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DEPARTMENT OF ECONOMICS
WORKING PAPERS 13

Hannu Piekkola

Intangibles: Can They Explain the Unexplained

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TABLE OF CONTENTS

1. INTRODUCTION 3

2. INTANGIBLE CAPITAL COMPONENTS AND DATA 4

3. ESTIMATION 9

4. INTANGIBLE CAPITAL, GLOBALIZATION, AND INFORMATION TECHNOLOGY 18

5. INTANGIBLE CAPITAL AND MARKET VALUE 22

6. CONCLUSIONS 27

BIBLIOGRAPHY 28

APPENDIX A. OCCUPATIONAL CLASSIFICATION OF NON-PRODUCTION WORKERS 32

APPENDIX B. SUMMARY OF VARIABLES AND CORRELATIONS 33

APPENDIX C. INDUSTRY CLASSIFICATION 35

APPENDIX D. LEV AND RADHAKRISHNAN'S EVALUATION OF INTANGIBLE CAPITAL 36

APPENDIX E. INTANGIBLE CAPITAL AND ASSET VALUES IN SELECTED FIRMS IN HELSINKI STOCK MARKET 39

ABSTRACT

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Intangible capital is embedded in the firm in running the business and in developing innovations. As part of a firm's intangible assets, organization capital is measured through marketing, administration, and management activity and by accounting for differences in productivity compared with other work. In this paper, intangible capital – organization capital along with ICT personnel, and R&D assets – are shown to explain the evolution of earnings and also the unexplained part of market value of firms. Intangible capital estimates are higher than those obtained in national-level approaches.

JEL classification: M40, J30, O30, M12, J62

KEYWORDS: Intangible capital, R&D, market valuation, linked employer-employee data

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1. Introduction

Economies today are facing a second wave of globalization, characterized by specialization in tasks and inter-industry trade (Baldwin, 2006). Intangible capital is the binding factor for maintaining the global network of production and marketing. It includes organization-related codified code, which makes it tacit and not directly transferable to other firms (Evenson et al., 1995). Prescott and Visscher (1980) introduced "organization capital" as the management-related abilities entailed in assessing the performance of the firm's personnel in improving matches between employees and jobs, working in teams and the human capital of the firm's employees. This broad definition emphasizes organization capital in people. Harvey and Novisevic (2005) also emphasized the managerial competencies appropriate for competing in a global context. Employees engaged in marketing are similarly at the core of organization capital as evidenced by Miyagawa and Kim (2008). Organization work connected with top management, marketing, and administration has become among the most highly rewarded, but influences book values predominantly only in mergers.

Ito and Krueger (1996) and Bresnahan and Greenstein (1999) suggest that organization capital complements investments in information, communications, and technology (ICT) and that it typically exceeds the direct financial costs of the ICT investments themselves. Brynjolfson, Hitt, and Yang (2002) argue that their reported large returns on ICT investments are largely explained by a relationship between the utilization of IT and skilled workers on the one hand, and human resource management on the other (with a greater decentralization of certain decision rights and team-oriented production). National accounts include software and databases using often ICT-related work expenditures as proxies for it, which is here referred to as 'ICT personnel assets'. Finally, we come to R&D expenditures, the first recognized type of intangible capital to be included in the satellite accounting of GDP by the OECD.

In this paper intangibles are also valued in terms of how they influence firm performance and it is shown that they also explain the unexplained part of firm's market value in market valuation models. In our analysis of Finnish firms over the period 1995–2006 we model the

firm's output as a function of physical capital, labor, with organizational work augmenting labor input and R&D assets (representing scientific innovative activities). In explaining asset productivities, we measure the relative productivity of organizational work. Hellerstein, Neumark, and Troske (1999) and Ilmakunnas and Maliranta (2005) analyze skill-adjusted labor input when the education and work experience of employees have differing marginal productivities while being perfect substitutes. We separate the productivity of organizational work from other kinds of work. ICT personnel assets and R&D assets are calculated using traditional measures with predetermined depreciation rates.

We also use compensation for organizational work as an instrument to explain sales growth in yearly industry-level estimates, using two-stage least squares (2SLS). In this alternative approach, Lev and Radhakrishnan (2003 and 2005) find that annual measures of organization/intangible capital predict market values of the firm well in advance. We similarly evaluate how measured intangible capital explains the market value over book value, beyond that explained by analysts' economic forecasts for the firms listed on the Helsinki stock exchange. We find organization capital to be industry-specific, supporting our estimation strategies. Intangibles are on average equivalent in value to around 24% of sales or more in global firms.

Section 2 of the paper discusses the composition of intangible capital and presents the data. The estimation and calculation of intangible capital is done in section 3. Section 4 analyzes intangibles as part of the globalization process. Section 5 incorporates intangible capital in a valuation model with evidence on its usefulness in some industries. Section 6 concludes the paper.

2. Intangible capital components and data

Intangible capital is usually measured at the national level and incorporates the values of entire sectors, such as financial services, the entertainment industry or computer software. We primarily measure a firm's own intangible capital. The classification given by Corrado, Hulten, and Sichel {Corrado, 2005 #725} to measure intangible capital at the national level is

shown in the first column of Table 1. The right column shows the firm-level approach, tracking similar categories.

Table 1. Intangible capital in the knowledge economy

Intangible Capital	
Corrado-Hulten-Sichel (2005)	Own Categories
Economic Competencies	
1) Brand Equity:	1) Organization capital
- Advertising	-Management
- Market Research	- Marketing
2) Firm-specific resources:	
- Firm-specific human capital (e.g. training)	
- Organization structure (e.g. management)	
Innovative Property	
1) Scientific research & development	1) Scienfific research & development
2) Non-scienfific research & development	
- R&D in social science and humanities	
- Mineral exploration	
- New motion picture films and other forms of entertainment	
- New architectural and engineering design	
- New product development in financial industry	
Digitalized information - ICT capital	
1) Software	1) ICT personnel assets
2) Database	

Sources: Corrado, Hulten, and Sichel (2005) and author's data.

Organization capital or firm-specific capital and organization structure are at the core of the economic competence category in Corrado, Hulten, and Sichel. This category includes the competence of the top management and that for human resources, as well as the marketing and selling efforts. The organizational structure for a firm's own account in Corrado, Hulten, and Sichel (2005) is measured by a predetermined share of management expenditures (20%) in the business sector. It also includes as firm-specific capital the training provided by the employer. Such information is provided by surveys. Market research activities in Corrado,

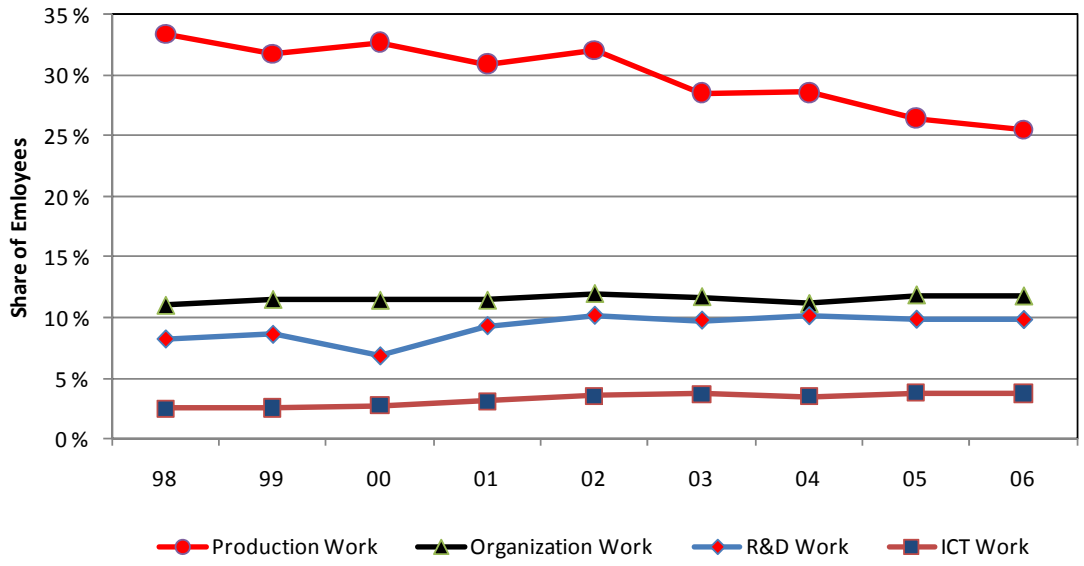
Hulten, and Sichel (2005) are measured by the size of the marketing industry in System of National Account; or in a study of the UK, Marrano and Haskel (2006) using private sources from media companies. We use compensation for marketing workers as well as for management as an instrument for the assessment of organization capital. Following Hellerstein, Neumark, and Troske (1999), we allow for the productivity of these organizational workers to differ from the average, which is taken into account in the valuation of organization capital. We also use selling, general, and administrative (SGA) expenses as an alternative instrument in a limited sample, where Anglo-American style operation-based accounts are available.

Scientific innovation capital is a category of its own, in which we only include R&D investment. For ICT capital, Corrado, Hulten, and Sichel include software and hardware expenditures that are currently recorded in national statistics. Brynjolfson, Hitt, and Yang (2002) refer to case studies indicating that computers and software are just the tip of the iceberg of the implementation costs of IT. We measure R&D and ICT assets based on compensation for R&D and ICT work, and adjust R&D total investment for its presumed 80% labor compensation share. It is noteworthy that software and database expenditures are in national statistics also often evaluated based on employment compensations on ICT work.

We use linked employer–employee data, which has been extensively utilized in the study of human capital formation starting with Abowd, Kramarz, and Margolis (1999). These data are convenient 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 7.2 million person-year and 44,816 firm-year observations for the years 1996–2006. The data include a rich set of variables covering compensation, education, and profession in business sector. Non-production employees receive salaries and production workers, 42% of all workers, receive an hourly wage. Employee compensation is evaluated from 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 Employers and is available for all employees in the firms considered (see Appendix A). 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 organization capital: management, marketing, and administrative work by those with tertiary education. We end up with 41 non-production worker occupations, which are listed in Appendix A. Following Figure 1 shows the share of workers in work related to production and intangible capital.

Figure 1. Share of private-sector employees engaged in work related to production and intangible capital in Finland (1998–2006)



The share of R&D workers is around 10% and the share of ICT workers is 3%, a share that has increased over time. 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). Half of all R&D workers do not have tertiary education. The share of those with tertiary education would not be too far from the 3.1% share reported by Statistics Finland. Figure 1 excludes non-production workers that are not engaged in intangible capital creation covering over 30-35% of the workforce. The share of production workers has fallen by a substantial amount from 33% to 25% (half of the employees in the data work in manufacturing).

Management (6.5%) and marketing (5.0%) are the main categories of organizational work. The share of organizational workers has stayed relatively the same at around 11% of employees. Hence, much of the increase in highly educated employment in the entire economy has taken place in the public sector, which is not considered here. The INNODRIVE project reveals that the share of personnel engaged in organizational work (management and marketing) is nearly the same in six European countries in the business, ranging between 16% in the Finland, 14% in the UK and 13%-18% in the Czech Republic and Slovenia). The share of management varies is around 6% Analyzing management expenses alone – as done in national measures of intangible capital – and ignoring marketing may offer a less comparable basis for an analysis of firm-specific resources or organization capital across countries. In the six European countries, the relative wage structure is also nearly the same. Management compensation is followed by compensation for ICT work and R&D in the same order.[1]

Employee data are linked to financial statistics data provided by the Suomen Asiakastieto [2], to include information on profits, value added, and capital intensity (fixed assets). To eliminate firms with unreliable balance sheets, we include in the analysis only firms that have on average at least 30 employees and real sales exceeding €2 million (in 2000 consumer prices CPI). The final linked employer–employee data of 2.08 million person-year observations cover 11,025 firm-year observations after dropping the years 1996–97 (used to build up R&D assets and ICT personnel assets). The employee data in the sample cover 287,160 employees annually on average (the original employee data cover 465,000 employees) and hence one-fourth of the entire workforce in the respective private sector.

Appendix B shows the summary of the rest of the variables in the estimation sample. Average sales are €84 million and average sales growth has been a rapid 4.2%. Appendix B reveals that organizational compensation is are of the same magnitude than that of R&D compensa-

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

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

tion, while the median compensation is higher. R&D work has more skewed distribution than organization work. Organization workers are on average 16% of all workers, while the median value is 9.6%. Over half of the firms have no ICT personnel (median is one worker). The final data on over 1,8556 firms also include the relatively low share of 86 firms that report operation-based balance sheets and notably SGA. Selling and administrative expenditures are on average nearly 31% of turnover, but the median value is less than 10% (in contrast to 17.5% in Lev and Radhakrishnan 2005). Some 40% of this relates to administration.

3. Estimation

Following Hellerstein, Neumark, and Troske (1999), we apply a constant returns-to-scale production function, where labor input is quality adjusted:[3]

$$SALE_{it} = b_{0it}(Q_{it}L_{it})^{b1} R\&D_{it}^{b2} PPE_{it}^{b3} M_{it}^{b4} \exp(e_{it}), \qquad (1)$$

where $SALE_{it}$ is the turnover of firm i in year t, $Q_{it}L_{it}$ is the labor quality input (L is total number of employees), $R\&D_{it}$ is plant-specific R&D capital, PPE_{it} is net plant, property, and equipment, M_{it} is material and e_{it} is an error term. Note that the specification imposes higher returns to an additional investment in R&D capital at low levels of it. It is therefore appropriate to have a wide definition of R&D occupations. Labor L_{it} is measured measured by units and not by total hours, which would include overtime hours for production workers. The regular weekly working hours for non-production workers have a low variation, while overtime hours of production workers would increase the sensitive of our measurements to productivity shocks. Because of the ambiquity in the measurement of valued added in services, we rather use turnover as our explanatory variable and use materials M_{it} as our additional control. We separate the labor input of organizational workers. We divide workers into two

[3] Caves and Barton (1990) and Jorgenson, Griliches, and Intriligator (1986) give details on estimating firm production functions with fixed effects.

categories, with the labor input of those that are not organization capital workers as the reference:

$$\begin{aligned} Q_{it}L_{it} &= aOC_{it} + (L_{it} - OC_{it}) \\ &= L_{it}\left[1 + (a-1)\frac{OC_{it}}{L_{it}}\right] \end{aligned}, \qquad (2)$$

where OC_{it} is the total number of organizational workers at the plant. OC_{it} relate to management and marketing. Here we allow for the productivity of organizational workers to differ from the average by factor a. In log form, we can approximately write $\log\left[1+(a-1)\frac{OC_{it}}{L_{it}}\right] \approx (a-1)\frac{OC_{it}}{L_{it}}$, since organizational workers are 18% of total workers and we are measuring relative productivity (so that the second term in squared brackets is not too far from zero). Hence, the estimable production function can be written as

$$\begin{aligned} \ln SALE_{it} = b_0 + b_1 \ln L_{it} + c_1 \frac{OC_{it}}{L_{it}} + b_2 RND_{it} \\ + b_3 PPE_{it} + b_4 M_{it} + b_{jt5}[Year] * IND_{jt} + e_{it} \end{aligned}, \qquad (3)$$

where $c_1 \equiv b_1[a-1]$, $b_{jt5}[Year] * IND_{jt}$ stands for the year t and industry j dummies and their interactions and e_{it} is the residual error. Thus, the additional value of organization capital can be written as $a = c_1 / b_1 + 1$. Our measure of organization capital is

$$ORG_{it} = aw_{it}^{OC} OC_{it} = w_{it}^{OC} OC_{it}[c_1 / b_1 + 1], \qquad (4)$$

where w_{it}^{OC} is annual compensations on organization work. From here on, c_1 / b_1 is referred to as the additional productivity of organizational work relative to annual compensations. Alternatively, we substitute SGA expenditures divided by the average hourly compensation as another measure of the share of workers engaged in intangible capital creation in general. The value of SGA is the wage bill multiplied by this share and relative productivity.

In R&D investment, we find it relevant to emphasize the historical values, as the returns from R&D work emerge in the long run. ICT personnel assets and R&D assets are considered more homogeneous than organization capital, so a common depreciation rate is applied across the industries. R&D assets are calculated assuming a 20% depreciation rate and using information on related wage compensation multiplied by 1.25 (assuming that employee compensation for R&D work is 80% of total expenses for R&D). R&D compensation is deflated by deflator for fixed capital formation and wage indices with equal weight, while the resulting R&D asset is then transformed back into nominal value. An R&D asset is based on observed figures over three years.

$$\begin{aligned}\text{R\&D Asset}_{it} \;=\; & 1.25*\{\text{R\&D}_{emp,it} + (1\text{-}\delta)\text{R\&D}_{emp,it-1} + (1\text{-}\delta^2)\text{R\&D}_{emp,it-2} \\ & + (1\text{-}\delta^3)\overline{\text{R\&D}}_{emp,it-3}\frac{1}{1-\delta+g_{R\&D}})\}\end{aligned} \quad , \qquad (5)$$

where δ is the depreciation rate, $g_{R\&D}$ is the growth of R&D investment, and $\overline{\text{R\&D}}_{emp,it-3} = (\text{R\&D}_{emp,it} + \text{R\&D}_{emp,it-1} + \text{R\&D}_{emp,it-2})/3$ is the average compensation for R&D work over the last three periods. The short time span of the data allow information on R&D for two lags, and the value of R&D stock from period *t*-3 backwards is evaluated assuming R&D compensation in period *t*-3 to be the average observed in periods *t*, *t*-1 and *t*-2. The average is used to decrease randomness when calculating past values. R&D growth $g_{R\&D}$ follows the sample average growth rate of 3%. ICT personnel assets are calculated directly from employee compensation, assuming a 33% depreciation rate (Corrado, Hulten, and Sichel, 2005 use a 36% depreciation rate for software).

The estimation is done separately for eight industries (or three industries in the sample of firms with operation-based balance accounts). Appendix C shows the adapted industry classification, which is grounded on Fama and French (1988) and (1997). The manufacturing of non-durables is separated (most them manufacturing electronic products and also food, textiles, and leather), as firms may more easily adapt their organization capital for the business cycle. For the sample of firms with operation-based accounts, SGA expenditures are used to

evaluate the number of organizational workers. The eight industries are aggregated into two main industries: services and others (with five sub-industries, including the production of non-durables, and only a few observations from energy, mining, construction, transportation, and others), and manufacturing (with two sub-industries, the production of non-durables having been excluded).

Table 2 reports the pooled estimates using the conventional production function that includes organizational work augmenting labour productivity in columns 1 and 4 and conventional production function in column 2 (all variables except shares are in log form). Column 3 uses the growth form of production function shown in Appendix D and taking as the instrument for organization capital the organizational compensation (OC) (all variables are in log difference).

Table 2. Random effects estimates in explaining sales and 2SLS estimates in explaining sales growth

	1 OC	2 OC	3 OC Growth	4 SGA
Organization worker share	0.579***	_	_	_
	(7.14)			
SGA worker share	_	_	_	0.0426
				(1.17)
Organization compensation	_	0.169***	0.560***	0.323***
		(14.89)	(10.38)	(4.96)
Net plant, property, equipment	0.215***	0.214***	0.181***	0.323***
	(24.4)	(20.31)	(14.59)	(4.96)
Employment	0.420***	0.336***	0.0342	0.189
	(22.6)	(18.42)	(1.7)	(1.48)
R&D asset	0.0232***	0.0261***	-0.0225	0.0649*
	(8.4)	(6.9)	(1.05)	(2.3)
Material	0.00892**	0.00662**	0.00516*	0.00783
	(4.59)	(2.8)	(2.21)	(0.84)
Observations	13259	8272	5853	473
Number of firms	2317	1592		81
Quasi R Squared within	0.305	0.301		0.27
Quasi R Squared between	0.742	0.769		0.642
Quasi R Squared	0.737	0.768		0.617

In columns 1-2, 4 random effects log estimates with robust t-statistics in parentheses, in column 4 for firms reporting operation-based financial accounts. Column 3 uses log-difference 2SL estimates described in Appendix D . Random effect estimates include year and industry 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. Recall from equation (4) that organizational workers bring additional value relative to compensations paid if the coefficient for the organizational worker share is positive. In the pooled regression, organizational workers appear to have twice (0.579/0.420+1) higher productivity relative to the average. For completeness, column 2 shows the Cobb-Douglas form with or-

ganizational compensation as one input (the organizational worker share do not enter the model). The coefficients for all factor inputs sum up to around 0.75. This is not far from constant returns to scale, at least if firm-level estimates ignore spillovers that would prevail at the national level (the production function then also internalizes these externalities in physical capital and intangibles). Organization capital is clearly an important input with a coefficient of 0.169, such that its average sales share of 4.5% is likely to undervalue its true contribution. Column 3 uses two-stage log-difference model used by Lev and Radhakrishnan (2005). The log difference model in column 3, based on equations (D.1) and (D.2) in Appendix D, shows that the elasticity between organizational compensation and sales growth is very high – at around 0.560. The coefficients for labor and R&D factor inputs turn out to be redundant. Column 4 uses the sample of 81 firms with operation-based balance sheets. The SGA worker share here is SGA expenditures divided by total employee compensation. The coefficient is a low 0.043.

We next report in Table 3 the average coefficients and mean t-statistics from an OLS estimation of equations (5) through (10) separately in the 72 industry-year categories. Fama and MacBeth's "t-statistics" $t(\overline{\beta}_k) = \overline{\beta}_k / \left(s(\beta_k) / \sqrt{72} \right)$ are shown for each of the coefficients (Fama and MacBeth, 1973). We also report coefficients weighted by the inverse of each variable's variance in each industry and year class.

Table 3. Average Coefficients and t-statistics of yearly estimates (1998–2006)

Panel Mean Estimate	(1) OC	(2) SGA
OC or SGA Share and OC Growth	2.055	-0.147
t-value	(5.71)	(1.05)
OC or SGA Share and OC Growth weighted	1.723	0.091
Net Plant, Property, Equipment	0.243	0.372
t-value	(4.42)	(4.6)
Net Plant, Property, Equipment weighted	0.201	0.326
Employment	0.555	0.425
t-value	(4.42)	(6.77)
Employment weighted	0.596	0.457
R&D Asset	0.065	0.069
t-value	(8.76)	(7.87)
R&D Asset weighted	0.056	0.043
Material	0.020	0.033
t-value	(.97)	(2.02)
Material weighted	0.009	0.030

OC (log) and OC growth (log difference) span over 8 industries and SGA (log) spans over 2 industries (services, production of non-durables, construction and other). Table shows the average coefficient, Fama and MacBeth's "t-statistics" and weighted average coefficient over the industries and years with inverse of variance as weight.

In column 1, the coefficient for organization worker share is 2.1 showing large productivity gains from recruiting organization workers. The ratio of this average coefficient for organizational worker share to that of the average coefficient for employment is 3.7, so organization capital is about 4 times more productive than average. This ratio is also almost twice as high as for the pooled estimation in Table 2, column 1. Weighting the coefficients by the inverse of variance yields lower figure of 2.9. Average hourly wage of organization capital is two times the overall average hourly wages so that productivity difference exceeds in any case that implied by wage differential. Column 2 in Table 3 shows that SGA activity in general

appears on average less than half to the productivity of organization work, which makes sense since SGA includes larger share of activities.[4] Table 4 shows the relative productivity of organization capital in various industries when estimates are weighted by the inverse of variance of the coefficient over the years.

Table 4. Mean coefficient ratio across industries (1998–2006)

Industry	(Coefficient OC Share / Coefficient Log Employment) +1
Service, Consumer Non-Durables Production	4.29
Consumer Durables Production (Cars, TVs, Furniture, Household Appliances; Transportation, Toys, Sports)	3.84
Other Manufacturing (Metal, Trucks, Planes, Office Furniture, Paper)	4.44
Chemicals and Allied Products, Energy, Oil, Gas, and Coal Extraction and Products	5.05
Business Equipment (Computers, Software, and Electronic Equipment), Money, Finance, Healthcare, Medical Equipment, and Drugs	5.21
Telecom, Telephone and Television Transmission	13.64
Wholesale, Retail, and Some Services, (Laundries, Repair Shops)	3.20
Other (Construction, Transportation, Building Materials, Mining)	2.61

The relative return on organization capital is highest in IT industry (by fifteen time) and in manufacturing (by fivefold fold). Services are heterogeneous and organization capital has the most significant relative productivity effect in business and medical services. We find such

[4] In what follows organization capital exceeding more than 150% of turnover or being negative and less than turnover in absolute amount are truncated (42 observations).

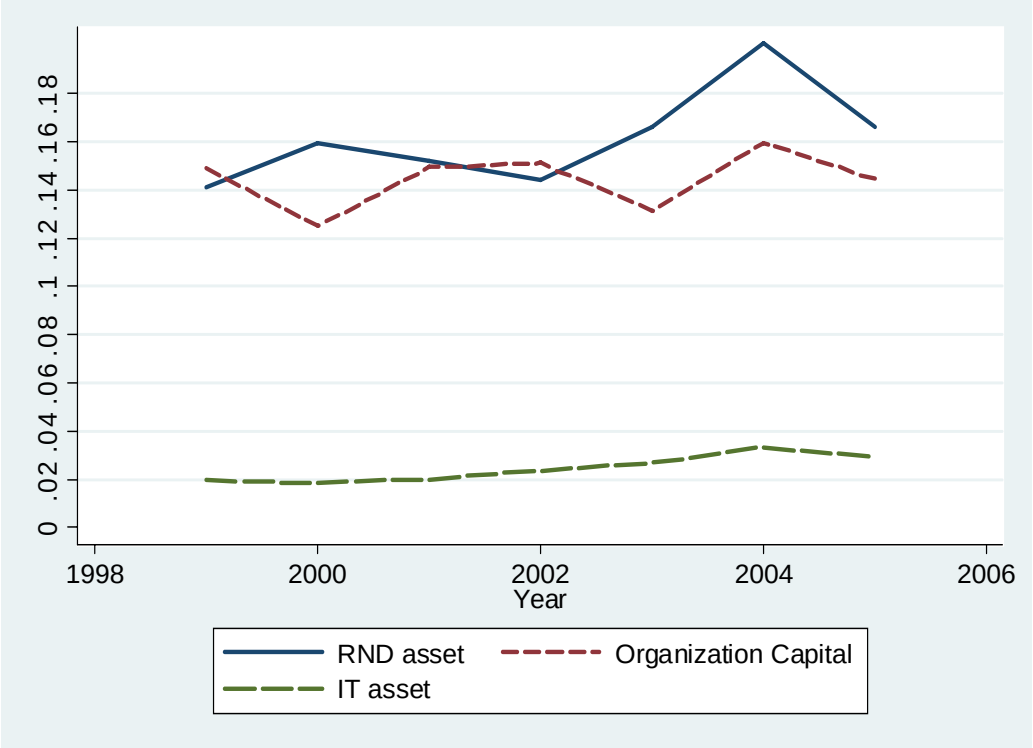
industry-level heterogeneity important later on when evaluating the contribution of intangible capital to market valuation. In an estimation of the effects of SGA expenditures, our estimation sample is fairly small – 454 observations – and can include many outliers (here the 5% of observations with coefficient ratio between SGA share and employment exceeding unity are truncated). Table 5 presents the estimates using either organization capital or SGA expenses as the basis for evaluating the productivity of organizational work.

Table 5. Intangible capital

Variable	Mean	Standard Deviaton	Mini-mum	Median Value	Max	Obs number
Book Value	52764	489713	-5E+06	2960	1.3E+07	9184
Organization Compensation	1548	8391	2.7	317	355112	10169
Organization Capital	7655	55608	11	1340	2971275	10169
Organization Compensation / Sales	0.032	0.049	2E-05	0.018	0.72	10169
Organization Capital / Sales	0.14	0.2	8E-05	0.076	1.5	10169
Organization Capital Growth/Sales	0.087	0.63	-9.2	0.024	2	6857
Intangible Capital/Sales	0.33	0.85	8E-05	0.15	38	10169
Intangible Capital/Sales, Firms Reporting SGA	0.29	0.43	0.0025	0.18	4.7	454
Intangible Capital/Sales SGA	0.26	0.33	0.0045	0.17	3.1	454

Table 5 shows that compensation for organizational work is 3.2% of sales, while organization capital is equivalent in value to around 14% of sales (the respective median values are 1.8% and 7.6%). The contribution of organization capital to sales growth is on average 8.7% of sales. Using SGA to evaluate the share of work related to intangible capital gives a figure of 26%, which is not too far from the intangible capital share of 29% from compensation-based evaluations (the sum of organization capital and ICT personnel assets in a comparable set of firms). Note, however, that the estimation sample is fairly small and results in a very high degree of variation in the estimates. We now turn in Figure 2 to the per sales evolution of organization capital, IT assets and R&D assets.

Figure 2. Organization capital, ICT, and R&D assets and organization capital growth per sales



Organization capital has varied around 13% of sales throughout the entire period and ICT assets are around 2.5% of sales, while R&D assets are on average around 16% of sales and have been increasing over time. Adding all these together gives our estimated share of intangible capital from sales, which was 33% in Table 5. The yearly variation in organization capital growth per sales instead closely tracks average sales growth (not shown).

4. Intangible capital, globalization, and information technology

Finnish multinational firms have expanded their activities and employment abroad. Employment at domestic plants has remained at about half a million, 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.[5] It can be argued that organization capital is needed to maintain the network of tasks spread over the plants across the countries. Lev and Radhakrishnan (2005) emphasized the use of information technology to enable internet-based operations and new production designs. Bartel and Lichtenberger (1987) argue that new ICT investments require complementary investments in a more skilled workforce and the adoption of new human resource practices such as performance-related pay (PRP).[6] Organization capital (growth and value) as well as ICT and R&D capital are interchangeably explained by other intangibles and all suggested complements to them.

$$K_{xit} = a_1 GLOB_{it} + a_2 PRP_{it} + a_3 K_{it}^{Other} + a_4 Y_{it} + m_0 + m_{jt1}[Year] * IND_{jt} + e_{it} \quad , \qquad (6)$$

where K_{xit} is either organization capital, ICT assets, or R&D assets, $GLOB_{it}$ is globalization proxies, PRP_{it} is the performance-related pay dummy, K_{it}^{Other} refers to the other intangibles, Y_{it} refers to the controls and $m_{jt1}[Year] * IND_{jt}$ stands for the year t and industry j dummies and their interactions. Globalization is measured by employment abroad, by the number of plants (1, 2-3, and 3<) and whether the firm is listed on the stock market. PRP_{it} receives the value of one if the firm has implemented a PRP scheme.[7] The control factors Y_{it} include market share $MKS_{imt} = SALES_{imt} / \sum_{j=1}^{n} SALES_{jmt}$ at the two-digit industry level. Table 6 shows the estimation results.

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[5] Data collected by Talouselämä magazine from the 500 largest firms in Finland give roughly the same figures. For those large firms with employees abroad, the average domestic employment is 4,400 and employment abroad is 2,200.

[6] For a description of PRP in Finland, see Piekkola (2005).

[7] PRP remunerations are paid afterwards based on the set targets. PRP schemes are a relatively recent form of compensation covering less than 10% of firms in 1995 and extending to over 60% of firms among those with more than 30 employees by 2006. The average pay is less than 5% of annual salaries (Confederation of Finnish Employers).

Table 6. Intangible capital and global firms

	Organization Capital	Organization Capital Growth	ICT Asset	R&D Asset
Organization Capital OC	_	_	0.468***	0.294***
			(19.37)	(10.49)
IT Assets	0.107***	0.163***	_	0.150***
	(19.25)	(12.03)		(11.22)
R&D Asset	0.0622***	0.0984***	0.147***	_
	(11.52)	(7.31)	(12.5)	
Foreign Employment	0.0883***	0.0616**	0.0698***	0.102***
	(7.77)	(2.65)	(4.36)	(4.63)
2-3 plants	0.473***	0.328**	0.626***	1.694***
	(7.05)	(3.25)	(4.42)	(9.79)
4 or more plants	0.598***	0.512***	0.725***	2.424***
	(7.52)	(4.42)	(4.53)	(12.68)
Listed Firm	3.463***	1.433***	2.185***	-5.898***
	(44.58)	(9.06)	(12.38)	(29.98)
Performance-Related-Pay	0.181***	0.112	0.123**	0.0938*
	(9.76)	(1.67)	(2.98)	(2.22)
Firm Age	-0.0353	0.265***	0.141*	-0.226***
	(1.16)	(4.2)	(2.48)	(3.4)
Market share	0.0144***	0.0179***	0.0168***	0.00922*
	(6.11)	(4.12)	(6.13)	(2.5)
Observations	9430	3650	9430	9430
Number of firms	1693	1166	1693	1693
R Squared within	0.183	0.0534	0.0208	0.0297
R Squared between	0.598	0.298	0.462	0.503
R Squared total	0.627	0.403	0.509	0.521

Random effects log estimates with robust t-statistics in parentheses. All variables except dummies and market share are in log form.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

It is first seen from Columns 1 and 2 show that the two approaches to measuring organization capital or its growth using log-difference model (from Appendix D) are largely explained by the same factors. The firm age is derived from the longest length of service among workers and has positive relation to intangible capital. Older firms have had longer period for accumulating intangible capital. These results show that a PRP scheme is also positively related to all intangibles. Clearly, human resource practices are an important part of

managing organization capital effectively and firms with greater investment in organization capital also apply PRP schemes.

The first three rows in columns 1-4 show that ICT assets, R&D assets, and organization capital are all positively related. In the correlation table in Appendix B, the correlations are around 0.7 (see Table B.2 in the Appendix). Firms investing 10% or more in organization capital increase their investment in ICT assets by 5% and in R&D assets by 3%. A 10% increase in investment in ICT assets or R&D assets in turn raises investment in organization capital by 1.1-1.6%. Organizational investment is followed by stronger investments in ICT and R&D rather than the other way around.

The analysis shows that global firms use more intangible capital, whether it is organization capital, ICT assets, or R&D assets. A surge of foreign employment by 10% increases all intangible assets in Finland by around 7%. The majority, 72% of these firms, are of Finnish origin so the organization capital in the parent Finnish firm is strengthened. It is also interesting to note that multinationals with two or more plants have around 50-60% more organization capital and ICT assets. Thus, large firms with many plants are typically those that have the greatest amount of intangible capital. Multiplant firms also have around twice more R&D assets. The firms listed on the Helsinki stock exchange have noticeably more intangible capital. It is clear also form later analysis that small listed firms have on average even greater investment in intangible capital than large firms (see Appendix E). Overall, the average organization capital per sales is double for international Finnish firms with employees abroad.
In sum, it is evident that intangibles play a pivotal role in a global firm. Investment in organization capital is followed by investments in ICT and R&D. All these intangibles may potentially have a large impact on the valuation of firms that may not have always been fully perceived, since it is difficult for investors to observe.

5. Intangible capital and market value

Our final step is to evaluate how organization capital enters into the valuation of the firm. It appears from many studies, such as Brynjolfsson, Hitt, and Yang (2002), that the value of intangible assets materializes over a longer period, especially in aspects such as business organization, which are disproportionately important for IT-intensive firms. In Van Bekkum (2008), most of the positive effect of SGA on growth value stems over a longer period from services such as finance, healthcare and business equipment. Market valuation models are able to account for these long-term productivity effects. We do this by using a residual income valuation model, which has been further improved by Ohlson (1995). We analyze whether organization capital can provide a solution for the weak relation found between value changes and accounting information as recorded in many studies, starting from Lev (1989). Market value is equal to the present value of future dividends:

$$MV_{it} = \sum_{\tau=1}^{\infty} \frac{E_t(DIV_{it+\tau})}{(1+r_i)^{\tau}}, \tag{7}$$

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*. The modified clean surplus relation reads as

$$BV_{it} = BV_{it-1} + FE_{it} + a_{it}K_{it} - DIV_{it}, \tag{8}$$

where BV_{it} is the book value (balance-sheet value of assets minus liabilities), FE_{it} is analysts' forecast one year ahead of earnings for a period ending at date *t*, and a_{it} is the value of the existing stock of intangible capital K_{it} (organization, ICT, or R&D) that is not included in these analyst forecasts. We next use equations (7) through (9) and write market value as a function of book value, discounted expected abnormal earnings, and intangible capital:

$$MV_{it} = BV_{it} + RE_{it} + K_{it}, \tag{9}$$

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 book value of equity grows at a rate of less than $1+r_i$, so that $(1+r)^{-\tau}E_t(BV_{t+\tau}) \to 0$, the residual earnings can be written as

$$RE_{it} = (1+r_{it})^{-1}(FE_{it} - r_{it}BV_{it-1}) + (FE_{it+1} - r_{it}BV_{it})(r_{it} - g_{it})^{-1}(1+r_{it})^{-2}, \quad (10)$$

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 of the systematic risk. The beta in the risk premium 1-beta is estimated by 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 includes all the companies listed on the Helsinki stock market in the period. To obtain 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%). In the estimation, we do not use sales as the scaling factor, since the firms are too heterogeneous in size. We use logarithmic approximate of (9) through (10)

$$\ln MV_{it} = \sigma_{fe}\ln FE_{it} + \sigma_r \ln r_{it} + \sigma_{bv}\ln BV_{it} + \sigma_{in}\ln K_{it} + \sigma_{year}Year_{it} + \sigma_{ind}Ind_{jt}. \quad (11)$$

where K_{it} is in intangibles by type (organization, IT and R&D) and estimation includes year $Year_{it}$ and industry dummies Ind_{jt}. It was shown in table 4 that the relative productivity of organization work differs by industry being highest in manufacturing and telecommunication. We interact organization capital with IT asset and manufacturing industry dummy to see whether the market value implications also differ. We can now test the extent to which

financial analysts comprehend the value and profit implications of organization capital in their analyses and consequent earnings forecasts. Table 7 shows first the summary table.

Table 7. Summary of Variables

Variable	Mean	Standard Deviation	Mini-mum	Median Value	Max	Obs
Market Value (€ 1000)	3975525	22000000	2240	211890	2.9E+08	303
Analyst Forecast Profits March (€ 1000)	158294	567501	78	15213	4531135	303
Discount rate	7.7	0.88	5.8	7.6	9.8	303
Book Value (Net of liabilities) (€ 1000)	1008883	2359399	11	98895	1.3E+07	303
Organization Capital	63938	216972	601	10648	2260244	303
ICT Personnel Asset	15591	48078	121	1822	385131	303
R&D asset	163587	668960	113	17870	5929139	303
Organization Capital/Sales	0.13	0.17	0.0011	0.08	1.3	303
ICT Personnel Asset/Sales	0.089	0.51	0.0006	0.011	8.3	303
R&D Asset/Sales	0.46	2.1	0.0012	0.12	30	303
Tangible Capital/Sales	0.39	0.78	0	0.27	7.8	303

It is apparent that in the 54 firms observed, the median market value exceeds book values on average by 400%. Organization capital is on average 13% of sales, as for the whole data in summary tables shown in appendix. Sum firms are intensive in R&D assets. The companies typically operate on a global scale and are large in size, which explains the notably higher investment in intangibles than that seen in other firms (the average across all firms is 24%). We also expect that analysts' forecasts and organization capital can play a widely differing role in services and manufacturing. Bloom, Sadun, and Van Reenen (2007) argue that the role of organization capital in productivity growth (and hence in market value) is more important in services and the manufacturing of non-durable goods than in the other manufacturing sector. Therefore ICT intensive production of non-durable goods are here pooled together with services. Sometimes the non-manufacturing sector suffers from a lower productivity growth rate than that of the manufacturing sector. Baumol (2004) explicitly emphasizes the innovative role of many small high-technology firms. Table 8 shows the results from the estimation of (12) across 58 firms listed on the stock market (with the first column with 62 firms as a reference in which intangible capital has been omitted).

Table 8. Estimates for organization capital and intangible capital in explaining market value less book value

	1	2	3	4 Market value below median	5 Market value above median	6 Manu-facturing Construc-tion	7 Services, ICT
Economic Forecast	0.477***	0.427***	0.436***	0.202**	0.470***	0.384***	0.540***
	(8.31)	(7.8)	(8.09)	(2.79)	(6.96)	(5.74)	(6.6)
Discount rate	-0.00851	-0.0272	-0.0268	-0.152	-0.329	0.201	-0.062
	(0.06)	(0.21)	(0.21)	(0.86)	(1.95)	(0.96)	(0.33)
Book Value Net of	0.192***	0.320***	0.295***	0.225***	0.363***	0.205***	0.448***
Liabilities	(3.83)	(5.44)	(5.31)	(4.54)	(4.63)	(3.73)	(3.31)
Organization Capital	_	-0.0629	0.343*	0.571	0.0159	0.457	0.431
	_	(0.83)	(1.97)	(1.44)	(0.07)	(1.25)	(1.91)
Organiz. Cap., ICT Asset	_	_	-0.0449**	-0.125*	-0.0143	-0.0376	-0.0509**
	_	_	(2.66)	(2.22)	(0.69)	(0.75)	(2.66)
Organiz. Cap., Manufact.	_	_	0.239**	0.407**	0.311	_	_
	_	_	(2.77)	(2.75)	(1.82)	_	_
ICT Asset	_	0.0939	0.506***	1.039*	0.159	0.586	0.510**
	_	(1.52)	(3.5)	(2.32)	(0.81)	(1.18)	(3.28)
R&D Asset	_	0.121*	0.102	0.0389	0.258**	0.0708	0.115
	_	(2.07)	(1.9)	(0.63)	(3.05)	(0.87)	(1.92)
Observations	356	328	328	134	194	182	146
Number of Firms	62	58	58	28	30	30	28
Quasi R Squared within	0.381	0.396	0.437	0.485	0.455	0.545	0.397
Quasi R Squared between	0.88	0.911	0.908	0.709	0.896	0.929	0.917
Quasi R Squared	0.911	0.944	0.941	0.821	0.947	0.95	0.958

Random effects log estimates with robust t-statistics in parentheses. Estimation includes four firm size dummies, year dummies and five industry dummies.

$^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$

In all estimates, a 10% improvement in economic forecast estimates made in march predict a 5% rise in market value of the firm in the entire year. Forecasts perform weakest in low-market value firms (column 4). Roughly one third of the rise in net book value is also reflected in market value. Thus economic forecast and improved net book value can explain substantial part of market value variation. Column 1 shows that these alone explain 89% of the variation in log of market value (the remaining 2% is due to additional variables, firm size,

five industry and year dummies). It is seen that higher discount rate (or systematic risk from beta estimates) is negatively but insignificantly correlated with market values.

The magnitude of the improvement in explanatory power is a modest 4% when including intangibles in column 2. In column 2, organization capital is on average insignificantly related to market value. Therefore, the estimations in columns 3-7 include the interaction with manufacturing dummy. Column 3 shows that intangible investments have contributed to market value especially in firms in manufacturing since the interaction term is positive. Organization capital is also interacted with ICT personnel assets, which has a negative and significant coefficient for the whole sample in column 3. Last column 7 shows that especially in services, organization capital does not improve market value when combined with ICT personnel assets. Bresnahan, Brynjolfsson, and Hitt (2000) 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. Here we do not find evidence for this. It can be concluded that organization capital investment increases market value in manufacturing and in services that are not very intensive in ICT personel assets.

In contrast to Cummins (2005), we find appreciable intangibles associated with R&D in the whole sample. R&D assets increase market values especially among the high market-value firms and in services and ICT sector. We also find ICT personnel assets to increase market value, which are substitutes for organization capital.

Tables E.1 and E.2 in the Appendix E finally shows the average intangible capital, book value and market value of the 59 firms over the period (average span of years is 5.7 in the nine year period 1998-2006). **Both in manufacturing and services** the low market value firms have greater share intangible capital from book value. The small listed firms in non-manufacturing (services, non-durable goods production, construction other) are particularly intensive in organization capital, where the intangibles exceed book value by 1.7. These small firms in non-manufacturing are also intensive in ICT personnel assets. It is among these small firms, where we find the observed negative interaction between ICT asset and organization capital. Here we can also see a negative correlation between intangible capital and market value, while the correlation is always positive in manufacturing.

6. Conclusions

Organization capital has increased in importance in the globalization process and is shown here to be conducive for the use of other intangibles. Greater organizational activity is followed by investments in ICT and R&D. Bloom, Sadun, and Van Reenen (2007) emphasized the importance of organization capital for productivity growth in services. The analysis in this paper shows that the productivity of organization capital workers is higher in high-market value manufacturing and in non-manufacturing that are not very intensive in IT assets. The value of organization capital investments varies by type and industry, and cannot be measured simply by capitalizing all the related expenses at a common predetermined rate, as is usually done in national measures of other intangibles. A full model incorporating organization capital is useful for explaining productivity growth or market valuation. Otherwise, a significant omitted-variable problem could arise if only R&D or ICT assets were used as a proxy for all forms of intangible capital.

Overall, intangible capital is on average around 33% of sales. To this should be added non-scientific R&D, while much of investment in software and database are likely to included in the national estimates used in system of accounts (that also use personnel expenditures as bases in the evaluation of the investment). Overall, the true value of intangible capital are higher than the estimates obtained in national level where the share of intangible capital from GDP is typically around 11%. Organization capital along with ICT personnel assets, and R&D assets also explain the unexplained variation in the market value of firms listed on the Helsinki stock market during 1995–2006. The analysis has shown that global firms with foreign activities and listed companies in general are investing a relatively greater share of their sales in intangible capital. In addition small firms listed in stock market are also very intensive in intangible capital. These observations are noteworthy because according to the

INNODRIVE project the growth of intangible capital assets in Finland has been lower in the 2000s compared with the 1990s, as has been the case for the whole of Europe.[8]

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[8] See http://www.innodrive.org.

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Appendix A. Occupational classification of non-production workers

	Occupation of Non-Production Worker	Organization Worker	R&D Worker	IT Worker
Manufacturing	Management	Management		
	R&D		x	
	R&D superior		x	
	Supply transport non-prod			
	Supply transport non-prod superior			
	Computer			x
	Computer superior			x
	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			x
	Computer processing services superior			x
	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		

Appendix B. Summary of Variables and Correlations

Table B.1 Summary of variables

Variable	Mean	Std	Median	Obs
Operating revenue / Turnover	83576	677228	15856	10169
Sales Growth	0.042	0.35	0.029	9286
Value Added	16888	79135	4288	10169
Sales Reporting SGA	479623	3E+06	61938	533
Selling, General, Administration	40016	196600	6879	546
SGA Share	0.31	0.87	0.065	546
Selling	24376	111019	3963	529
Administration	16429	91858	2550	545
Employment	249	875	73	10169
Employees in Organization Work	33	166	7	10169
Organization Worker Share	0.16	0.19	0.096	10169
Organization Compensation	1548	8391	317	10169
Management Compensation	1001	6746	175	10169
Management personnel	20	126	3	10169
Marketing, Purchases Compensation	546	2544	100	10169
Marketing personnel	13	63	2	10169
Administration Compensation	928	3631	185	10169
Administration personnel	22	73	5.1	10169
ICT Compensation	460	3682	26	10169
ICT personnel	8.8	65	1	10169
R&D Compensation	1540	19571	72	10169
R&D Asset	10132	122119	495	10169
Net Plant, Property, Equipment	24943	162951	2523	10169
Material	2468	13693	201	10169
Hours per capita	1292	1330	1329	10169

Table B.2 Summary of correlations

	Org. Cap	Org Growth	ICT Asset	R&D Asset	Net Plant, Property.	Manage-ment	Market-ing	Admin. Comp.
Organization Capital	1							
Organization Capital Growth	0.01	1						
ICT Asset	0.76	0.03	1					
R&D Asset	0.64	0.22	0.70	1				
Sales Growth	0.00	0.02	-0.03	0.00	1			
Net Plant, Property, Equipment	0.38	0.06	0.29	0.21	-0.01	1		
Material	0.36	0.21	0.27	0.43	0.01	0.73	1	
Management Compensation	0.80	0.02	0.64	0.73	0.00	0.36	1.00	1
Marketing Compensation	0.84	0.01	0.65	0.53	-0.01	0.52	0.62	1.00
Administration Compensation	0.41	0.03	0.65	0.52	-0.03	0.34	0.43	0.45

Appendix C. Industry classification

	Industry	NACE Rev. 1	Main industry
1	Service, consumer non-durables: food, tobacco, textiles, apparel, leather, hotels, entertainment, and utilities	DA, DB, DC, DL (335), DM (354), E, H	Services, production of non-durables
2	Consumer durables: cars, TVs, furniture, household appliances, transportation, toys, and sports	DM (excl. 354) DL (322-323) DN (excl. 3611-3612) I (excl. 642)	Manufacturing
3	Other manufacturing: metal, trucks, planes, office furniture, and paper	DM (351-353) DD, DE, DK, DN (3611-3612), DJ, DN	Manufacturing
4	Chemicals and allied products, energy, oil, gas, and coal extraction and products	DG (excl. 244), DH, DI, DF	Manufacturing
5	Business equipment: computers, software, and electronic equipment; money, and finance Healthcare, medical equipment, and drugs	DL (300, 311-316, 332-335) K (721-724) J, K (incl. 721-724) N (private), DG (244)	Services, production of non-durables
6	Telecoms, telephone and TV transmission	I (642)	Services, production of non-durables
7	Wholesale, retail, and some services, (laundries and repair shops)	J, K (excl. 721-724)	Services, production of non-durables
8	Other: construction, transportation, building materials, and mining	CA, CB, F	Construction, others

Appendix D. Lev and Radhakrishnan's evaluation of intangible capital

Growth estimates are done using an annual growth equation following Lev and Radhakrishnan (2005), i.e. log differencing the model using as an instrument occupational compensation (OC_{it}), so that

$$\begin{aligned}\log(SALE_{ijt} / SALE_{ij,t\text{-}1}) \;=\; & c_{0jt} \;+\; g_{0jt}\log(OC_{ijt} / OC_{ij,t\text{-}1}) \\ & +\; c_{1jt}\log(PPE_{ijt} / PPE_{ij,t\text{-}1}) \;+\; c_{2jt}\log(EMP_{ijt} / EMP_{ij,t\text{-}1}) \\ & +\; c_{3jt}\log(\mathrm{R\&D}_{ijt} / \mathrm{R\&D}_{ij,t\text{-}1}) + \;\log(e_{ijt} / e_{ij,t\text{-}1})\end{aligned} \tag{D.1}$$

$$\begin{aligned}\log(OC_{ijt} / OC_{ij,t\text{-}1}) \;=\; & b_{0jt} \;+\; b_{1jt}\log(OC_{ij,t-1} / OC_{ij,t\text{-}2}) + b_{2jt}\log(SALE_{ij,t-1} / SALE_{ij,t\text{-}2}) \\ & + b_{3jt}\log(PPE_{ijt} / PPE_{ij,t\text{-}1}) \;+\; b_{4jt}\log(EMP_{ijt} / EMP_{ij,t\text{-}1}) \\ & +\; b_{5jt}\log(\mathrm{R\&D}_{ijt} / \mathrm{R\&D}_{ij,t\text{-}1}) + \;\log(u_{ijt} / u_{ij,t\text{-}1})\end{aligned} \tag{D.2}$$

and using a cross-sectional estimation for nine industries *j* for years $t \;=\; 1998,\ldots,2006$. To offer a comparable analysis to Lev and Radhakrishnan (2005), sales *SALE* are deflated by the consumer price index, capital PPE by the capital investment index, and R&D capital by capital investment and wage indices with equal weight. The Hicks-neutral contribution of organization capital b_{0it} includes common organization capital (often narrowed to define output-augmenting technical change) c_{0it} and the returns to firm-specific organization capital $g_{0t}\log(OC_{it})$:

$$\log(b_{0it}) \;=\; c_{0t} \;+\; g_{0t}\log(OC_{it}) \tag{D.3}$$

The production function is estimated in 2SLS from

$$\begin{aligned}\log(SALE_{ijt} / SALE_{ij,t\text{-}1}) \;=\; & c_{0jt} \;+\; g_{0jt}\log(OC_{ijt} / OC_{ij,t\text{-}1}) \\ & +\; c_{1jt}\log(PPE_{ijt} / PPE_{ij,t\text{-}1}) \;+\; c_{2jt}\log(EMP_{ijt} / EMP_{ij,t\text{-}1}) \\ & +\; c_{3jt}\log(RND_{ijt} / RND_{ij,t\text{-}1}) + \;\log(e_{ijt} / e_{ij,t\text{-}1})\end{aligned} \tag{D.4}$$

$$\log(OC_{ijt} / OC_{ij,t\text{-}1}) = b_{0jt} + b_{1jt}\log(OC_{ij,t-1} / OC_{ij,t\text{-}2}) + b_{2jt}\log(SALE_{ij,t-1} / SALE_{ij,t\text{-}2}) + b_{3jt}\text{Region}_{ijt} + b_{4jt}\log(PPE_{ijt} / PPE_{ij,t\text{-}1}) + b_{5jt}\log(EMP_{ijt} / EMP_{ij,t\text{-}1}) + b_{6jt}\log(RND_{ijt} / RND_{ij,t\text{-}1}) + \log(u_{ijt} / u_{ij,t\text{-}1}) \quad \text{(D.5)}$$

using a cross-sectional estimation in nine industries *j* for years $t = 1998,\ldots,2006$. Organization capital expenditures are here tied to the firm's past commitments (the lagged value of the organization capital instrument) and are a proportion of past activity levels (sales). Growth effects are evaluated f by comparing the expected output (sales) computed with and without the common and firm-specific organization capital. The expected output of firm *i* in year *t* with organization capital is given by

$$SALE^{*}_{it} = SALE_{i,t-1}\{\exp\{c^{*}_{0t} + g^{*}_{0t}\log(OC_{it} / OC_{i,t\text{-}1}) + c^{*}_{1t}\log(PPE_{it} / PPE_{i,t\text{-}1}) + c^{*}_{2t}\log(EMP_{it} / EMP_{i,t\text{-}1}) + c^{*}_{3t}\log(RND_{it} / RND_{i,t\text{-}1}) + \log(e_{it} / e_{i,t\text{-}1})\} \quad , \quad \text{(D.6)}$$

and the expected output of firm *i* without the effect of organization capital is

$$SALE^{**}_{it} = SALE_{i,t-1}\{c^{*}_{1t}(PPE_{it} / PPE_{i,t-1}) + c^{*}_{2t}(EMP_{it} / EMP_{i,t-1}) + c^{*}_{3t}(RND_{it} / RND_{i,t-1})\} \quad . \quad \text{(D.7)}$$

The instrument-based estimate of organization capital using occupational compensation (OC) is the difference between expected sales *with* and *without* organization capital, given by

$$ORG^{Growth}_{it} \equiv SALE^{*}_{it} - SALE^{**}_{it} \quad , \quad \text{(D.8)}$$

where $SALE_{it}^{*}$ and $SALE_{it}^{**}$ are given by (D.6) and (D.7) respectively, and transformed into nominal values. The quantity ORG_{it}^{Growth} is the inflated nominal value using the general price deflator. Accumulating organization capital over time is considered later when assessing its impact on market value.

Appendix E. Intangible Capital and Asset Values in Selected Firms in Helsinki Stock Market

Table D.1 Average Intangible Capital, Book Value and Market Value in Manufacturing

Name	Intangible Capital	Book Value	Int.Cap/ BV	Market Value	Market Value/Book Value
Metso	585	217	270 %	1839	8.5
Upm_Kymmene	344	6508	5 %	9733	1.5
Rautaruukki	278	1075	26 %	878	0.8
Storaenso	277	8390	3 %	6511	0.8
Fortum	262	1603	16 %	10300	6.4
Kemira	193	882	22 %	1336	1.5
M_Real	118	2191	5 %	832	0.4
Kone	95	1392	7 %	3195	2.3
Nokianrenkaat	65	238	27 %	1642	6.9
Perlos	63	119	53 %	2088	17.5
Tamfelt	43	98	44 %	139	1.4
Ponsse	27	38	70 %	244	6.5
Raisio	20	237	9 %	180	0.8
Outokumpu	17	2523	1 %	1631	0.6
Correl. with Intangible Capital		0.31		0.44	
Average			40 %		4.0
Atria	30	186	16 %	54	0.3
Honkarakenne	20	24	84 %	19	0.8
Componenta	19	5	397 %	32	6.8
Lannentehtaat	18	79	23 %	83	1.0
Tulikivi	18	27	67 %	40	1.5
Salcomp	17	46	38 %	134	2.9
Nordicaluminium	16	16	101 %	53	3.2
Exel	15	23	65 %	168	7.3
Olvi	14	58	24 %	41	0.7
Marimekko	9	18	53 %	75	4.3
Martela	9	41	21 %	26	0.6
Pohjoiskarjalan	9	76	11 %	71	0.9
Elecster	7	10	69 %	15	1.5
Kesla	7	6	120 %	5	0.8
Stromsdal	5	4	133 %	6	1.7
Larox	4	13	27 %	17	1.3
Correl. with Intangible Capital		0.64		0.82	
Average			78 %		2.2

Table D.2 Average Intangible Capital, Book Value and Market Value in Services, ICT and Other

Name	Intangible Capital	Book Value	Int.Cap/ BV	Market Value	Market Value/Book Value
Nokia	4823	9962	48 %	27200	2.7
Elisa	734	1625	45 %	1415	0.9
Tietoenator	679	1025	66 %	2060	2.0
Finnair	463	427	108 %	348	0.8
Orion	351	498	70 %	750	1.5
Yit	129	184	70 %	474	2.6
Vaisala	103	116	88 %	257	2.2
Comptel	67	37	180 %	203	5.5
F_Secure	53	43	125 %	437	10.2
Huhtamaki	23	1254	2 %	1023	0.8
Scanfil	20	87	23 %	212	2.4
Pohjolabank	20	10	195 %	353	35.0
Aldatasolution	17	20	86 %	108	5.4
Ramirent	15	101	15 %	793	7.9
Lemminkainen	15	144	10 %	137	1.0
Almamedia	5	532	1 %	575	1.1
Correl. with Intangible Capital		0.70		0.73	
Average			71 %		5.1
Etteplan	111	17	660 %	44	2.6
Digia	67	21	315 %	57	2.7
Raute	41	30	135 %	26	0.9
Solteq	29	11	269 %	18	1.7
Rocla	28	16	173 %	24	1.5
Affecto	26	5	555 %	44	9.6
Okmetic	21	74	29 %	123	1.7
Pkcgroup	21	30	70 %	236	7.9
Sshcommunication	13	18	73 %	52	2.9
Basware	12	26	45 %	80	3.1
Incap	7	7	98 %	15	2.1
Ilkkayhtyma	2	35	6 %	63	1.8
Correl. with Intangible Capital		-0.14		-0.15	
Average			192 %		3.3

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