intangibles in the private sector making a sample correction. Figure 1 first shows the share of workers in work related to production and intangible capital in the LEED data.

Figure 1. Share of private-sector employees engaged in work related to intangible capital in Finland (1998–2008)

[2] Suomen Asiakastieto is the leading business and credit information company in Finland.

The share of R&D workers has increased from 10% to 12% and the share of organizational workers from 8% to 10% of employees over time. It should be noted that part of the increasing share of intangible workers is explained by the fact that the share of production workers has fallen by a substantial amount, from around 38% to 30%; this is important because half of the employees included in the data work in manufacturing. In R&D, the category of non-production workers is broad, with the coding matched to architects and engineers (214), life science and health professionals (221 and 222), and physical and engineering science professionals (311) in ISCO-88 codes. The share of ICT workers is 3%, a share that has also increased over time to around 4%. Management (4.5%) and marketing (4.3%) are the main categories of organizational work. The INNODRIVE project financed by the EU 7th Framework Programme reveals that the share of personnel engaged in organizational work (management and marketing) is comparable in six European countries, ranging from 9-10% in Finland and Germany to 14% in the UK and ranging between 13%-18% in the Czech Republic and Slovenia. Analyzing management expenditures alone, as is done in the national measures of intangible capital in CHS, and ignoring marketing may offer a less comparable basis for an analysis of firm-specific resources or organizational capital across countries.

Appendix B shows the summary of the rest of the variables in the estimation sample. Average sales are €16 million, and average sales growth has been a rapid 3.8%. Over half of the firms have no ICT personnel (the median is one worker).

3. Methodology

Following the methodology described in Piekkola, Görzig and Riley (2010), the basic idea is that each firm is producing goods of the following types:

- Organizational competencies (OC),
- Information and, communications technology (ICT), and
- Research and development (R&D).

It is assumed that the production of these types of goods is directed towards the firm's own uses. The OC, R&D and ICT employees are also engaged in current production, which means that the service life of the goods they produce is less than a year. Following the INNODRIVE project's approach, a fraction of OC, R&D and ICT work is engaged in the production of intangible goods, whose fractions are set at 20% for OC, 70% for R&D, and 50% for ICT. To evaluate the value of intermediate and capital costs related to labor costs necessary in the production of intangible capital goods, the following industries within NACE category 7 have been chosen:

- Other business activities (Nace 74) as a proxy for OC goods,
- Research and development (Nace 73) as a proxy for R&D goods, and
- Computer and related activities (Nace 72) as a proxy for ICT goods.

We assume that the weighted average relation between the production factors (labor, intermediates, and capital) in these industries can also be taken as an indicator for the cost structure in own-account production of these types of goods in the firms. Following Piekkola, Görzig and Riley (2010), data for the assessment of these factors are taken as a weighted average using the EU KLEMS database for Germany (40% weight), UK (30% weight), Finland (15% weight), Czech Republic and Slovenia (7.5% weights). Central settings are thus

Table 1. OC, R&D and ICT multipliers and depreciation

	OC	R&D	ICT
Combined weighted multiplier M_{IC}	0.35	1.1	0.7
Depreciation rate δ_{IC}	0.25	0.2	0.33

The combined multiplier M_{IC} is the product of the share of intangible-type work and the use of the other inputs.[3] Overall, organizational investment is 35% of wage costs when the use of intermediates and capital are added to the wage costs that are 20% of all wage costs in organizational work. In R&D and ICT work, the total wage costs are closer approximates of the total investment. Conventional capital stock estimates use the perpetual inventory method to quantify the capital stock. Using the EU KLEMS methodology, the general definition of the closing stock K_t for an establishment is given by:

$$K_t = K_{t-1}(1-\delta) + I_t \,, \qquad (2)$$

with I_t for the capital formation of the current year and a constant depreciation rate δ. Microdata do not allow for a long history of intangible capital accumulation. Capital stocks are based on observed figures and an estimate of the initial closing capital stock $K_{\theta-1}$ in the last year before observations for a firm begin. We apply the following sum formula of a geometric row to estimate the initial stock:

$$K_{\theta-1} = \hat{I}\,\frac{1-(1-\delta-g)^T}{1-(1-\delta-g)}\,, \qquad (3)$$

where $\hat{I}$ is the initial investment, δ is the depreciation rate, and g is the growth of capital stock. $\hat{I}$ is set to be the average investment in the five-year period following the first observation year θ. The average is used to assess the average investment rate over the business cycle. The initial investment $\hat{I}$ is taken as the starting value for the back extrapolation using the growth rate of investment g before the first observation. *T* should theoretically be infinite, but for practical purposes, it can be set to 100. Growth rate g is set at 2%, which follows the sample average growth rate of 2% of real wage costs for intangible capital-type work.

---

[3] Capital cost is the sum of the external rate of return 4% (representing the market interest rate) and depreciation multiplied by net capital stock.

Expenditure-based calculations have been made for every type of intangible expenditure, $I_{ICit} \equiv M_{IC} w_{ICit} L_{ICit}$ with $IC = OC,\ R\&D, ICT$. Here, M_X is the weighted multiplier in Table 1 by which labor costs have to be multiplied to assess total investment expenditures on intangibles, w_{ICit} is the wage cost for every type of worker (deflated by earnings index) and L_{ICit} is the respective labor input.

The performance-based approach uses these estimates as a starting point but re-estimates the productivity of organizational workers (and R&D workers). In Mankiw, Romer and Weil (MRW) (1992), the human capital investment decision for each individual is made by the individuals themselves as part of their long-term investment (the alternative investment is in physical capital through savings). It is convenient to model the production function following MRW, but with human capital replaced by organizational capital. The organizational capital inherit in each organizational worker is considered as fixed and determined by the combination of labor costs with intermediates and capital, as in the expenditure-based approach. The effective labor input, however, is quality-adjusted for the productivity of organizational workers that may differ from the wage costs used in the expenditure-based calculations. Indeed, Hellerstein, Neumark, and Troske HNT (1999) find a clear productivity-wage gap among the managers. They also remark that labor market theory has no clear explanation for this. Ilmakunnas and Piekkola (2010) further provide evidence that in Finland, organizational workers in particular, and to some extent, R&D workers, increase profitability so that productivity exceeds the wage costs.

Organizational capital is suggested here as the important missing input in production that may explain the productivity-wage gap. Thus, our first argument is that the high returns are explained by the omitted organizational capital in the production function. There are also other explanations for the gap that relate to the difficulty of assessing management's productivity in general, and below, we sum up all the arguments.

1. Organizational work creates organizational capital.
2. Complementarities exist with other unobserved inputs, or inputs not properly controlled for in estimation.
3. Management and marketing workers may be paid in shares or in other non-wage benefits.
4. The output of these workers may be difficult to observe.

Managers are also partly remunerated in shares, and therefore, wages don't reflect their remuneration in full. Rent sharing has also become more common but is usually not intended to give all benefits to employees. Intangible goods are indeed by definition assumed to be owned by the firm, and hence, the rewards are not (at least fully) compensated for workers. The productivity estimate is sensitive to the inclusion of all types of unobserved inputs and is thus open to the bias of omitting inputs not properly controlled for in estimation. Accordingly, we include in the production function all types of intangible capital stock using an expenditure-based method and organizational capital per organizational worker (which is considered as fixed). In the simplest framework, workers are divided into two categories: organization workers, OC, and other NON-OC (or for R&D and NON-R&D workers). The performance-based measure of OC investment is given by:

$$I_{OCit} \equiv M_{OC} \hat{w}_{OCit} L_{OCit}, \quad (5)$$

where M_{OC} is the total multiplier as given before in a separate production function (from Table 1) and $\hat{w}_{OCit}$ is the estimated true productivity of OC-labor that may deviate from the wage costs. The quality-adjusted labor is

$$L_t \equiv L_{NON-OCt} + a_t L_{OCt} \equiv q_t L_t, \quad (6)$$

in which $a_t \equiv \hat{w}_{OCit} / w_{NON-OCit}$ is the relative productivity of organizational workers with respect to the rest of the workers with an average annual compensation $w_{NON-OCit}$ that is assumed to reflect their marginal productivity given perfect competition, $q_t \equiv 1 + (a_t - 1) z_{OCt}$ denotes the quality adjustment due to different productivity levels of organizational and other workers where $z_{OCit} \equiv \frac{L_{OC}}{L_{NON-OCt} + L_{OCt}}$. In the constant returns-to-scale production function estimation, the explanatory variable is turnover, including investment in all types of intangibles $y_{it} = SALES_{it} + I_{OCtt} + I_{RNDtt} + I_{ICTtt}$ for firm *i* in year *t*.[4]

$$y_{it} \;=\; b_{0it}(q_{it}L_{it})^{(1-b_{OC}-\sum_x b_X)} \left(k_{OCit}L_{OCit}\right)^{b_{OC}} \prod_X K_{Xit}{}^{b_X} \exp(e_{it}) \,, \qquad (7)$$

where K_{Xit} is capital or material of type *X= R&D, ICT*, *PPE* (plant, property and equipment), MAT and *eit* is an error term. We use material MAT_{it} as our control variable in the ideal production function. Organizational capital per worker k_{OCit} is considered as fixed and hence entering the constant in the estimation. The organizational labor L_{OCit} is correlated with quality-adjusted labor $q_{it}L_{it}$ and cannot be used as an independent regressor. We approximate the former organizational capital deepening effect using a proxy for the number of organizational workers given by an industry average value in five firm-size categories, denoted as $\overline{L}_{OCit}$. Finally, the specification imposes higher returns to an additional investment in all types of intangible capital at low levels. It is therefore appropriate to use a wide definition of occupations that are engaged in the production of intangible capital.

Following HNT in log form, we can approximately write $\log q_t = \log\left[1+(a_t-1)z_{OCt}\right] \approx (a_t-1)z_{OCt}$ because organizational workers are 10% of total workers and because we are measuring relative productivity (so that the second term in squared brackets does not deviate significantly from zero). The final estimation is done by industry and year, and the reference productivity level is that of the non-organizational workers in each industry j. Our estimation equation, then, is

$$\begin{aligned} \ln y_{it} &= b_{0jt} + c_{jt}z_{OCit} + b_{OCjt}\ln \overline{L}_{OCit} + b_{Ljt}\ln L_{it} \\ &\quad + \sum_X b_{Xjt}K_{Xit} + \; d_{jt}[Year]*IND_{jt} + e_{it} \end{aligned} \quad , \qquad (8)$$

---

[4] Caves and Barton (1990) and Jorgenson, Griliches, and Intriligator (1986) provide details regarding the estimation of firm production functions with fixed effects.

where $b_{Ljt} = 1 - \alpha - \varphi$, $c_{OCjt} \equiv (1 - \alpha - \varphi)[a_{jt} - 1] = b_{Ljt}[a_{jt} - 1]$ and $b_{jt5}[Year]*IND_{jt}$ stands for the year t and industry j dummies and their interactions and e_{it} is the residual error. The relative productivity of organizational workers is $a_{jt} = c_{jt} / b_{Ljt} + 1$. Here, c_{jt} / b_{Ljt} shows the magnitude by which the marginal productivity of management and marketing work exceeds that of the rest of the workers in the industry. Productivity is thus $(c_{jt} / b_{jt} + 1 - 1) / 1 = c_{jt} / b_{jt}$ percent higher than for the rest of workers. The organizational investment and productivity of organizational workers is then given by

$$I_{OCit} \equiv M_{OC} \hat{w}_{OCjt} L_{OCit} \tag{9}$$

$$\hat{w}_{OCjt} = a_{jt} w_{NON-OCjt} . \tag{10}$$

In empirical estimates, the hypothetical wage sum $w_{NON-OCjt} L_{OCit}$ is evaluated from the annual wage sum for organizational workers multiplied by the hourly wage ratio of organizational and other workers in each industry. The estimation is conducted separately for four industries: (i) manufacturing, (ii) construction and other, (iii) business services, telecommunication, and finance and (iv) other services. We first show pooled estimates before estimating by industry and year. Here, we also control for the endogeneity bias caused by productivity shocks, using the Olley and Pakes (1996) approach, which accounts for the possibility that the measures of intangibles are correlated with these shocks. [5] The intangibles are the state variables that adjust slowly. The firm can manage intangibles by hiring new employees for tasks related to organizational work. The hiring rate would thus be a proxy variable for the productivity shocks in the same way as Olley and Pakes use investments. We also control for the selectivity caused by the exit of firms. Following Olley and Pakes, the likelihood of exit is modeled with a probit model, and the predicted probability is used as an additional variable in the second step. We also report GMM-SYS estimates from Blundell and Bond (1998) as an additional robustness check. Table 2 reports the pooled data equation (8) that includes

[5] The estimation procedure is adapted from Yasar, Raciborski, and Poi (2008).

organizational work augmenting labor productivity (all variables except shares are in log form).

Table 2. Pooled OLS and Olley-Pakes estimates in explaining sales net of organizational capital

	1	2 Olley-Pakes	3 GMM-SYS
Organization worker share	0.735***	0.705*	0.151
	(9.89)	(2.4)	(0.48)
Organizational workers by industry, firm size	0.155***	0.271***	0.305***
	(12.01)	(24.76)	(4.09)
Employment	0.380***	0.265***	0.328***
	(24.68)	(26.08)	(5.05)
Net plant, property, equipment	0.135***	0.139***	0.0894*
	(22.98)	(26.35)	(2.36)
R&D capital	0.132***	0.140***	0.0494
	(21.96)	(24.53)	(1.37)
ICT capital	0.0547***	0.0656***	0.0174
	(8.94)	(11.27)	(0.76)
Material	0.0706***	0.0786***	0.0656**
	(16.79)	(24.27)	(2.65)
Observations	7386	8011	7386
Number of firms			966
R Squared	0.79	0.82	
Arrelano-Bond test AR(1) first difference p-value			0.000
Sargan test of overidentifying restrictions p-value			0.000
Hansen test of overidentifying restrictions p-value			0.034

All estimations include year and industry dummies and their interactions. All except organizational worker share are in logs; organizational workers are industry-firm size averages. Olley-Pakes estimates with proxies are: hiring up to fourth potency, organization worker share up to fourth potency and interaction to hiring. The state variable is organizational worker share and the number of repetitions in bootstrap is 30. In GMM-SYS, GMM-type instruments include organizational worker share, R&D capital, ICT capital, net plant, property and equipment, all with lags. IV-type instruments include industry and year dummies and their interactions.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Column 1 shows that sales are positively related to the share of organizational workers. Organizational workers have higher productivity relative to the rest of the workers if the coefficient for the organizational worker share is positive. In the pooled regression, organizational workers appear to have a 190% higher productivity than the rest of the workers (from 0.735/0.38). Column 2 shows the estimate when the bias caused by the productivity shock is controlled using Olley-Pakes estimates. Organizational workers here appear to have around 270% higher productivity than do the rest of the workers. GMM-SYS in column 3 gives the lowest productivity.[6] Overall, our OLS estimates are not likely to be biased upwards due to productivity shocks. Our main interest is the evolution of intangible capital stock over the years and by industry. We next report in Table 3 the average coefficients and mean t-statistics from an OLS in the four industries by year and the hourly wage ratio between organizational and the rest of workers.

Table 3. Average coefficients and t-statistics by industry and year (1998–2008)

Industry	Observations	OLS relative productivity	w_{OC} / $w_{NON\text{-}OC}$
Manufacturing	8,215	2.44	1.35
Construction, transportation, building materials, mining	7,429	3.27	1.37
Business services, telecommunication, finance	2,138	1.24	1.03
Other services	4,693	3.20	1.68
Industry weighted average		2.76	1.39

The organizational workers have higher productivity than the rest of workers in every industry. Productivity exceeds the wage ratio in all industries. As found in Ilmakunnas and Piekkola (2010), the productivity gap exceeds the wage cap as the average hourly wage of organizational capital is around 1.4 times that of the rest of the workers. Services are heterogeneous.

6 The GMM results should be treated with caution, as the Sargan test rejects the overidentifying restrictions.

The returns are surprisingly lower in business service, telecommunication and finance than in other services.

Table 4 presents the average estimates and reports the intangibles per value added as well (value added includes investment in all types of intangibles). Expenditure-based (EXP) measurement applies expenditures with the parameter set in Table 1, using (5) to calculate investment, and performance-based (PER) applies industry-year specific productivity of organizational or R&D workers as given by equations (9) and (10). Here, the estimates are derived assuming the performance-based method for each asset by time. Value added is at market prices (factor prices + effective value added tax 19.9%) and includes investment in intangibles using the expenditure-based method. In the last two columns, firm-level sample data are made representative of the private sector in Finnish economy excluding agriculture, health and education sectors and large part of finance. Statistics Finland provides the distribution of firms by different turnover sizes at the industry level (the one digit level). We adjust our figures for the difference in the number of firms in our sample and in the whole Finnish business sector in five firm-size and one-digit industry categories. [7]

Table 4. Intangible capital

	Sample			Businesses[1]	
Variable[2]	Mean	Standard Deviation	Median	Mean	Median
Value added at market prices (€ 1000)	19344	90134	3955		
Book value of assets (€ 1000)	37678	423727	1382		
Organization capital (€ 1000)	5886	32529	1108		
Organization capital / value added (PER)	23.0 %	0.013	23.0 %	26.0 %	26.0 %
Organization capital / value added (EXP)	8.4 %	0.0047	8.5 %	8.4 %	8.2 %
R&D capital / value added (PER)	22.0 %	0.035	23.0 %	26.0 %	26.0 %
R&D capital / value added (EXP)	25.0 %	0.017	26.0 %	28.0 %	27.0 %

[7] In aggregation the following categories are used: 1 turnover under 2 million Euros, 2 turnover between 2 and 10 million Euros, 3 turnover between 10 and 40 million Euros, 4 turnover between 40 and 200 million Euros, and 5 turnover over 200 million Euros (at 2000 consumer prices).

ICT capital/value added	2.7 %	0.0041	3.0 %	3.7 %	3.2 %
Organizational invest./value added (PER)	5.6 %	0.008	5.5 %	5.5 %	4.9 %
Organizational invest./value added (EXP)	2.1 %	0.001	2.1 %	2.1 %	2.1 %
R&D investment/value added (PER)	5.9 %	0.015	5.6 %	10.0 %	10.0 %
R&D investment/value added (EXP)	5.1 %	0.002	5.2 %	5.7 %	5.5 %
ICT investment/value added (EXP)	0.9 %	0.001	1.0 %	1.2 %	1.1 %
Intangible capital/value added (PER)	47.0 %	0.035	49.0 %	56.0 %	58.0 %
Intangible capital/value added (EXP)	36.0 %	0.025	37.0 %	40.0 %	39.0 %
Intangible investment/value added (PER)	12.0 %	0.016	12.0 %	19.0 %	18.0 %
Intangible investment/value added (EXP)	8.1 %	0.003	8.2 %	9.0 %	8.8 %
PPE/value added	85.0 %	0.083	82.0 %	63.0 %	65.0 %

1 Business aggregates through weighting by the difference in the total sales of firms in the sample and in the whole Finnish business sector in five firm-size and one-digit industry categories. 2 Fixed 2000 prices. EXP=expenditure based, PER=performance based, O-P=Olley-Pakes performance based, PPE=Net plant, property, equipment.

The last line in Table 4 shows that the tangible capital (PPE) share of valued added is 63% in the private sector. Smaller and service sector firms are less capital intensive and are underrepresented in our data, which explains the higher share (85%) in the sample. Service sector firms and small firms, however, are not less capital intensive in terms of organizational capital as the figures are close the same with or without sample size correction. Using the sample corrected figures, organizational capital stock is equivalent in value to 26% of value added in the performance-based approach. The expenditure-based approach yields a three times lower share of 8.4%.

R&D-intensive firms are not overrepresented in our data, and the valued added share increases to 28% after sample correction, which is close to the level of organizational capital per value added using performance-based estimates. The share would be close to the same using performance-based estimation, so the choice between performance- and expenditure-based estimation is less relevant. Performance-based measures of R&D investment are ignored in what follows. ICT capital makes up as much as around 3% of valued added.

Overall intangible capital is 58% of value added in the private sector if we rely on performance-based estimates for organizational capital. This is a little less than the 63% share of tangible investments in net plant, property, and equipment (which approximates investment in machinery and equipment other than transportation). We now turn in Figure 2 to the evolution of organizational, IT and R&D investment and capital stock per value added over time, and again after sample correction so that the figures are representative of the private sector.

Figure 2. Organizational, ICT, and R&D investment per value added from 1998-2008

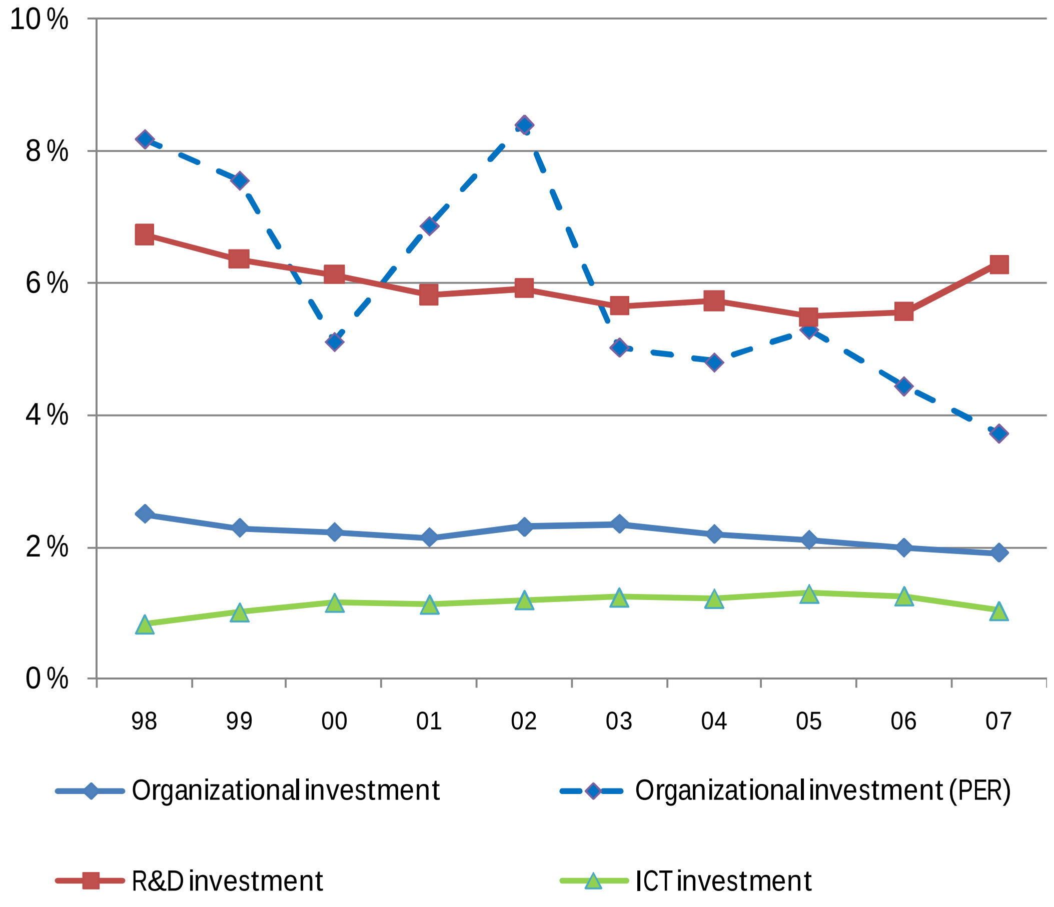
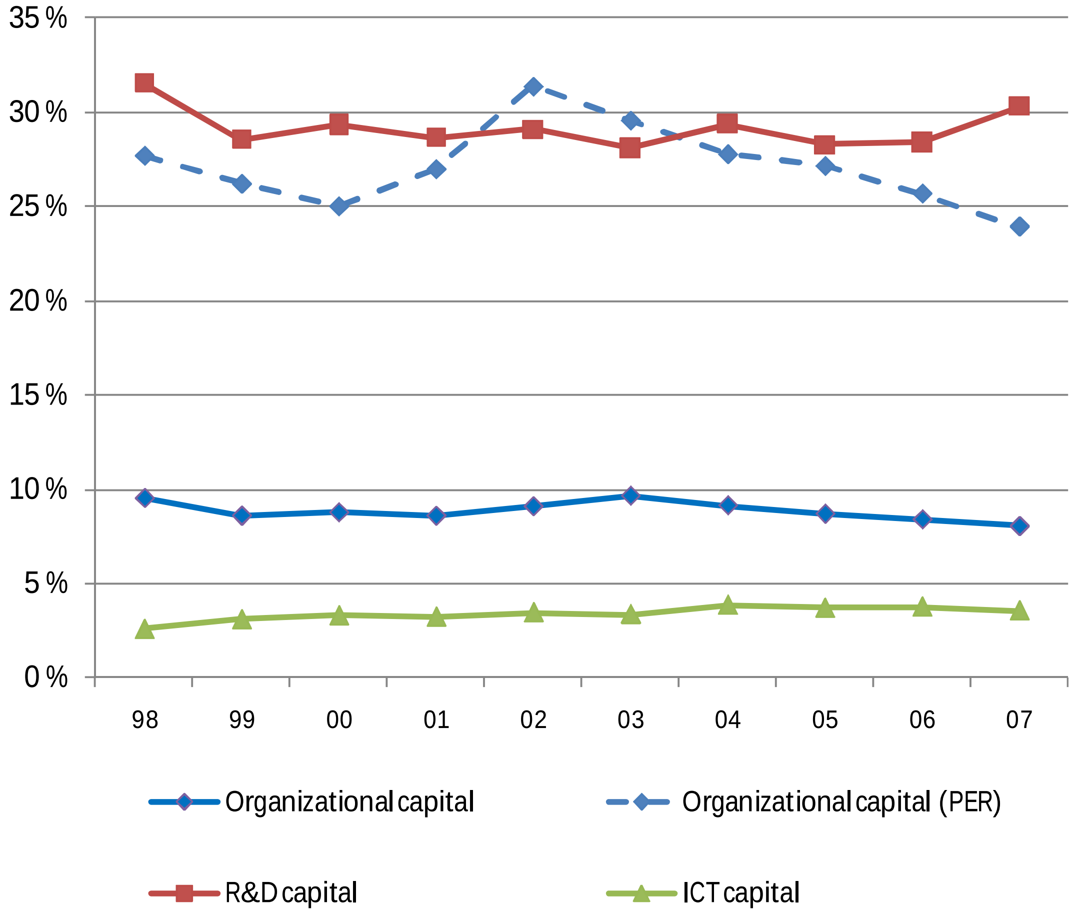


Figure 3. Organizational, ICT, and R&D capital stock per value added from 1998-2008



The R&D investment rate has stayed around 6% (figure 2) and the R&D capital stock at around 29% of value added (figure 3). The organizational investment and organizational capital stock shares have been of the same magnitude, according to the performance-based approach. Organizational investment and capital shares are found notably lower using the expenditure-based approach. ICT capital is concentrated in business equipment, finance, healthcare and telecommunication with ICT capital being 3.4% of value added [8]; and over the entire private sector, the average investment share is around 1% of value added. Adding

[8] Industries include computers, software, and electronic equipment; finance; healthcare, medical equipment, and drugs; and telecoms, telephone and TV transmission

all of these together provides our estimated share of intangible investment at 19% of valued added, leading intangible capital to be 60% of valued added using the performance-based approach towards organizational capital. The intangible capital stock share has hovered around the same level. Investment in intangibles has not compensated for the decrease in net plant, property and equipment.

4. Intangible capital and market value

Market approach evaluates how intangibles enter into the valuation of the firm based on future expected performance. This gives support for performance-based valuation if intangibles are valuable far beyond what is suggested by assessing expenditures. It appears from many studies (e.g., Brynjolfsson, Hitt, and Yang, 2002) that the value of intangibles materializes over a longer period, especially in areas such as business organization, which are disproportionately important for ICT-intensive firms. In Van Bekkum (2008), most of the positive effect of selling, general and administration (SGA) on growth value stems over a longer period from services such as business equipment, finance, and healthcare. Market valuation models are also able to account for these long-term productivity effects. We already know from the productivity analysis and from Ilmakunnas and Piekkola (2010), using essentially the same data, that intangibles increase productivity more than wage expenditures, thus improving profitability.

Lev and Radhakrishnan (2003 and 2005) use intangibles-related work as an instrument to explain sales growth in yearly industry-level estimates using the two-stage least squares (2SLS) method. They find that annual measures of organizational/intangible capital predict the market value of the firm well in advance. Their proxy for organizational capital (selling, general and administration expenditures) has a high correlation of 0.96 to sales. Consistent with the q-theory, we use replacement values and thus expenditure-based estimates in our calculations for intangible costs. The model incorporates the forecasts by economic analysts using a residual income valuation model that has been further improved by Ohlson (1995). Intangible capital can potentially explain the weak relationship found between value changes and accounting information as recorded in many studies starting with Lev (1989). Market value is equal to the present value of future dividends:

$$MV_{it} = \sum_{\tau=1}^{\infty} \frac{E_t(DIV_{it+\tau})}{(1+r_i)^{\tau}}, \qquad (11)$$

where MV_{it} is the market value of equity at time *t*, DIV_{it} is the dividends received at the end of period *t*, r_i is the discount rate, and E_t is the expectation operator based on the information set at date *t*. Let BV_{it} = the balance-sheet value of assets including non-recorded intangibles (minus liabilities); we use information on capitalized assets. The clean surplus relation reads as

$$BV_{it} = BV_{it-1} + FE_{it} - DIV_{it}, \qquad (12)$$

where FE_{it} is the analysts' forecast one year ahead of earnings for a period ending at date *t*. We next use equations (11) and (12) and write the market value as a function of book value, discounted expected abnormal earnings, and intangible capital:

$$MV_{it} = BV_{it} + RE_{it}, \qquad (13)$$

where $RE_{it} = \sum_{\tau=1}^{\infty}(1+r_i)^{-\tau}[FE_{it} - r_i BV_{it-1}]$ is the present value of abnormal earnings at the end of year *t* extrapolated to infinity. With the assumption that the total capital stock grows at a rate of less than $1+r_i$, so that $(1+r)^{-\tau} E_{t+\tau}(B_{it+\tau}) \to 0$, the residual earnings can be written as

$$\begin{aligned} RE_{NPVit} = (1+r_{it})^{-1}\left[FE_{it+1} - r_i BV_{it}\right] + \\ \left[FE_{it+2} - r_i BV_{it+1}\right]/(r_i - g_i)^{-1}(1+r_i)^{-2}, \end{aligned} \qquad (14)$$

where g_{it} is the growth rate of abnormal earnings, which is set at r_{it} minus 3%. In empirical estimates, the discount rate r_{it} is the sum of the return on government bonds for the shortest period available (five years) and the systematic risk 1 - beta. The beta in the risk premium is estimated using the capital asset pricing model for the companies listed on the Finnish stock market. Thus, the beta for each year is estimated using observations from the preceding 60 months. The data used include all of the companies listed on the Helsinki stock market during the period. To obtain a reasonable value in the volatile Helsinki stock market, the systematic risk (one minus beta) is scaled down so that on average, the discount rate on corporate bonds is twice the average return on government bonds (which is 4.5%). We follow the typical linear market value model applied by Hall, Thoma, Rorrisi (2007), among others. Bresnahan, Brynjolfsson, and Hitt (2000) have found certain organizational practices combined with investments in information technology to have been associated with significant increases in productivity in the late 1980s and early 1990s. We combine organizational and ICT capital within the firm because these have been found in the literature to be strongly complementary. The firm's assets enter additively, so we may write the estimable function under constant returns to scale $\sigma = 1$ as

$$\begin{aligned} MV_{it} &= q_t^e \left(1 + F_{it}\right) \left[\gamma_{RE} RE_{it} + K_{it} + \sum_{IC} \gamma_{IC} K_{IC,it} \right]^{\sigma} \\ &= q_t^e \left(1 + F_{it}\right) K_{it} \left(1 + \gamma_{RE} RE_{it} / K_{it} + \sum_{IC} \gamma_{IC} K_{IC,it} / K_{it} \right)^{\sigma}, \end{aligned} \tag{15}$$

where K_{it} is physical capital, $K_{IC,it}$ is intangible capital divided by the sum of organizational and ICT capital (OCICT) and R&D capital (R&D) and F_{it} is the share of employment abroad. The expected share price q_t^e is the average Tobin's q, or ratio of market value to the replacement cost of the firm based on the share price in previous period. Note that the investment decision for period t depends on the expected evolution of abnormal earnings, and this information has a direct bearing on market values, too. The formulation tests whether this standard economic analysis fully accounts for the intangible capital investment decision. γ_{RE}, γ_{IT} are the respective marginal values to physical capital at a given point and to the extent that economic forecasts have not fully accounted for the marginal value of intangibles. The abnormal earnings thus capture how well the standard analysis is able to predict the future evolution of capital formation. A second novelty here is to account for the globalization and increased activities abroad. Employment at domestic plants has remained at about half a million in our data, while employment abroad has expanded from 137,000 in 1996 to nearly 400,000 by 2006, according to data from the Bank of Finland on foreign direct investment. Most of this internationalization is conducted by the listed firms that are included in our analysis. Thus, a substantial part of the tangible and intangible capital invested abroad may not enter balance sheets that are based on operations at home.

Following the usual analysis, we define Tobin's q with respect to physical capital. We estimate in logarithmic form but similarly to Hall et al., and in contrast to some of the earlier approaches, we do not use the approximation $\log(1_{it} + \gamma K_{IC,it} / K_{it}) \approx \gamma K_{IC,it} / K_{it}$, $IC = OCIT, RND$ because intangibles are a notable share of all capital. The same applies to the employment abroad share, as the ratio has increased from less than 10% to about 90% in firms listed in the Helsinki stock market. Rearranging and taking the log yields

$$\ln Q_{it} = \ln q + \ln[1 + \gamma_{RE} \frac{RE_{it}}{K_{it}} + \sum_{IC} \gamma_{IC} \frac{K_{IC,it}}{K_{it}}] + \ln[1 + F_{it}], \tag{16}$$

where $Q_{it} \equiv MV_{it} / K_{it}$ is Tobin's q. The intercept $\ln q$ represents the average logarithm of Tobin's q of current total capital stock when the future evolution of assets, as expected by standard economic analysis, is captured by abnormal profits (zero for Tobin's q equal to one). $q\gamma_{OCIT}$ and $q\gamma_{RND}$ are the absolute hedonic prices of the respective intangible capital components. The estimable equation is

$$\ln Q_{it} = \ln q + \ln[1 + \gamma_{RE} \frac{RE_{it}}{K_{it}} + \sum_{IC} \gamma_{IC} \frac{K_{IC,it}}{K_{it}}] + \log[1 + F_{it}] + D_{jt} + e_{it}, \tag{17}$$

where D_{jt} includes year and industry dummies and four firm-size dummies. We can now test the extent to which financial analysts comprehend the value and profit implications of organizational capital in their analyses and consequent earnings forecasts. Table 5 shows the summary table first.

Table 5. Summary of variables

Variable	Mean	Standard Deviation	Median Value
Market Value (€ 1 million)	41344	63343	7610
Analyst forecast profits March (€ million)	2017	2263	634
Book value (net of liabilities) (€ million)	12848	12008	8747
Abnormal earnings (€ million)	1212	4551	2383
Net Plant, Property, Equipment (€ million)	878	1045	611
Fixed asset (€ million)	5218	4453	4059
Market value/Fixed asset	6.2	7.2	1.5
OC and ICT capital stock (€ million)	192.0	199.0	90.0
R&D capital stock (€ million)	1027	1223	113
Abnormal earnings/Fixed asset	24 %	2.20	47 %
OC and ICT capital stock/Fixed asset	6 %	0.093	4 %
R&D capital stock/Fixed asset	23 %	0.29	10 %
Employment abroad share	48 %	0.24	56 %

The companies typically operate on a global scale and are large in size. It is apparent that in the 65 firms observed, the median market value is close to the median book value less liabilities. Net plant, property and equipment account for about a 15% share of total fixed assets. Abnormal earnings are on average positive, which is partly explained by intangibles insufficiently recorded in balance sheets. The median share from fixed assets is 4% for the sum of organizational and ICT capital and 10% for R&D capital. We use non-linear estimates controlling for firm size (four size categories) and industries (four industries). We also show the elasticities with respect to Tobin's q as given by

$$\frac{\partial \ln q_{it}}{\partial \ln x_{it}} = \frac{\gamma_x \frac{K_{x,it}}{K_{it}}}{1+\gamma_{RE}\frac{RE_{it}}{K_{it}}+\gamma_{OCIT}\frac{K_{OCICT,it}}{K_{it}}+\gamma_{RND}\frac{K_{RND,it}}{K_{it}}}, \tag{18}$$

where $x_{it} = \gamma_{RE} RE_{it} / K_{it}, \gamma_{OCIT} K_{OCICT,it} / K_{it}, \gamma_{RND} K_{RND,it} / K_{it}$. Table 6 shows the regression results and the corresponding elasticities between Tobin's q and intangibles.

The model explains around 45% of the variation in net profits. R Squared would be 15% lower ignoring intangibles (not shown). Intangible capital has a strong effect on market valuation. The elasticity with respect to market value is around 0.65 for OC and ICT capital and 0.5 for R&D capital, which is not very sensitive to the inclusion of abnormal earnings (columns 1 and 2). It is safe to say that intangibles have strong predictive power for market value and are in excess of that explained by standard economic analysis. A 10% increase in intangibles, whether as the sum of organizational and ICT capital or RND capital, increases market value by about 5-6.5% beyond that explained by economic forecast.

In contrast to Cummins (2005), we find that appreciable intangibles are also associated with R&D capital in the total sample. R&D investments are more important in high-market value firms that are closer to the economic frontier. Firms close to the frontier have to invest more into R&D in order to maintain the technology advantage and to keep the marginal returns high. It is also seen that globalized firms have been successful in increasing their market values. Increasing employment abroad by 10% increases market value by the same magnitude, but this only holds for non-manufacturing firms.

Table 6. Non-linear estimates for organizational capital and intangible capital in explaining market value

	1	2	3 High MV	4 Low MV	5 Manu-facturing	6 Non-manu-facturing
Constant (average log Tobin's q)	-0.208	-0.572**	-0.185	-0.186	0.346	-0.275
	(1.04)	(2.68)	(0.71)	(0.7)	(1.42)	(0.88)
Abnormal earnings/ fixed capital	0.102***		0.0630**	0.0635**	0.163***	0.0707**
	(7.2)		(2.97)	(2.92)	(8.3)	(3.22)
OC and ICT capital / fixed capital	12.49***	21.69***	15.73***	15.93***	8.430***	6.995**
	(5)	(5.05)	(4.02)	(3.95)	(3.7)	(2.63)
R&D capital / fixed capital	1.004**	1.305*	1.202**	1.212*	6.551***	0.877*
	(2.84)	(2.37)	(2.6)	(2.56)	(5.51)	(2.28)
Employment abroad share	1.423***	1.834***	1.126**	1.145**	0.212	2.664***
	(4.55)	(4.94)	(3.16)	(3.12)	(1.16)	(3.38)
Observations	626	626	320	309	304	322
R Squared total	0.47	0.42	0.57	0.55	0.66	0.43
Average elasticity and standard errors using "delta" method						
Abnormal earnings/ fixed capital	0.501		0.501	0.501	0.502	0.501
	(0)		(0)	(0)	(0)	(0)
OC and ICT capital / fixed capital	0.649	0.680	0.660	0.661	0.593	0.613
	(0.015)	(0.015)	(0.017)	(0.018)	(0.018)	(0.024)
R&D capital / fixed capital	0.513	0.512	0.513	0.513	0.573	0.515
	(0.004)	(0.005)	(0.005)	(0.005)	(0.013)	(0.006)

Non-linear estimates with robust t-statistics in parentheses. Estimation includes four firm size dummies, year and four industry dummies. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5. Conclusions

Intangibles have increased in importance during the globalization process. The estimates obtained on the national level indicate that the share of intangible investment from GDP is around 7% for Finland or as found in Jalava, Aulin-Ahmavaara and Alanen (2007), 15% from private sector value added. In our estimates, the own-account intangibles share of value added is 9% according to the expenditure-based approach but is found to be twice that in a performance-based evaluation of organizational capital. The performance-based approach receives considerable support from the market valuation model. Therefore, the intangible investment level is likely to be higher than the expenditure-based national estimates imply.

The performance-based evaluation of management and marketing shows that R&D capital and organizational capital stocks are nearly equal, at around 26-28% of value added. Intangible capital has accounted for around 60% of value added in the economy. However, the increase in the intangible capital has not compensated for the decrease in other machinery and equipment (net plant, property and equipment), which have decreased in 1998-2007 from 85% to 60% of value added.

Intangible capital is an important missing factor in q-theory. Intangible capital stock explains the unexplained variation in the market value of firms listed on the Helsinki stock market during 1998–2007. Intangibles give valuable information regarding future performance, not only for high-market value firms. Bloom, Sadun, and Van Reenen (2007) emphasize the importance of organizational capital to productivity growth in services, but intangible capital is equally important in manufacturing. A 10% increase in intangibles, whether as the sum of organizational and ICT capital or of RND capital, increases the firm's market value about 6% beyond that explained by economic forecast.

Taking into account intangible capital abroad or outside Europe has also had a significant effect in the evolution of market value, national measures of intangibles cannot capture the globalization effects. Future research should further develop performance-based methodologies and market valuation models that are better adapted to the firm-level evaluation of intangibles under the pressures of globalization.

Bibliography

Abowd, J.M., F. Kramarz, and D.N. Margolis. 1999. High Wage Workers and High Wage Firms. *Econometrica* 67, no. 2: 251-333.

Bartel, A.P. and F.R. Lichtenberg. 1987. The Comparative Advantage of Educated Workers in Implementing New Technology. *Review of Economics and Statistics* 69: 1-11.

Bloom, N., R. Sadun, and J. Van Reenen. 2007. Americans Do I.T. Better: US Multinationals and the Productivity Miracle, CEPR Discussion Paper no. 6291, Centre for Economic Policy Research, London.

Bresnahan, T.F. and S. Greenstein. 1999. Technological Competition and the Structure of the Computer Industry. *Journal of Industrial Economics* 47, no. 1: 1-40.

Bresnahan, T.F., E. Brynjolfsson, and L.M. Hitt. 2000. Technology, Organization, and the Demand for Skilled Labor. In *The new relationship: Human capital in the American corporation* ed. M.M. Blair and T.A. Kochan. Washington, D.C.: Brookings Institution Press: 145-184.

Brynjolfsson, E., L.M. Hitt, and S. Yang. 2002. Intangible Assets: Computers and Organizational Capital. Brookings Papers on Economic Activity, no. 2002-1, Brookings Institution, Washington, D.C.: 137-181.

Corrado, C., Hulten, C., and Sichel, D. 2005. Measuring capital and technology: An expanded framework. In *Measuring Capital in the New Economy, Studies in Income and Wealth,* ed. C. Corrado, J. Haltiwanger, and D. Sichel. Chicago: The University of Chicago Press.

Corrado, C., Hulten, C., and D. Sichel. 2006. Intangible Capital and Economic Growth. National Bureau of Economic Research Working Paper no. W11948. Cambridge, MA: National Bureau of Economic Research.

Cummins, J. 2005. A new approach to the valuation of intangible capital. In *Measuring Capital in the New Economy* ed. C. Corrado, J. Haltiwanger and D. Sichel. National Bureau of Economic Research, Studies in Income and Wealth 65. Chicago: University Chicago Press: 47-72

Blundell, R. and S. Bond. 1998. Initial Conditions and Moment Restrictions in Dynamic Panel Data Models. *Journal of Econometrics* 87, 115–143.

Evenson, R.E., L.E. Westphal, J. Behrman, and T.N. Srinivasan. 1995. Technological Change and Technology Strategy. In Handbook of Development Economics IIIA, ed. J. Behrman and T.N. Srinivasan. Amsterdam, New York and Oxford: Elsevier Science, North Holland: 2209-2299.

Fama, E.F. and J.D. MacBeth. 1973. Risk, Return, and Equilibrium: Empirical Tests. *Journal of Political Economy* 81, no. 3: 607-636.

Fama, E.F. and K.R. French. 1988. Permanent and Temporary Components of Stock Prices. *Journal of Political Economy* 96, no. 2: 246-273.

———————. 1997. Industry Costs of Equity. *Journal of Financial Economics* 43, no. 2: 153-193.

Giorgio Marrano, M. and J. Haskel. 2006. How much Does the UK Invest in Intangible Assets, Department of Economics Working Paper no. 578, Queen Mary, University of London.

Griffith, R., S. Redding, and J. Van Reenen. 2004. Mapping the Two Faces of R&D: Productivity Growth in a Panel of OECD Countries. *Review of Economics & Statistics* 86, no. 4: 883-895.

Hall, R.E. 2000. E-Capital: The Link between the Stock Market and the Labor Market in the 1990s. Brookings Papers on Economic Activity, no. 2000-2, Brookings Institution, Washington, D.C.: 73-102.

Hall, R.E., Thoma G., and S. Torrisi. 2007. The Market Value of Patents and R&D: Evidence from European firms. NBER Working Paper no. 13426.

Hellerstein, J.K., D. Neumark, and K.R. Troske. 1999. Wages, Productivity, and Worker Characteristics: Evidence from Plant-Level Production Functions and Wage Equations. *Journal of Labor Economics* 17, no. 3: 409-446.

Huttunen, K. 2007. The Effect of Foreign Acquisition on Employment and Wages: Evidence from Finnish Establishments. *Review of Economics and Statistics* 89, no. 3: 497-509.

Ilmakunnas, P. and M. Maliranta. 2005. Technology, Worker Characteristics, and Wage-Productivity Gaps. *Oxford Bulletin of Economics and Statistics* 67, no. 5: 623-645.

Ito, T. and A.O.E. Krueger. 1996. Financial Deregulation and Integration in East Asia. In NBER-East Asia Seminar on Economics 5, Chicago and London: University of Chicago Press.

Jalava, J. Aulin-Ahmavaara P., and A. Alanen. 2007. Intangible Capital in the Finnish Business Sector. ETLA, Discussion Papers no. 1103.

Jorgenson, D.W. and B.M. Fraumeni. 1992. Investment in Education and U.S. Economic Growth. *Scandinavian Journal of Economics* 94: 51-70.

Jorgenson, D.W., Z. Griliches, and M.D. Intriligator. 1986. Econometric Methods for Modeling Producer Behavior. In Handbook of Econometrics, Volume 3, ed. Z. Griliches, and M.D. Intriligator. Amsterdam; Oxford and Tokyo: North-Holland; distributed in the US and Canada by Elsevier Science, New York: 1841-1915.

Lev, B. 1989. On the Usefulness of Earnings and Earnings Research: Lessons and Directions from Two Decades of Empirical Research. *Journal of Accounting Research* 27: 153-192.

Lev, B. and S. Radhakrishnan. 2003. The Measurement of Firm-Specific Organization Capital, NBER Working Paper no. 9581.

———————. 2005. The Valuation of Organizational Capital. In Measuring Capital in the New Economy ed. C. Corrado, J. Haltiwanger and D. Sichel. NBER Studies in Income and Wealth 65, Chicago: University Chicago Press: 73–99.

Ohlson, J. 1995. Earnings, Book Values and Dividends in Equity Valuation. *Contemporary Accounting Research* 11, no. 2: 661–687.

Olley, G.S. and A. Pakes. 1996. The Dynamics of Productivity in the Telecommunications Equipment Industry. *Econometrica* 64, no. 6: 1263-1298.

Piekkola H., Görzig, B., and R. Riley. 2010. Production of own account intangible investment: Methodology in Innodrive project. Innodrive Working Paper No 1.

Subramaniam, M. and M. Youndt. 2005. The influence of intellectual capital on the types of innovative capabilities. *Academy of Management Journal* 48: 450-463.

Van Bekkum, S. 2008. Do Intangible Investments Create Value? Comparing Capitalization Rates of Listed Firms, Economics Program Working Paper no. 08-05, Conference Board, New York, NY.

Youndt, M., M. Subramaniam, and S. Snell. 2004. Intellectual Capital Profiles: An Examination of Investments and Returns. *Journal of Management Studies* 41, 335-61.

Yasar, M., R. Raciborski, and B. Poi. 2008. Production Function Estimation in Stata using the Olley and Pakes Method. *Stata Journal* 8 no. 2: 221-231.

Appendix A. Occupational classification of non-production workers

	Occupation of non-production worker	Organizational worker	R&D worker
Manufacturing	Management	Management	
	R&D		x
	R&D superior		x
	Supply transport non-prod		
	Supply transport non-prod superior		
	Computer		
	Computer superior		
	Safety quality maintenance non-prod		
	Marketing purchases non-prod	Marketing	
	Marketing purchases non-prod superior	Management	
	Administration non-prod	Administration	
	Administration non-prod superior	Administration	
	Finance admin non-prod		
	Finance admin non-prod superior	Management	
	Personnel management non-prod	Administration	
	Cleaner, garbage collectors, messengers		
Services	Media		
	Computer processing services		
	Computer processing services superior		
	Salesperson contract work services		
	Warehouse transport services		
	Maintenance gardening forest services		
	Teacher, counceling, social science professionals		
	Hotel restaurants		
	Hotel restaurants superior		
	Social and personal care		
	Health sector		
	Forwarder services		
	Purchases and sales services		
	Insurance worker		
	Insurance worker superior		
	Small business manager		
	Finance services		
	Finance services superior	Management	
	Marketing services		
	Marketing services superior	Marketing	
	R&D worker services		x
	Personnel project manag services	Administration	
	Personnel project manag services superior	Management	
	Administration services		
	Administration services superior	Management	

non-prod=non-production, admin=administration.

Appendix B. Summary of Variables and Correlations

Table B.1 Summary of variables

Variable	Mean	Std	Median	Obs
Value added factor prices	16489	78438	3460	20115
Operating revenue / Turnover	64175	583169	9710	20115
Sales Growth	0.038	0.35	0.028	17765
Employment	214	820	52	20115
Employees in organizational work	18	108	2	20115
Organizational worker share	8.5 %	0.14	3.3 %	20114
Organizational compensation	1198	7751	135	20115
Organizational compensation per value added	6.0 %	0.0027	6.0 %	20115
Management compensation	569	5398	56	20115
Management personnel	9.2	70	1	20115
Marketing, purchases compensation	361	2256	0	20115
Marketing personnel	8.7	53	0	20115
ICT compensation	937	14227	0	20115
ICT personnel	9573	100499	922	10675
R&D compensation	263	2545	0	20115
R&D capital	5.7	54	0	20115
Net plant, property, equipment	17061	125785	1083	20115
Material	5760	30070	726	20115

UNIVERSITY OF VAASA

DEPARTMENT OF ECONOMICS
WORKING PAPERS

1. PETRI KUOSMANEN & JUUSO VATAJA (2002). Shokkien välittyminen asunto- ja osakemarkkinoilla. 46 s.
2. PETRI KUOSMANEN (2002). Asunto- ja osakesijoitukset optimaalisessa portfoliossa. 30 s.
3. HANS C. BLOMQVIST (2002). Extending the second wing: the outward direct investment of Singapore. 20 s.
4. PETRI KUOSMANEN (2005). Osakemarkkinoiden korkoherkkyys Suomessa. 20 s.
5. PETRI KUOSMANEN (2005). Osakemarkkinat ja talouskasvu Suomessa 21 s.
6. JUUSO VATAJA (2005). Finland's macroeconomic development in EMU. Some initial experiences. 16 s.
7. JUUSO VATAJA (2005). Initial economic experiences in EMU – the case of Finland. 26 s.
8. HANNU PIEKKOLA (2007). Actuarial fair pension reform: Postponed retirement and redistribution of pension wealth – Evidence from Belgium, Finland, Germany and Spain. 46 s.
9. HANNU PIEKKOLA (2008). Kilpailukykyä tiedosta ja taidosta. Virkaanastujaisesitelmä. 18 s.
10. PETRI KUOSMANEN & JUUSO VATAJA (2008). The role of stock markets vs. the term spread in forecasting macrovariables in Finland. 31 s.
11. MERVI TOIVANEN (2009). Financial interlinkages and risk of contagion in the Finnish interbank market. 39 s.
12. MIKKO LINTAMO (2009). Technical change and the wage-productivity gap for skills: A comparative analysis between industries. 33 s.
13. HANNU PIEKKOLA (2009). Intangibles: Can they explain the unexplained. 38 s.
14. PEKKA ILMAKUNNAS & HANNU PIEKKOLA (2010). Intangible investment in people and productivity. 44 s.
15. HANNU PIEKKOLA (2010). Intangibles: Can they explain the unexplained? Revised version. 32 s.

ISBN 978–952–476–329–5