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Intangibles: Can They Explain the Unexplained ?

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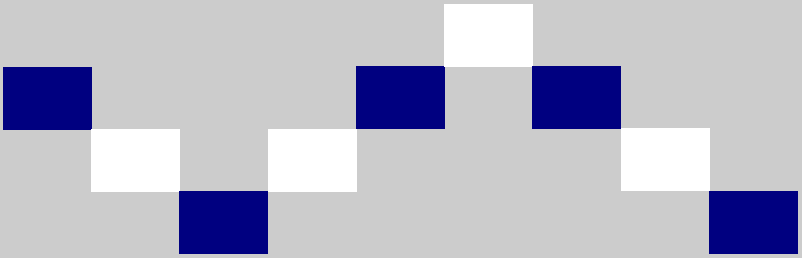

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Abstract

Intangible capital is embedded in the firm insofar as it is used to run the business and to develop innovations. The main contribution of this paper is its extension of the concept of the firm's intangible assets to include organizational capital at the firm level using performance-based measurement through marketing and management activity . Intangible capital – organizational, Information, communications, and technology and R&D capital – is shown to explain the evolution of earnings and to increase the market value of firms. Organizational capital grows with a firm's level of globalization, suggesting that it is a crucial input for multinational firms. Intangible capital estimates are higher than those obtained in national-level approaches for private business.

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

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

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1. Introduction

The creation and introduction of new products typically requires expenditures on marketing and organizational investment that need to be recognized as intangible investments. Corrado, Hulten, and Sichel CHS (2006) take a broad view of intangible capital, defined as expenditures by firms in the current period intended to enhance profitability in the future using tools other than tangible capital. At firm-level intangibles can be broadly defined as organizational, R&D and ICT capital. An integral part of intangibles is organizational capital, in particular the management-related abilities associated with marketing and the performance of the firm's personnel in improving team work and successfully matching jobs and employees. As suggested by Miyagawa and Kim (2008), employees engaged in marketing are also at the core of organizational capital.

Ito and Krueger (1996) and Bresnahan and Greenstein (1999) suggest that organizational capital complements investments in ICT and thus that the organizational capital needed may typically exceed the direct financial costs of the ICT investments themselves. Information, communications, and technology (ICT) work is heavily concentrated in industries such as business services and finance and needs to be analyzed in juncture with organizational capital. Hitt and Yang (2002) argue indeed that their 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 (with a greater decentralization of certain decision rights and team-oriented production). Finally, we come to R&D expenditures, the first and only recognized type of intangible capital to be included in the satellite accounting of GDP by the OECD.

Our second focus is the relation of the assessed intangibles to increased specialization and slicing of the value chain in maintaining the global network of production. Outsourcing may cause more intangibles being concentrated in the regions where the headquarters are positioned. The second wave of globalization indeed includes specialization in tasks, and in inter-industry trade, and organizational restructuring (Baldwin, 2006, Evenson et al., 1995). Prescott and Visscher (1980) first allowed "organization capital" to also include the human capital of a firm's employees. However, intangibles may not be directly transferable to other

firms through job switches in the way that human capital is. Our third focus is on whether intangibles is of the kind firm-specific human capital that can explain the market value of firms beyond that explained by standard economic analysis. Organizational work connected with top management, marketing, and administration is expected to have become among the most highly rewarded and has value on the internal labour market, but may also increase market value of the firm.

Most of the returns in successful management accrue to firm value and are only partly passed along to the management. Thus management expenditures may not directly correlate with the firm value. In our analysis of Finnish firms over the period 1996–2008, we model the firm's output as a function of organizational work augmenting labor input together with physical capital, labor and R&D capital (representing scientific innovative activities). We thus measure the relative productivity of organizational work relative to other type of work. We adapt the methodology from Hellerstein, Neumark, and Troske (1999) and Ilmakunnas and Maliranta (2005). The simplifying assumption is that organizational workers and other type of workers have different marginal productivities but otherwise are perfect substitutes. While organizational capital is hard to measure without this kind of performance valuation, R&D investment and ICT investments have traditionally been valued using expenditure-based measures with predetermined depreciation rates. An alternative approach could be to extend performance-based measurement to all intangibles as in Ilmakunnas and Piekkola (2010) in their decomposition of total factor productivity effects.

Lev and Radhakrishnan (2003 and 2005) use intangibles-related work as an instrument to explain sales growth in yearly industry-level estimates using two-stage least squares (2SLS). 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 here. Moreover, administration expenditures may also be an indicator of inefficiency. However, the results here also indicate that market value is positively related to intangible capital and that multinational firms have more organizational capital. We find organizational capital to be important in nearly all industries, which supports our estimation strategies. We also check the robustness of our results using Olley and Pakes (1996) estimates with hiring as our control for productivity

shocks. On average, intangibles account for about 25% of sales values and 50% of book values net debt in listed firms.

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 analyzes intangibles as part of the globalization process. Section 5 incorporates intangible capital into a valuation model and shows the magnitude of intangibles relative to recorded balance sheets and market values. Section 6 concludes.

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 measure a firm's own intangible capital. The classification provided by Corrado, Hulten, and Sichel (2005) 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	2) Macro: Non-scientific research &
- R&D in social science and humanities	development
- 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 capital
2) Database	

Sources: Corrado, Hulten, and Sichel (2005).

Organizational 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 human resources as well as the 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. It 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 only cover R&D capital. For ICT capital, Corrado, Hulten, and Sichel include software and hard-

ware expenditures that are currently recorded in national statistics. Brynjolfsson, 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 ICT. Organizational capital should also include part of the implementation costs. National income accounting frequently use ICT-related work expenditures as proxies for software and hardware.

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 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%).

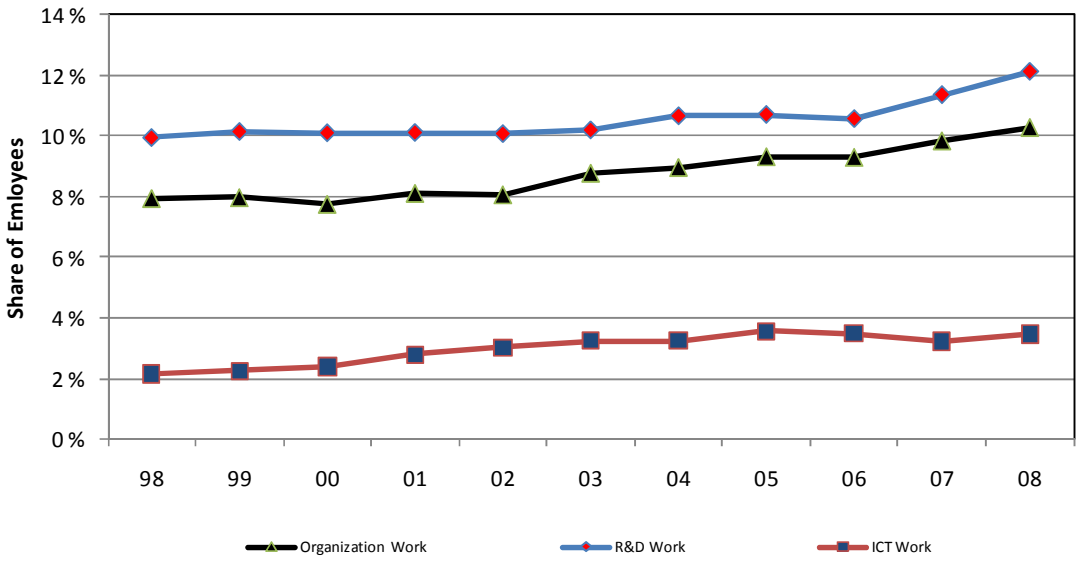
The occupational classification is specific to the data from the Confederation of Finnish Employers and is available for all employees in the firms considered (see Appendix A). The occupational codes can be transformed into ISCO-88 using additional information on education level (for qualifications) and industrial codes. Most importantly, the occupations in manufacturing and services are separated. Organizational compensation is obtained from occupations classified as relating to organizational 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.

Employee data are linked to financial statistics data provided by the Suomen Asiakastieto[1], 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 those firms that have at

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

least 30 employees on average and real sales exceeding €2 million (in 2000 consumer prices). The final linked employer–employee data of 4.14 million person-year observations cover 1,766 firms with 12,823 firm-year observations after dropping the years 1996–97, 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), and hence, one-third of the entire workforce in the private sector industries. Figure 1 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)



The share of organizational workers has increased over time from 8% to 10% of employees. Management (4.5%) and marketing (4.3%) are the main categories of organizational work. The INNODRIVE project reveals that the share of personnel engaged in organizational work (management and marketing) is comparable in six European countries, ranging from 9 % in Finland to 14% in the UK and ranging between 13%-18% in the Czech Republic and Slovenia. The share of management hovers around 6%. Analyzing management expenditures alone – as is done in national measures of intangible capital – and ignoring marketing may

offer a less comparable basis for an analysis of firm-specific resources or organizational 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.[2]

Figure 1 shows that the share of R&D workers is around 10.5% and is increasing. The share of ICT workers is 3%, a share that has also increased over time to around 4%. 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. 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 in the data work in manufacturing.

Appendix B shows the summary of the rest of the variables in the estimation sample. Average sales are €102 million, and average sales growth has been a rapid 4.3%. Appendix B reveals that total compensation for organizational work exceeds that of compensation for R&D work and especially that the median compensation is much higher. Organization workers are on average 10% of all workers, while the median value is 6.1%. R&D work has even a more skewed distribution than organization work. Over half of the firms have no ICT personnel (the median is one worker) in the final data on over 1,786 firms.

3. Methodology

Intangibles are valued based on historical pricing. Investment can be in tangible capital *PPE* or in organizational capital *ORG*, research and development R&D or information and communication technology ICT, so including net plant, property and investment PPE we have an investment good I_{Xt} with price P_{IXt} of type $X = ORG,\ PPE, R\&D, ICT, PPE$. It is important to emphasize the historical values because the returns emerge in the end. Each

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

type of capital accumulates according to the perpetual inventory model $K_{Xt} = I_{Xt} + (1-\delta_X)K_{Xt-1}$ with depreciation rate δ_X, which differs according to the type of asset of type. Final consumption goods sales with real output volume in period t is denoted by C_t with price P_{Ct}. The production function and flow account for each of sectors become

$$\begin{array}{ll} \textit{Capital production function} & I_{Xt} = F_{IX}(L_{IXt}, K_{IXt}, t) \\ \textit{Capital flow account} & P_{IXt}I_t = P_{Lt}L_{It} + P_{Xt}K_{IXt} \\ \textit{Consumption production function} & C_t = F_C(L_{Ct}, K_{CXt}, t) \\ \textit{Consumption flow account} & P_{Ct}C_t = P_{Lt}L_{Ct} + P_{Xt}K_{CXt} \end{array} . \quad (1)$$

All capital appears in the production functions as a cumulative stock (K_{Xt}) and not as an intermediate input as with other types of labor (L_t). In the conventional production function, workers engaged in organization, management, R&D and ICT would be part of labor as input (which could be separately priced), and only physical capital would remain in cumulative stock. On the right-hand side of the flow account (here for capital), payments to that stock ($P_{Xt}K_{Xt}$) appear rather than payment for an intermediate input such as labor ($P_{Xt}L_{IXt}$). The production functions in each equation are linked to the accounting identities by the assumption of marginal productivity pricing. The total output (Y_t) identity is expanded to include the value of output of the intangible capital on the production side and the payments to the stock of organization workers on the income side:

$$P_{Yt}Y_t = P_{Ct}C_t + \sum P_{IXt}I_{Xt} = P_{Lt}L_t + \sum P_{KXt}K_{Xt} . \quad (2)$$

The value of any capital asset to be shown in the balance sheet represents the present value of the future income streams coming from the asset, suitably discounted. In the estimation of R&D and ICT capital, we rely on the traditional perpetual inventory method. Labor compensation can be close to the overall value of R&D activity. For example, Kauhanen and Piekkola (2006) find evidence that R&D workers may have a better idea of the proper performance measures and prefer compensation where these targets are also included in performance-related-pay negotiated with employers. R&D capital is thus calculated using in-

formation on related wage compensation multiplied by 1.25 assuming that employee compensation for R&D work is 80% of total expenses for R&D. We also assume a 20% depreciation rate (CHS use 15%). R&D compensation is deflated by the wage indices, while the resulting R&D capital is then transformed back into nominal values. R&D capital is based on observed figures over three years:

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

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 allows 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 workers are a relatively low share of all workers outside business equipment and finance. The difficulty in measuring the value also explains why in many countries including Germany, personnel costs are used as proxies for these expenditures when constructing figures for national accounts. ICT capital is calculated directly from employee compensation here, assuming a 33% depreciation rate, and is concentrated in business equipment and finance (Corrado, Hulten, and Sichel, 2005 use a 36% depreciation rate for software).

In the valuation of organizational capital, we believe that the performance-based approach is necessary because most of the returns in successful management accrue to firm value and are only partly passed along to the management. In the estimation of the production function, we explore sales instead of value added but use materials as an additional control. We use a constant returns-to-scale production function where labor input is quality-adjusted and thus, workers are divided into two categories: organization workers and others. Because of the

ambiguity in the measurement of valued added in services, we use turnover as our explanatory variable and use materials M_{it} as our additional control.[3]

$$SALE_{it} = b_{0it}(Q_{it}L_{it})^{b1} R\&D_{it}^{b2} PPE_{it}^{b3} M_{it}^{b4} \exp(e_{it}), \quad (4)$$

where
$$\begin{aligned} Q_{it}L_{it} &= w_{OCit}OC_{it} + w_{it}(L_{it} - OC_{it}) \\ &= w_{it}\left[(w_{OCit} / w_{it})OC_{it} + (L_{it} - OC_{it})\right], \end{aligned}$$

and where $SALE_{it}$ is the turnover of firm *i* in year *t*, $Q_{it}L_{it}$ is the labor quality input (L is the total number of employees, w_{OCit} is hourly compensations for organization workers, w_{it} is hourly compensations for the remainder of the workers), $R\&D_{it}$ is plant-specific R&D capital, PPE_{it} is net plants, 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 use a wide definition of R&D occupations. Labor L_{it} is 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 level of variation, while overtime hours for production workers would increase the sensitivity of our measurements to productivity shocks. Following Hellerstein, Neumark, and Troske (1999), the estimated relatively productivity defined as a substitutes for wage ratio w_{OCit} / w_{it}:

$$Q_{it}L_{it} = w_{it}L_{it}\left[1 + (a-1)\frac{OC_{it}}{L_{it}}\right], \quad (5)$$

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

where OC_{it} is the total number of organizational workers at the plant. OC_{it} relates to management and marketing. In log form, we can approximately write $\log\left[1+(a-1)\frac{OC_{it}}{L_{it}}\right]$ $\approx(a-1)\frac{OC_{it}}{L_{it}}$ because organizational workers are 9% 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 estimable production function can be written as

$$\ln SALE_{it} = [b_0 + b_1 \ln w_{it}] + b_1 \ln L_{it} + c_1 \frac{OC_{it}}{L_{it}} + b_2 RND_{it} + b_3 PPE_{it} + b_4 M_{it} + b_{jt5}[Year] * IND_{jt} + e_{it}, \quad (6)$$

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. In equation (6), the additional value of organizational capital is $a = c_1 / b_1 + 1$. 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 measure of organizational investment is thus

$$I_{ORGit} = a w_{jt} OC_{it} = w_{jt} OC_{it}[c_1 / b_1 + 1], \quad (7)$$

where w_{jt} is the reference hourly wage of non-organizational workers in the industry. Here, c_1 / b_1 shows the magnitude by which the productivity of organizational work exceeds that of the rest of the workers in the industry. Productivity is thus $(c_1 / b_1 + 1 - 1)/1 = c_1 / b_1$ percent higher than for the rest of workers. As a proxy for $w_{jt} OC_{it}$, we use the sum of annual compensations for organizational workers in the firm evaluated at the shadow price of average hourly wages in the industry. The latter is achieved by calculating the industry-level ratio of the average hourly wage of organizational workers to the average hourly wage of the rest of the workers and multiplying total annual compensation by this ratio. We lack proper data on annual hours worked and thereby on hourly wages. Hourly wages plus social security tax

(30%) multiplied by 1800 hours and by the number of organization workers would yield twice lower annual compensation at shadow prices than what we obtained using annual compensation figures directly as the basis for assessment. Thus, hourly wages are severely undervalued in comparison with the actual annual earnings.

The depreciation of organizational capital could simply follow that assumed to hold for ICT or R&D capital. CHS assume that 40% of management expenditures are depreciated within a one year, which, using a single declining balance, implies a life of 2.5 years. The COIN-VEST project, in collaboration with the central statistical office in UK, has surveyed firms about life length by asset category, obtaining a figure of 2.7 years in training, reputation and branding. We use a life length figure at the conservative end (2 years) so that the depreciation rate is 50%. Following the same assumptions as for R&D and ICT investment, stock values are given by

$$K_{ORG,it} = \{I_{ORGit} + (1-\delta)I_{ORGit-1} + (1-\delta^2)I_{ORGit-2} + (1-\delta^3)\bar{I}_{ORG}\frac{1}{1-\delta+g_{ORG}}\}, \quad (8)$$

where the depreciation rate δ is 0.5 and growth g_{ORG} follows a predetermined rate of 3% (here, the deflator used is the producer price index, and real values are transformed back into nominal values). The estimation is conducted separately for eight industries. Appendix C shows the adapted industry classification, which is based on Fama and French (1988) and (1997). The manufacturing of non-durables is separate (with most of them manufacturing electronic products and also food, textiles, and leather) because in these industries firms may more easily adapt their organizational capital for business cycles and are in this respect more comparable with service sector firms.

We also control for the endogeneity bias caused by productivity shocks, using the Olley and Pakes approach that accounts for the possibility that the measures of intangibles are correlated with these shocks. Assume that the error term of the model is decomposed into two

parts, $e_{it} = u_{it} + v_{it}$, where u_{it} is a productivity shock that is correlated with the variables measuring organizational capital-related work. For example, during positive shocks, the firm may be more inclined to invest in intangibles. The intangibles are the state variables that adjust slowly. The firm can more easily 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. If hiring depends on the shocks and the intangible variables, inverting this relationship indicates the shock as a function of hiring and the state variables. These, together with their higher powers and interactions, can hence be used as proxies for productivity shocks.

In the first step, the log of sales is regressed on the controls and the proxy including its polynomials and organizational worker share and their interactions to approximate the true, unknown relationship between the variables. The first step gives an expression of the firm-specific shocks in terms of the estimated polynomial and the intangible variables. In the second step, assuming a Markov process for the productivity shock, log sales minus the contribution of the controls is regressed on the organizational worker share and a polynomial of the shocks. We also control for the selectivity caused by the exit of firms. Following Olley and Pakes (1996), the likelihood of exit is modeled with a probit model, and the predicted probability is used as an additional variable in the second step.[4] Our main interest is the evolution of intangible capital stock over the years and by industry. Table 2 first reports the pooled estimates over industries using the derived production function that includes organizational work augmenting labor productivity (all variables except shares are in log form).

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

Table 2. OLS and Olley-Pakes estimates in explaining sales

	1	2 Olley-Pakes	3 GMM-SYS
Organization worker share	1.249***	1.794***	1.889***
	(19.54)	(8.21)	(4.44)
Employment	0.599***	0.558***	0.394**
	(60.9)	(90.54)	(3.1)
Net plant, property, equipment	0.178***	0.176***	0.328***
	(30.28)	(44.55)	(4.28)
R&D asset	0.0219***	0.0398***	0.0289*
	(9.99)	(18.71)	(2.25)
Material	0.0878***	0.110***	0.0833*
	(23.28)	(44.75)	(2.3)
Observations	14951	0.761	17179
Number of firms			2072
R Squared	0.728	0.761	
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			0.000

Log OLS estimates with t-statistics in parentheses, in column 2 Olley-Pakes estimates with proxies: hiring up to fourth potency, organizational worker share up to fourth potency and interaction between organizational worker share and hiring. State variable is organizational worker share and number of repetitions in bootstrap is 30. GMM type instruments include organizational worker share, employment, net plant, property and equipment, R&D asset all with lags. IV-type instruments include industry and year dummies and their interactions. All estimations include year and industry dummies and their interactions.

Column 1 shows that sales are positively related to the share of organizational workers. Recall from equation (7) that organizational workers bring additional value 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 210% higher productivity than the average (from 1.249/0.599). 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

320% higher productivity than the rest of the workers. Thus, our OLS estimates are not likely to be biased upwards. We next report in Table 3 the average coefficients and mean t-statistics from an OLS and Olley-Pakes estimations of equation (6) separately in the 88 industry-year categories. Fama and MacBeth's "t-statistics" $t(\overline{\beta}_k) = \overline{\beta}_k / \left(s(\beta_k) / \sqrt{88} \right)$ 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 class.

Table 3. Average coefficients and t-statistics of yearly estimates (1998–2008)

	1	2	3
Panel Mean Estimate		Weighted	Olley-Pakes
OC Share	1.393	0.998	1.263
t-value	(5.59)		(5.17)
Employment	0.613	0.593	0.531
t-value	(12.46)		(12.19)
Net Plant, Property, Equipment	0.160	0.164	0.135
t-value	(5.04)		(4.96)
R&D asset	0.038	0.023	0.031
t-value	(2.23)		(2.12)
Material	0.116	0.089	0.128
t-value	(3.41)		(3.82)

Estimation spans over 8 industries. Table shows the average coefficient, Fama and MacBeth's "t-statistics" and weighted average coefficient over the industries and years with inverse of variance in the industry as weight.

In column 1, the unweighted average coefficient for the organization worker share is 1.393, showing again large productivity gains from recruiting organization workers (weight by turnover would yield 1.455). The ratio of this average coefficient of organizational worker share to that of the average coefficient for log employment is 2.2, so organizational capital is about 220% more productive than on average. This percent is close to the same for the pooled estimation given by 210% from column 1 in Table 2. Weighting the coefficients by the inverse of the variance in the industry would yield a lower ratio of 1.7 (column 2). It is also seen that the OLS estimates (column 1) and Olley-Pakes estimates (column 3) are close to the same.

The 220% higher productivity also implies that the productivity gap exceeds the wage cap because the average hourly wage of organizational capital is around two times that of the rest of the workers. Ilmakunnas and Piekkola (2010) indeed find evidence that intangibles increase productivity more than they do wage expenditures, thus improving profitability.

Table 4 shows the relative productivity of organizational capital in various industries. We report OLS and Olley-Pakes estimates with hiring as proxy as before. The following table reports the estimates by industry:

Table 4. Mean ratio of the coefficient of organizational worker share to the coefficient of log employment by industry (1998–2008)

Industry	OLS	Olley-Pakes
Service, Consumer non-durables production	2.29	1.20
Consumer durables production (cars, TVs, furniture, household appliances; transportation, toys, sports)	1.60	1.01
Other manufacturing (machinery, metal, trucks, planes, office furniture, paper)	1.88	2.66
Chemicals and allied products, Energy, Oil, Gas, and Coal Extraction and Products	1.71	1.76
Business equipment (computers, software, and electronic equipment), Finance, Healthcare, Medical equipment, and Pharmaceuticals	-0.82	0.25
Telecom, telephone and television transmission	1.18	1.10
Wholesale, retail, and some services (laundries, repair shops)	0.73	2.27
Other (construction, transportation, building materials, mining)	2.31	1.76
Industry weighted average	1.78	1.60

The organizational workers have higher productivity than the rest of workers in every industry, except in business equipment. Services are heterogeneous, and the returns are lower in business services and in wholesale and retail than in other services. However, the second column reports Olley-Pakes estimates that are positive also in these industries. On the other hand, it emerges that in businesses with low adjustment costs, as in the production of non-

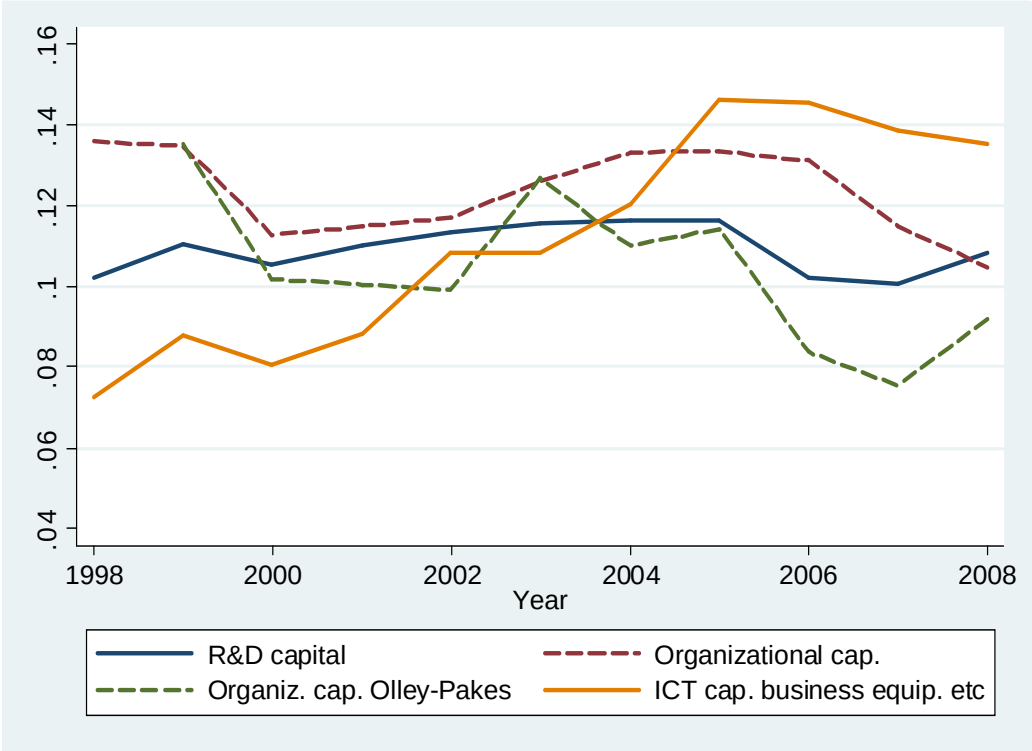
durables, the OLS estimates can be biased upwards. In these industries, the Olley-Pakes estimates are much lower than OLS. Overall, table 4 shows that the average OLS and Olley-Pakes estimates are still fairly similar. Table 5 presents the average estimates using firm-level turnover as weights and reports the intangibles per sales as well.

Table 5. Intangible capital

Variable	Mean	Standard Deviaton	Median Value	Obs number
Book value of assets	2469175	4282568	221694	11263
Organization compensation	70327	126484	9324	12823
Organization compensation/sales	2.1 %	0.032	0.012	12823
Organization capital	431799	781834	54915	12484
Organization capital Olley-Pakes	342591	586494	49793	11489
Organization capital/sales	12 %	0.17	7.2 %	12484
Organization compensation/sales Olley-Pakes	10 %	0.15	5.4 %	11489
R&D asset/sales	11 %	0.27	5 %	12823
ICT asset/sales	1.4 %	0.055	0.5 %	12823
Intangible capital/sales	25 %	0.38	17 %	12484
Intangible capital/sales Olley-Pakes	23 %	0.37	16 %	11489
Net plant, property, equipment/sales	25 %	0.55	10 %	12823

Table 5 shows that compensation for organizational work is 2.1% of sales, while organizational capital per sale is equivalent in value to around 12% in OLS and 10% in the Olley-Pakes estimation (the respective median values are 7.2% and 5.4%). Intangibles make up as much as 25% of intangibles, equalling the share of tangible investments. Moreover, we have incompletely measured software and databases although compensation for ICT work is often used as a proxy for these expenditures. We now turn in Figure 2 to the evolution of organizational, IT and R&D capital per sale, again using firm-level turnover as the weight.

Figure 2. Organizational, ICT, and R&D capital per sales 1998-2008



Organizational capital decreased from 13.5% of sales in 1998-99 to 10% of sales by 2008. Organizational capital using Olley-Pakes estimates shows an equal downward trend. ICT capital is concentrated in business equipment, finance, healthcare and telecommunication, where the share has increased to around 14% of sales (industries include computers, software, and electronic equipment; finance; healthcare, medical equipment, and drugs; and telecoms, telephone and TV transmission.) When spread over all industries, the share stays below 2% (not shown). R&D capital per sale is little below the level of organizational capital per sale and has stayed around the same over the years. Adding all of these together provides our estimated share of intangible capital from sales, which was 25% in Table 5 (or 23% with Olley and Pakes). This share has remained stable throughout the years. ICT and R&D capital have hence compensated for the loss in organizational capital.

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 500,000, 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 organizational capital is needed to maintain the network of tasks spread over the plants across countries. Lev and Radhakrishnan (2005) emphasize 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] Organizational investment (growth and value) as well as ICT and R&D investment are interchangeably explained by all suggested complements to them.

$$\begin{aligned}\log I_{IC,it} = \; & a_1 \log I_{IC,it-1} + a_2 GLOB_{it} + a_3 PRP_{it} + a_4 Y_{it} \\ & + m_0 + m_{jt1}[Year] * IND_{jt} + e_{it}\end{aligned} \quad , \qquad (9)$$

where I_{ICit} is either organizational, ICT, or R&D investment, $GLOB_{it}$ is globalization proxies, PRP_{it} is the performance-related pay dummy, 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 according to the log of employment abroad, 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

[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, 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 used in 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).

share $MKS_{imt} = SALES_{imt} / \sum_{j=1}^{n} SALES_{jmt}$ at the two-digit industry level. Table 6 shows the estimation results. To overcome common problems concerning the endogeneity of the lagged dependent variable and other potentially endogenous variables, we rely on instrumental variable techniques: GMM-SYS (Blundell-Bond, 1998). GMM-SYS estimate turns out to be the most efficient given the persistence of the dependent variable.

Table 6. Intangible investment and global firms

	1 Organizational investment	2 R&D Expenditures	3 ICT Expenditures
Lagged dependent variable	0.452***	0.524***	0.621***
	(5.18)	(5.09)	(5.77)
Domestic employment	-0.00854	0.118	0.287
	(0.08)	(1.16)	(1.58)
Foreign employment	0.119	0.116	0.0569
	(1.37)	(1.48)	(0.99)
2-3 plants	2.664***	1.579***	-0.553
	(4.22)	(3.52)	(1.41)
4 or more plants	2.258***	0.521	-1.295*
	(3.54)	(0.78)	(2.01)
Net plant, property, equipment	-0.00986	0.131*	0.236*
	(0.18)	(1.98)	(2.27)
Firm age	0.0317	-0.00494	-0.0684
	(0.1)	(0.02)	(0.15)
Market share	0.0221	0.0218**	0.0135
	(1.59)	(2.64)	(0.85)
Listed Firm	-19.99	-63	7.065
	(0.37)	(1.16)	(0.43)
Performance-related-pay	0.197	0.35	0.336*
	(0.66)	(1.13)	(2.07)
Firm size 20-49	-1.801	-1.722	-0.117
	(1.25)	(1.62)	(0.15)
Firm size 150-499	-0.962	-0.679	0.594
	(0.88)	(0.66)	(0.85)
Firm size >499	0.548	-0.433	-0.33
	(0.54)	(0.43)	(0.37)
Sample size	10603	10603	1249
Number of firms	1664	1664	207
Arrelano-Bond test AR(1) first difference p-value	1.113	0.489	1.529
Sargan test of overidentifying restrictions p-value	0.00	0.10	0.00

Hansen test of overidentifying restrictions p-value	-0.520	0.852	0.996

All variables except dummies and foreign employment share are in logs. GMM type instruments include employment, employment abroad and plant, property and equipment , all with lags. IV-type instruments include industry and year dummies and their interactions. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

All intangible investment and expenditures, whether organizational, ICT or R&D, are positively related. In the correlation table in Appendix B, the correlations in the per sales values are around 0.2 (see Table B.2 in the Appendix). It is visible in Columns 1 through 3 that the growth in organizational investment and ICT and R&D expenditures is also largely explained by the same factors. An important finding is that multinational firms with many plants exhibit stronger growth in intangible investment. Organizational and R&D investments are most clearly concentrated in globalizing firms that are large in size and have an increasing share of market value (in R&D investment). The analysis thus shows that global firms invest in intangible capital. It is also interesting to note that multinationals with two or more plants have around 250% more organizational investment and 150% more R&D investment in the short run . Thus, large firms with many plants are typically those that have the greatest amount of intangible capital. The firms listed on the Helsinki stock exchange do not, however, have noticeably more organizational or other types of intangible capital after all these factors are controlled for. It is also clear from the later market valuation analysis that small listed firms have on average even greater investment in intangible capital than do large firms. Finally, firm age, derived from the longest length of service among workers, has no clear relation to intangible investment.

In sum, it is clear that intangibles play a greater role in a global firm. At the same time, organization capital per sale has decreased on average over time. All of these intangibles may potentially have a large impact on the valuation of firms, which is the subject of our next section.

5. Intangible capital and market value

Our final step is to evaluate how intangibles enter into the valuation of the firm. We already know from Ilmakunnas and Piekkola (2010), using essentially the same data, that intangibles increase productivity more than wage expenditures, thus improving profitability. It appears from many studies (e.g., Brynjolfsson, Hitt, and Yang, 2002), that the value of intangible assets also 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 able to account for these long-term productivity effects. Rather than examining (positive) profitability effects, we analyze whether intangible capital has greater predictive power than forecasts by economic analysts. We do so by using a residual income valuation model that has been further improved by Ohlson (1995). We analyze whether organizational capital can explain the weak relation 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:

$$MV_{it} = \sum_{\tau=1}^{\infty} \frac{E_t(DIV_{it+\tau})}{(1+r_i)^{\tau}}, \tag{10}$$

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

$$BV_{it} = BV_{it-1} + FE_{it} + a_{it}K_{IC,it-1} - DIV_{it}, \tag{11}$$

where BV_{it} is the book value (balance-sheet value of assets minus liabilities), FE_{it} is the 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 $K_{IC,it}$ (organization, ICT, or R&D) that is not in-

cluded in these analyst forecasts. We next use equations (10) and (11) and write market value as a function of book value, discounted expected abnormal earnings, and intangible capital:

$$MV_{it} = BV_{it} + RE_{it} + K_{IC,it} \ , \tag{12}$$

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

$$\begin{aligned} RE_{it} = {} & (1+r_{it})^{-1}(FE_{it} - r_{it}BV_{it-1}) + \\ & (FE_{it+1} - r_{it}BV_{it})(r_{it} - g_{it})^{-1}(1+r_{it})^{-2} \end{aligned}, \tag{13}$$

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 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 because the firms are too heterogeneous in size. We use the logarithmic approximations of (12) through (13)

$$\begin{aligned} \ln MV_{it} = {} & \sigma_{fe} \ln FE_{it} + \sigma_r \ln r_{it} + \sigma_{bv} \ln BV_{it} + \sigma_{in} \ln K_{IC,it} \\ & + \sigma_{jt}[Year] * IND_j \end{aligned}, \tag{14}$$

where $K_{IC,it}$ is in intangibles by type (organizational, ICT and R&D) and the last term stands for the year and industry dummies and their interaction. It is shown in Table 4 that the relative productivity of organizational work differs by industry and is highest in manufacturing and telecommunications. 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 7 shows the summary table first.

Table 7. Summary of variables

Variable	Mean	Standard Deviation	Median Value	Obs
Market Value (€ 1000)	45364	66298	7959	393
Analyst Forecast Profits March (€ 1000)	2034	2265	610	393
Discount rate	7.9	0.7	7.9	393
Book Value (Net of liabilities) (€ 1000)	5695	4660	5763	393
Organization capital (€ 1000)	958	993	357	393
ICT capital (€ 1000)	136	154	45	393
R&D capital (€ 1000)	2143	2415	196	393
Organization capital/sales	10 %	0.12	7 %	393
Organization capital/sales Olley-Pakes	8 %	0.1	5 %	393
ICT capital/sales	1 %	0.024	1 %	393
R&D capital/sales	13 %	0.14	16 %	393
Plant, Property, Equipment/sales	21 %	0.29	6 %	393

The companies typically operate on a global scale and are large in size. It is apparent that in the 55 firms observed, the median market value exceeds book values by a factor of 7 on average. Intangibles sum up to around half of book value. Organizational capital is on average 10% of sales and is thus below the figures for the data at large; see Table 5. The firms are relatively intensive in their R&D capital, which has a 13% share of sales. We also expect that analysts' forecasts and organizational capital can play a different role in services and manufacturing. Bloom, Sadun, and Van Reenen (2007) argue that the role of organizational capital in productivity growth (and hence in market value) is more important in services and in the manufacturing of non-durable goods than in the other manufacturing sector. Therefore, the ICT-intensive production of non-durable goods is here pooled together with services. Bau-

mol (2004) explicitly emphasizes the innovative role of many small high-technology firms. Here we analyze separately manufacturing and non-manufacturing. Table 8 shows the results of the estimation of (14) across 55 firms listed on the stock market using random effect estimates (the first column is a reference in which intangible capital has been omitted from the regressors).

Table 8. OLS estimates for organizational capital and intangible capital in explaining market value less book value

	1	2	3 Olley-Pakes estimates	4 Manufacturing Construction	5 Services, ICT
Economic forecast	0.388***	0.351***	0.352***	0.195***	0.574***
	(7.39)	(7.77)	(7.56)	(6.21)	(7.03)
Discount rate	0.268*	0.208	0.21	0.912***	0.0838
	(2.27)	(1.81)	(1.81)	(5.69)	(0.51)
Book value	0.568***	0.482***	0.484***	0.557***	0.363***
	(9.7)	(8.09)	(8.11)	(11.72)	(3.61)
Organization capital	_	-0.900**	-0.693*	-0.755	-0.439
	_	(2.81)	(2.38)	(1.14)	(1.1)
Organization capital squared	_	0.0467**	0.0370**	0.0472	0.0182
	_	(3.13)	(2.64)	(1.44)	(1)
ICT capital	_	0.194***	0.206***	0.182*	0.199***
	_	(4.4)	(4.55)	(2.35)	(3.56)
R&D capital	_	0.0295	0.0435	-0.119*	0.136**
	_	(1.07)	(1.62)	(2.49)	(3.27)
Firm size <200	0.151	0.227	0.274	-0.421*	-0.123
	(1.23)	(1.51)	(1.9)	(2.25)	(0.57)
500<=Firm size<2000	0.309***	0.341***	0.314**	0.461*	0.349*
	(3.63)	(3.63)	(3.45)	(3.14)	(2.12)
2000 <=Firm size	-0.0464	-0.0464	-0.514***	-0.542***	-0.339
	(0.34)	(0.34)	(3.49)	(3.7)	(1.3)
Observations	462	404	401	192	221
R Squared	0.89	0.92	0.92	0.96	0.91

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

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

A 10% improvement in the economic forecast estimates made in March predicts a 3-4% rise in the market value of the firm over the entire year. The forecasts perform weakest in manufacturing (column 4). Over half of the rise in the net book value is also reflected in market value. Thus, economic forecast and improved net book value can explain a substantial part of market value variation. It is visible that a higher discount rate (or systematic risk from beta estimates) is also positively and significantly correlated with market value, which is contrary to our expectations. Column 1 shows that these alone explain over 89% of the variation in the log of market value (including the influence of additional variables, firm size, and five industry and year dummies).

The magnitude of the improvement in explanatory power is a modest 3% when including intangible capital. For organizational capital to improve, market value intangibles have to exceed €139 million in OLS estimates, and this holds for 10 of the 55 firms; see appendix D. The non-linearity is roughly the same when Olley-Pakes estimates have been used. Recall that large firms with market power and global operations have a lot of organizational capital and that this can relate positively to market values. 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 1990, and this pattern may better hold for the largest firms in Finland. Like Cummins (2005), we do not find that appreciable intangibles are associated with R&D except in non-manufactuing. We find instead that ICT capital increases market value. We also find that the results are roughly the same in manufacturing and non-manufacturing with the exception of R&D. The intangibles are not more valuable outside manufacturing, although R&D capital may better signal new implementable innovations and marketing abilities.

Tables D.1 and D.2 in the Appendix D show the average intangible capital, book value and market value of the 55 firms over the period (the average span of years is 7.3 in the eleven-year period from 1998-2008). Firms are divided into those with market value per book value above the median (Table D.1) and below the median (Table D.2). In firms with high market value per book value in Table D.1, intangibles are on average 53% of the book value, whe-

reas the equivalent figure is four times higher (199%) for firms that have low market value per book value ratios in Table D.2. The sales weighted ratio of market value to book value over all firms is 100%, but this figure is lower (44%) for the low market-value per book value firms, so the inclusion of small firms explains the very high ratios of intangible capital to book values in Table D.2. One intuitive explanation for this is that small firms that are intensive in intangible capital are more likely to be listed on the stock market to have their intangibles priced in the market.

6. Conclusions

Intangibles have increased in importance during the globalization process. Bloom, Sadun, and Van Reenen (2007) emphasize the importance of organizational capital to productivity growth in services, which is confirmed by our analysis. Intangibles have persistently accounted for around 25% of sales throughout the period, which is the same as the share for tangible fixed assets. A full model incorporating organizational capital is useful in explaining productivity growth or market valuation. 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. A performance-based evaluation of management and marketing is also necessary because organizational expenditures as such may indicate excessive administrative expenses.

R&D capital and organizational capital are roughly equal share of share and around 90% of intangibles. The ICT capital share is less below 10% and concentrated in specific business services and equipment industries but should not be ignored given the significant effects on market valuation. Physical capital stock constituted 25% of GDP in the private sector, and intangibles including advertising, training, software and non-scientific R&D are likely to exceed this share. The estimates obtained on the national level in INNODRVE indicate the share of intangible capital from GDP to be around 15% for Finland in the INNODRIVE project, and the estimate obtained here exceed this even though non-scientific R&D and some of the investment in software and database are omitted. Organizational capital, along with ICT and R&D capital, also explains 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. Intangible capital grows with a firm's level of globalization, suggesting that it is a crucial input for multinational firms. In addition, small firms listed in stock market are also very intangible capital intensive. These observations are noteworthy because according to the INNODRIVE project, the growth of intangible capital assets in the EU-27 was lower in the first half of 2000s than in the latter half of the 1990s.[8] Small firms should be listed in stock markets to develop a better valuation of intangibles, but listings have been rare in recent years. Future research should further develop a performance-based methodologies that are better adapted to the firm-level evaluation of intangibles, providing the tools for improving productivity and performance.

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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	102543	713704	19115	12823
Sales Growth	0.043	0.45	0.027	11908
Value Added	18959	80538	5003	12823
Employment	318	990	104	12823
Employees in organizational work	30	138	7	12823
Organizational worker share	10.0 %	0.13	6.1 %	12822
Organizational compensation	2321	11777	507	12823
Management compensation	949	6785	197	12823
Management personnel	15	88	4	12823
Marketing, purchases compensation	610	2939	111	12823
Marketing personnel	15	69	2	12823
ICT compensation	532	4019	35	12823
ICT personnel	10	72	1	12823
R&D compensation	1818	20871	98	12823
R&D capital	12055	138096	708	12823
Net plant, property, equipment	26204	157615	2535	12823
Material	9520	43253	1432	12823
Organizational capital per sales	22.0 %	27.0 %	13.0 %	12484
Organizational capital per sales Olley and Pakes	19.0 %	25.0 %	10.0 %	11489
R&D capital per sales	22.0 %	150.0 %	3.7 %	12823
ICT capital per sales	2.7 %	16.0 %	0.3 %	12823
Intangible capital per sales	47.0 %	160.0 %	20.0 %	12823
Intangible capital per sales Olley and Pakes	42.0 %	160.0 %	16.0 %	12823

Table B.2 Summary of correlations

	Org. Inv.	ICT Inv.	R&D Inv.	Sales Growth	Net plant, property, equipm. per sales
Organizational investment per sales	0				
ICT investment per sales	-0.12	0			
R&D investment per sales	-0.04	-0.01	0		
Sales growth	-0.07	-0.02	-0.02	0	
Net plant, property, equipment per sales	0.13	0.01	-0.01	-0.15	1
Material per sales	-0.03	0.00	-0.02	-0.16	0.11

Appendix C. Industry classification

	Industry	NACE Rev. 1	Main industry
1	Services, 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 sport goods	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; 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. Intangible Capital and Asset Values in Selected Firms on the Helsinki Stock Market

Table D.1 Average Intangible Capital, Book Value in High Market Value / Book Value Firms

Name	Intangible Capital	Book Value	Int.Cap/ BV	Market Value	Market Value/Book Value
Nokia	6738	9291	73 %	88400	9.5
Metso	1117	1561	72 %	1964	1.3
Finnair	927	433	214 %	1078	2.5
Elisa	805	1322	61 %	1415	1.1
Upm_Kymmene	497	6166	8 %	6366	1.0
Orion	495	457	108 %	686	1.5
Wartsila	370	1144	32 %	4338	3.8
Rautaruukki	367	1190	31 %	625	0.5
Storaenso	294	7821	4 %	4872	0.6
Kone	220	1777	12 %	3195	1.8
Outotec	207	193	107 %	1339	6.9
Sanoma	205	806	25 %	1406	1.7
Yit	196	677	29 %	3337	4.9
Outokumpu	170	3236	5 %	3462	1.1
M_Real	152	2134	7 %	1506	0.7
Vaisala	150	128	118 %	336	2.6
Kemira	140	744	19 %	792	1.1
Kesko	121	1356	9 %	1607	1.2
Konecranes	111	163	68 %	555	3.4
F_Secure	95	45	209 %	437	9.6
Nokianrenkaat	84	342	25 %	2778	8.1
Ahlstrom	84	938	9 %	1094	1.2
Hkscan	69	162	43 %	604	3.7
Tamfelt	59	93	64 %	153	1.6
Lemminkainen	44	131	34 %	239	1.8
Ponsse	40	43	92 %	368	8.5
Raisio	39	258	15 %	357	1.4
Ramirent	32	106	30 %	339	3.2

Scanfil	25	95	26 %	54	0.6
Aldatasolution	21	19	108 %	137	7.1
Almamedia	9	524	2 %	575	1.1
Correl. with Intangible Capital		0.67		0.98	
Average			53 %		3.1

Table D.2 Average Intangible Capital, Book Value in Low Market Value / Book Value Firms

Name	Intangible Capital	Book Value	Int.Cap/ BV	Market Value	Market Value/Book Value
Etteplan	134	17	768 %	25	1.5
Ixonos	106	11	973 %	33	3.0
Digia	70	11	607 %	102	8.8
Atria	66	236	28 %	347	1.5
Raute	52	31	166 %	44	1.4
Solteq	47	11	438 %	9	0.8
Rocla	38	15	249 %	26	1.7
Pkcgroup	32	35	92 %	236	6.7
Honkarakenne	27	23	121 %	20	0.9
Okmetic	27	60	45 %	72	1.2
Tulikivi	26	24	104 %	40	1.6
Lannentehtaat	25	85	30 %	79	0.9
Olvi	25	59	42 %	214	3.6
Salcomp	23	43	54 %	130	3.0
Nordicaluminium	21	24	88 %	126	5.3
Martela	19	38	52 %	51	1.4
Componenta	19	52	36 %	128	2.5
Sshcommunications	18	19	94 %	37	1.9
Exelcomposites	17	19	88 %	101	5.3
Marimekko	14	19	71 %	121	6.2
Elecster	10	10	99 %	9	0.9
Kesla	8	6	131 %	21	3.4
Pohjois_Karjalankirjapaino	8	24	33 %	53	2.2
Ilkkayhtyma	7	38	18 %	114	3.0
Correl. with Intangible Capital		0.08		-0.03	
Average			199 %		2.9