Received 13 October 2022
Revised 28 December 2022
Accepted 20 May 2023

Intangible capital and financial leverage in SMEs

Antti Norkio
University of Vaasa, Vaasa, Finland

Abstract

Purpose – Intangible capital (IC) is an important factor for economic growth and firm performance. The role IC has played has become even more crucial in recent decades, possibly influencing debt capacity and default risk assessment. This paper studies how entrepreneurial and employee-based IC affects financial leverage.

Design/methodology/approach – Employer–employee unbalanced panel data provided by Statistics Finland that refer to Finnish small and medium-sized enterprises (SMEs) are used. Intangibles are measured with an expenditure-based method. Employee-based IC and entrepreneurial knowledge are used to explain debt financing in SMEs.

Findings – The findings imply that IC-intensive firms have less debt capacity due to weak pledgeability and asymmetric information between borrower and lender. Entrepreneurs with managerial or financial knowledge increase the firm's debt capacity compared to other entrepreneurs, especially in knowledge-intensive services (KIS). One explanation is that the entrepreneurs are more competent in negotiating with lenders as the entrepreneurs possess better financial skills. Entrepreneurs with technical knowledge decrease the firm's debt capacity in all industries.

Originality/value – While some earlier research focused on the IC–financial leverage relationship, hardly any study has looked at entrepreneurial IC. This paper provides new insights by including entrepreneurial IC alongside employee-based IC.

Keywords Intangible capital, Financial leverage, Firm financing, Innovation management, Entrepreneurship, SME

Paper type Research paper

1. Introduction

This paper examines the impact of intangible capital (IC) on financial leverage within Finnish small and medium-sized enterprises (SMEs). Although some earlier research focused on the IC–financial leverage relationship, to the best of our knowledge no study has included entrepreneurial IC, despite it being a significant factor for firms' financial performance (see, e.g. Dillen *et al.*, 2019; Watson *et al.*, 2003; Brüderl and Preisendörfer, 2000). The gap in existing studies including entrepreneurial IC might partly be due to the scarcity of such data. Entrepreneurial IC shows entrepreneurs' orientation and capabilities in their intangible assets and knowledge, which can roughly be divided into technical and managerial knowledge or ability. This form of IC refers to the entrepreneurs' ability to manage, for instance, innovation processes, daily operations of the firm and various kinds of negotiation processes with creditors and other stakeholders. These abilities are likely differently distributed across this range of operations depending on whether the entrepreneur is focused on technical or managerial knowledge. This paper offers new insights into how

JEL Classification — G32, O32, O34

Funding: This work was supported by the EU's Horizon 2020 GLOBALINTO project for the period 2019–2022 (grant number 822229). (www.globalinto.eu).

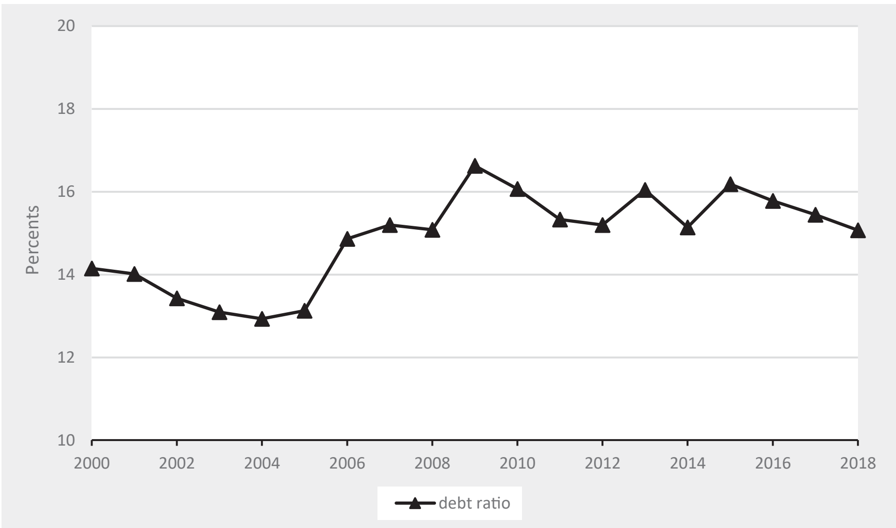
Managerial Finance
Vol. 50 No. 2, 2024
pp. 434-450
Emerald Publishing Limited
0307-4358
DOI 10.1108/MF-10-2022-0488

entrepreneurial IC – related to management and finance [organizational capital (OC)] and research and development (R&D) – affects debt financing.

The causal effect between IC and debt financing may not be that straightforward because of IC's high adjustment costs (Hall and Lerner, 2010) and weaker pledgeability, compared to that of tangible capital (Giglio and Severo, 2012). Intangible-intensive firms are found to have tighter credit constraints, in part because IC cannot be efficiently redeployed by the lender (Rampini and Viswanathan, 2013). The weak pledgeability might also cause asymmetric information between borrower and lender (Hall and Lerner, 2010), which adds to the risks the creditor faces. Despite the weaker pledgeability, i.e. collaterability, it has also been found that firms with identifiable intangible assets engage in more leveraging (Lim *et al.*, 2020). Horsch *et al.* (2021) further note that IC actually supports financial leverage in USA publicly listed firms. Graham *et al.* (2015) state that the financial leverage of USA firms has increased over the decades, while asset tangibility has decreased. In Finnish SMEs, financial leverage has increased slightly since the early 2000s (Figure 1).

Still, knowledge is limited with respect to the debt financing of intangible-intensive firms, especially while considering entrepreneurial IC, even though IC's significance is likely to rise in the future due to digitalization and a better educated labor force. This paper is the first to include entrepreneurial IC while studying IC's impact on financial leverage. In addition, the results are analyzed separately for manufacturing and knowledge-intensive services (KIS) firms, showing that IC-intensive firms have less debt capacity than other firms. Entrepreneurs with managerial or financial knowledge increase their firm's debt capacity more than other entrepreneurs, particularly in KIS. One explanation for this is that they are more competent in negotiating with lenders as they possess superior financial skills. Entrepreneurs with technical knowledge, in contrast, decrease their firm's debt capacity in all industries.

Section 2 of this article presents literature about IC and firm financing and develops hypotheses. Section 3 describes the data and Section 4 outlines the methodology. Section 5 presents the results while Section 6 provides some concluding remarks.



Source(s): Created by author

Figure 1. Yearly averages of debt ratio weighted by sales

2. Literature review

IC refers to a large share of different assets, for instance, databases, software, human capital, OC, branding and scientific R&D. These assets, among other intangibles, are key factors for ensuring innovation, which is a significant driver of economic growth (Piekkola, 2011). The importance of IC for economic growth has increased (Jona-Lasinio and Meliciani, 2018); for instance in the United States of America, half of all firms' investments are directed to IC (Corrado *et al.*, 2009). However, the definition of IC is neither very specific nor clear. Corrado *et al.* (2005) offer one of the broadest definitions: "any use of resources that reduces current consumption in order to increase it in the future . . . qualifies as an investment." This means that all investments, for e.g. made in the firm's organization, could be regarded as some kind of capital. Naturally, the pledgeability of several forms of IC is extremely weak, which weakens the reasoning for discussing "capital" in terms of financing. Nevertheless, one can also find IC like patents that are redeployable by the creditor and thus efficiently pledgeable (Amable *et al.*, 2010). In this study, we use an expenditure-based IC calculation method based on using labor costs and entrepreneurial income related to innovative work as a proxy for IC (see Piekkola, 2020; Rahko and Piekkola, 2020). This method enables us to consider such IC, which cannot be directly determined by inspecting a firm's financial statements. The IC measurement method is described in more depth in subsection 3.4.

In theory, tangible capital increases a firm's financial leverage since it is more liquid than IC (Harris and Raviv, 1991), even though it can be very country and business sector specific (Koralun-Bereźnicka, 2013). Yet, it can also increase the probability of the firm's default due to the higher financial leverage, while the regulation of pledgeability affects its financial leverage as well. For instance, firms operating in environments with looser regulations of land tradability tend to have higher financial leverage (Hall, 2012). The same mechanism also works between financial leverage and debt maturity, namely regulatory institutions can influence the financial leverage of firms by adjusting the tradability of their assets. This finding is consistent with Campello and Giambona (2013) who show that salability is an important factor while considering pledgeability.

While tangible capital increases debt capacity, the impact of IC is more ambiguous. Hall and Lerner (2010) state that IC and financial leverage have a negative relationship due to information asymmetry and a lack of collateral, notwithstanding Lim *et al.* (2020) suggest that the relationship would be positive. Horsch *et al.* (2021) also note that IC actually supports financial leverage. However, both studies only consider identifiable IC, whereas this paper applies a broader approach by exploiting the expenditure-based method described in subsection 3.4 as it enables us to view IC as a much broader concept and include IC that would be overlooked if we were to stick to identifiable assets alone. In fact, Sun and Xiaolan (2019) do not observe a correlation between IC and debt issuance. It is also possible that IC-intensive firms have relatively more short-term debt than firms with less IC (see Li, 2018).

With regard to the characteristics of different kinds of IC, we note that they might have some fundamental differences in terms of finance. As intangible investments rely on internal finance more than tangible investments (see Thum-Thysen *et al.*, 2019), we assume that this constraint is emphasized especially with R&D investments (see Hall *et al.*, 2016) due to their venturous and risky characteristics: complex projects, difficulty of monitoring and inherent uncertainty (Revest and Sapio, 2012). OC investments are directed at subjects somewhat more easily perceived as focusing more on running the existing business. We assume that it is easier for lenders to assess the risk level of such investments compared to R&D, making lenders more willing to fund them. This reasoning also finds support with Revest and Sapio (2012), Deakins and North (2013) and Carpenter and Petersen (2002) who state that technology-based small firms (which are R&D-intensive by definition) must generally rely on internal finance.

Long and Malitz (1985) note that debt and R&D investments have a negative relationship due to tighter credit constrains. A tighter credit constraint follows from weak pledgeability as

IC cannot be efficiently redeployed by the lender in the event of a default (Rampini and Viswanathan, 2013). This means that internal finance is a comparably important source for funding intangible investments (see Thum-Thysen *et al.*, 2019). We also assume that, compared to other IC investments, R&D investments rely even more on internal finance because of their venturesome nature and riskiness (see Hall *et al.*, 2016). The relatively low value of IC as collateral leads to the first hypothesis, namely:

H1. While employee-based IC (both R&D and OC) decreases financial leverage, the impact for R&D is stronger due to its venturous and risky characteristics.

While entrepreneurial IC is a sort of specific segment of IC, it can especially be seen as an entrepreneurial capability or knowledge. Such abilities are likely differently distributed into the range of operational tasks entrepreneurs face, depending on whether the entrepreneur is focused on technical or managerial knowledge. We may hence assume that entrepreneurs possessing different kinds of orientations and knowledge also have some differences in terms of their financial skills. Revest and Sapio (2012) describe how technology-oriented entrepreneurs have limited financial skills. In contrast, we may assume that entrepreneurs with managerial or financial knowledge, including occupations like administration managers and finance professionals (see Appendix 2), have better financial skills than technology-oriented entrepreneurs. Hence, they might be more competent in negotiating with lenders, resulting in higher debt capacity. This is supported by Cowling *et al.* (2016) who note that entrepreneurs holding financial qualifications are more likely to have access to credit. The second and third hypotheses are as follows:

H2. The managerial and financial knowledge of entrepreneurs (OCE, see Table 1) increases financial leverage.

H3. The technical knowledge of entrepreneurs (R&DE, see Table 1) decreases financial leverage because it is linked to limited financial skills and venturous projects.

The hypotheses differ between OCE and R&DE since entrepreneurs possessing managerial or financial knowledge are more related to day-to-day operations of the firm and shorter projects than R&D-focused entrepreneurs. The latter engage more on innovative and

Variable	Explanation
debt ratio	Long-term debt divided by total assets (%). See Equation (1)
OC/L	Employee-based organizational capital divided by the number of employees. Calculated from labor costs related to organizational workers
R&D/L	Employee-based R&D capital divided by the number of employees. Calculated from labor costs related to R&D workers
OCE	Entrepreneurial organizational capital. Calculated from the entrepreneurial income of entrepreneurs possessing managerial or financial capability or knowledge
R&DE	Entrepreneurial R&D capital. Calculated from the entrepreneurial income of entrepreneurs possessing technical capability or knowledge
K/L	Tangible capital, i.e. buildings and machinery, divided by the number of employees
ROA	Return on assets measured as *net income/total assets*
Firm risk	Standard deviation of net income covering periods t, $t-1$ and $t-2$
L	The number of employees
Firm age	Calculated from the year the firm entered the VAT register, or the year it was founded; the earlier one is used
HighTech	A dummy variable for high-tech firms
machinv/L	Net investments in machinery divided by the number of employees

Source(s): Created by author

Table 1. Definitions of the variables

venturous long-term projects, which emphasizes the problem of asymmetric information between borrower and lender.

3. Data

3.1 Sample

The firm-level linked employer–employee data provided by Statistics Finland consist of data for Finnish limited companies between 2000 and 2018 with remote access in the Globalinto 2019–2022 project as part of European Union (EU) Horizon 2020 The mechanisms to promote smart, sustainable and inclusive growth under grant agreement No 822259. The observations refer to firms with more than 9 but less than 251 employees. We exclude firms with lower employment since the characteristics of micro firms can differ significantly from those of SMEs. Construction, agriculture and financial and insurance firms are also excluded. In construction, the measurement of tangible capital and OC is imprecise in our data, while in agriculture intangibles are usually defined as monetary values of non-market goods, and thus, the methodology applied in this study cannot be applied. Moreover, the capital structure of financial and insurance firms may differ so distinctly from those of other firms that they should be considered in a separate study. We focus on SMEs because they have a crucial role in creating new job vacancies. The net employment change was negative in Finnish SMEs only in 2009 and 2013. The job creation and destruction rates are available from the author upon request.

3.2 Variables

The dependent variable is the debt-to-total-assets ratio (debt ratio), calculated by dividing long-term debt by total assets. Values of the debt ratio that are negative or larger than 200 (%) are excluded (574 observations). These outliers can indicate remarkable negative equity, for e.g., when the firm is going out of business, or they could be typos.

$$Debtratio_{i,t} = \frac{longtermdebt_{i,t}}{totalassets_{i,t}} \times 100. \quad (1)$$

Yearly averages of the debt ratio are shown in Figure 1. The averages are weighted by sales to reduce the distortion created by the considerable share of small firms. The largest one per mille of firms in terms of sales is omitted from the calculation to reduce the yearly fluctuation caused by some of the biggest firms in terms of sales. Hence, the figure expresses more clearly the development of financial leverage in the whole sample. The financial crisis can be detected in the graph as the debt ratio increases until 2009. However, it also remained high after the crisis.

The explanatory IC variables are the natural logarithms of OC and R&D capital per employee. The IC variables are generated by accumulating the labor costs related to innovation work. The IC measurement method is discussed in more detail in subsection 3.4. We also include variables of entrepreneurial IC (ICE) for OC and R&D. This can be seen as an entrepreneur's capability or knowledge. ICE variables are measured by the same method as for the IC variables, except they are generated by accumulating the entrepreneurial income of entrepreneurs with IC-related occupations (see Appendix 2).

In addition, we include the natural logarithm of the number of employees (L) as a proxy for returns to scale. Tangible capital (K), i.e. buildings and machinery, also serves as a control variable. Firm age is added to control the different financial needs of young and old firms. Profitability (*ROA*) is included since higher profitability lowers preferences for debt due to the higher internal finance. Firm risk is added as well because it lowers potential debt service capacity due to the uncertainty of future cash flows. Definitions of all these variables may be found in Table 1.

Revest and Sapio (2012) refer to the difficulties of technology-based small firms while seeking to raise debt as their projects are often risky and usually have a lack of collateral, which stresses the problem of asymmetric information between borrower and lender. A high-tech dummy variable is, therefore, included as a control variable. We also include industry- and time-fixed effects (FE) to control industry-specific characteristics and production shocks. One- and two-period lagged investments in machinery per employee (*machinv/L*) are used as additional instruments in instrumental variable regression with a generalized method of moments (IV-GMM) estimations to control productivity shocks.

3.3 Descriptive statistics

In Table 2, Panel A presents the descriptive statistics of the variables. The mean debt ratio is 17% while the median is 8%. As we may see, R&D/L is the most prominent IC variable. Average R&D per employee is EUR 30,400 and entrepreneurial R&DE is on average EUR 7,560. However, tangible capital is much more significant with an average value of EUR 229,000. The values are measured in thousands of 2015 euros. In total, 9% of all firms are

Panel A: Details of the variables

Variable	Mean	Median	Std	N
debt ratio	16.73	7.66	22.35	138,112
OC/L	14.36	4.60	26.84	138,112
R&D/L	30.40	12.57	66.36	138,112
OCE	1.84	0.00	17.28	138,112
R&DE	7.56	0.00	54.15	138,112
K/L	228.76	169.45	327.47	138,112
ROA	0.04	0.05	0.19	138,112
Firm risk	0.08	0.05	0.10	138,112
L	37.44	23.00	38.57	138,112
Firm age	20.70	21.00	10.57	138,112
HighTech	0.09	0.00	0.28	138,112
machinv/L	12.57	1.36	23.88	138,112

Panel B: Correlation with dependent and intangible variables

	debt ratio	OC/L	R&D/L	OCE
OC/L	−0.073*			
R&D/L	−0.037*	0.296*		
OCE	−0.028*	0.309*	0.141*	
R&DE	−0.030*	0.154*	0.392*	0.197*

Panel C: Variance inflation factor

	VIF
L	11.55
K/L	9.83
Firm age	5.07
R&D/L	3.31
OC/L	2.39
Firm risk	1.71
R&DE	1.41
OCE	1.23
ROA	1.12
HighTech	1.02
Mean VIF	3.87

Note(s): In Panel A, values of intangible and tangible capital in thousands of 2015 euros. OCE and R&DE refer to entrepreneurial IC. L refers to the number of employees. In Panel B, * indicates a significance level of 0.05
Source(s): Created by author

Table 2.
Descriptive statistics

considered as high-tech manufacturers and the firms' median age is 21 years. If a firm does not have a certain capital or debt, the variable is given a value of 0.

In Table 2, Panel B presents a correlation table with a dependent variable and the IC variables. The IC variables have a negative correlation with the debt ratio, providing support for the theory of weak pledgeability. Panel C shows the variance inflation factor (VIF), which is used to test multicollinearity. Although some positive correlations exist between IC variables, VIF does not indicate a problem of multicollinearity within the variables of interest (see Neter *et al.*, 1989; Hair *et al.*, 1995). *L*, *K/L* and *Firm age* are included as control variables and are thus allowed to have higher VIF values.

3.4 IC measurement method

We evaluate intangibles from innovation labor costs, relying on the same expenditure-based estimation method for IC variables as used by Piekkola (2020), Rahko and Piekkola (2020) and Eklund (2020). A portion of intangible-related labor costs multiplied by a factor multiplier is used as a proxy for nominal IC investments $P^N_{i,t}N^{IC}_{i,t}$ in Equation (2) (see Piekkola, 2020). They are split into OC (management capital) and R&D according to an employee's occupation (see Appendix 2). The presumed innovation-generating time-use shares of these intangible-related employees are 0.45 for OC and 0.9 for R&D. We obtain the combined multiplier by multiplying the time-use shares of innovative work by a factor multiplier, which covers the assumed use of other factor inputs (tangible capital and intermediates) per unit of labor input. The nominal IC investments are calculated as follows:

$$\begin{aligned} P^N_{i,t}N^{IC}_{i,t} &= z^{IC}l^{IC}M^{IC}_{i,t} \\ &= A^{IC}M^{IC}_{i,t}, \end{aligned} \tag{2}$$

where IC refers to the IC sectors: OC and R&D. z^{IC} is the factor multiplier and l^{IC} is the employment share used for innovative work. $M^{IC}_{i,t}$ is the labor costs of IC employees and A^{IC} is the combined multiplier, which is measured by multiplying the employment share by the factor multiplier. The combined multipliers are 0.7 for OC and 1.1 for R&D. The multipliers are compiled in Table A2 in Appendix 2. $P^N_{i,t}$ is the IC specific deflator. After the yearly IC investments are calculated, they are accumulated by the equation as follows:

$$R^{IC}_{i,t} = R^{IC}_{i,t-1}(1-\delta_{IC}) + N^{IC}_{i,t}, \tag{3}$$

where $R^{IC}_{i,t}$ is the real stock of IC, δ_{IC} is the IC specific depreciation rate and $N^{IC}_{i,t}$ is the deflated IC investment in period t (Piekkola, 2020). The theory assumes a constant depreciation rate δ_{IC} for IC. The depreciation rate for OC is 20% in line with Lev *et al.* (2016) and Squicciarini and Le Mouel (2012), and for R&D, it is 15% in accordance with the latter authors.

In addition, we have variables for entrepreneurial IC, which has hardly been studied in the literature, perhaps partly due to the scarcity of such data. The variables are derived from entrepreneurial income using the same method as that used for employee-based IC variables from labor costs. However, entrepreneurial IC may be seen more as an entrepreneurial capability or knowledge focused on certain occupations. It is distributed for OCE and R&DE (where E refers to "entrepreneurial") according to the occupation of an entrepreneur. For entrepreneurial ICE, the combined multipliers are the same as for employee-based IC.

4. Methodology

An IV-GMM estimator is used due to endogeneity concerns to explain the debt ratio. Use of the IV-GMM estimator allows us to solve endogeneity problems by instrumenting endogenous variables with exogenous instrumental variables and ensure robustness against heteroscedasticity (Baum *et al.*, 2003). The explanatory variables are instrumented because they are autocorrelated and potentially endogenous, where the latter can arise from omitted unobservable variables, measurement error or reverse causality. Investments in IC can be affected by some unobservable variables, such as growth opportunities or the entrepreneur's risk aversion, which are very hard, if not impossible, to measure precisely. The same factors can also affect the firm's capital structure. There also exists a potential measurement error, given that we are proxying IC by using intangible-related labor costs and entrepreneurial income. Finally, it is possible that firms raise their debt level to invest in IC. In addition, firms with less financial leverage might be willing to make bigger investments.

One-period lagged values of IC and ICE variables, tangible capital, ROA and the number of employees are used as instrumental variables to restrain the potential endogeneity problem. Since R&D is related to long-term innovation processes (see Hall and Lerner, 2010) and entrepreneurial capability can be seen as a relatively persistent factor (Gompers *et al.*, 2010), a two-period lagged entrepreneurial R&DE is also used as an instrumental variable. One- and two-period lagged investments in machinery per employee (*machinv/L*) are additionally used as instruments to control productivity shocks.

Our model is supported statistically because the results of the C (also called the difference-in-Sargan) tests and Hansen J tests indicate the instrumental variables are valid and the structural model is correctly specified. The statistics are reported in the estimation tables. A C test is conducted to test the endogeneity of instrumented variables (Hayashi, 2000). A Hansen J test is carried out to test the validness of the instrumental variables and whether the equation is correctly specified (Hansen, 1982). Equation (4) defines the general model.

$$y = X\beta + u, E(uu') = \Omega, \tag{4}$$

where $X(N \times k)$ is the matrix of k regressors. By using IV-GMM, we can define matrix $Z(N \times l)$, where $l > k$. The excluded instruments are the lagged values of the regressors. The l instruments generate a set of l moments $g_i(\beta) = Z_i' u_i = Z_i'(y_i - X_i\beta)$, where g_i is specified as an l-vector. All these l moments are considered to be sample moments, which may be written as follows:

$$\bar{g}(\beta) = \frac{1}{N}\sum_{i=1}^{N} g_i(\beta) = \frac{1}{N}\sum_{i=1}^{N} Z_i'(y_i - X_i\beta) = \frac{1}{N}Z'u. \tag{5}$$

This expression is solved using the GMM estimator (Baum *et al.*, 2003). Due to the sensitivity of the IV-GMM method, ordinary least squares (OLS) with industry- and time-FE (OLS-FE) is run to check the results' robustness as it is less sensitive to changes in the model. These OLS-FE estimations reveal the results are not sensitive to the estimation method used. The function to be estimated is given in Equation (6), where the regressors represent X in Equation (4) and the coefficients stand for β.

$$\begin{aligned} Debtratio_{i,t} &= \beta_0 + \beta_{OC}\frac{OC_{i,t}}{L_{i,t}} + \beta_{RD}\frac{R\&D_{i,t}}{L_{i,t}} + \beta_{OCE}OCE_{i,t} + \beta_{RDE}R\&DE_{i,t} + \beta_K\frac{K_{i,t}}{L_{i,t}} + \\ &\beta_R ROA_{i,t} + \beta_{FR}FirmRisk_{i,t} + \beta_{age}FirmAge_{i,t} + \beta_{HT}HighTech_{i,t} + \beta_L L_{i,t} + \beta C'_{i,t} + u_{i,t}. \end{aligned} \tag{6}$$

OC and *R&D* refer to employee-based IC in different occupations (see Appendix 2). *OCE* and *R&DE* refer to respective intangibles measured from entrepreneurial income. K is tangible capital and L is the number of employees. All these aforementioned explanatory variables are in natural logarithmic form. *ROA* is return on assets measured as *net income/total assets* and *FirmRisk* is the standard deviation of net income covering periods t, $t-1$ and $t-2$. *HighTech* is a dummy variable for high-tech manufacturing firms. More detailed explanations of these variables are provided in subsection 3.2 and compiled in Table 1. In addition, C' denotes year dummies ($year_t$) and the Nace Rev 2 classification of economic activities ($industry_{i,t}$), which are controlling production shocks and industry-specific characteristics and u is the residual.

5. Results and discussion

First, we analyze financial leverage only with employee-based IC and then include entrepreneurial ICE to create new insights regarding how different entrepreneurial abilities and knowledge affect financial leverage. Table 3 presents the results for all firms. In Table 4, the results are shown separately for manufacturing and KIS (Table A3 see Appendix 3). Due to the sensitivity of the IV-GMM method, OLS with industry- and time-FE is also run to check the results' robustness. We use year dummy variables and the two-digit Nace Rev 2 classification of economic activities as control variables, although they are not reported. The results show that employee-based IC mostly has a negative impact on financial leverage. The managerial or financial knowledge of entrepreneurs supports financial leverage, whereas their technical knowledge has the opposite impact.

5.1 All firms

In Table 3, we analyze financial leverage for all firms. In column (1) that only includes employee-based IC, both employee-based IC variables have a negative impact on financial

Table 3.
Explaining the debt-to-total-assets ratio

Debt ratio	(1) IV-GMM	(2) IV-GMM	(3) OLS-FE	(4) OLS-FE
OC/L	−0.520***	−0.543***	−0.383***	−0.407***
	(0.053)	(0.054)	(0.046)	(0.047)
R&D/L	−0.232***	−0.206***	−0.181***	−0.148***
	(0.051)	(0.052)	(0.044)	(0.045)
OCE		0.205**		0.242***
		(0.088)		(0.079)
R&DE		−0.178***		−0.217***
		(0.058)		(0.053)
K/L	0.745***	0.745***	0.801***	0.801***
	(0.045)	(0.045)	(0.041)	(0.041)
ROA	−54.565***	−54.599***	−28.922***	−28.921***
	(0.999)	(0.999)	(0.500)	(0.500)
Firm risk	−13.221***	−13.277***	1.640	1.667*
	(1.323)	(1.322)	(0.998)	(0.998)
Firm age	−0.127***	−0.126***	−0.107***	−0.106***
	(0.007)	(0.007)	(0.007)	(0.007)
HighTech	−6.005***	−5.959***	−5.953***	−5.866***
	(1.076)	(1.076)	(0.924)	(0.924)
L	−1.903***	−1.858***	−1.741***	−1.692***
	(0.089)	(0.095)	(0.079)	(0.084)
Constant	31.449***	31.326***	27.487***	27.293***
	(0.798)	(0.806)	(0.542)	(0.551)
N	138,112	138,112	138,112	138,112
R^2	0.117	0.117	0.162	0.162
C test p value	0.000	0.000		
Hansen J p value	0.775	0.286		

Note(s): Asterisks indicate the significance level, * <0.1, ** <0.05 and *** <0.01. The C test is also known as the difference-in-Sargan test. Heteroscedasticity robust standard errors are in parentheses. The results for year dummy variables and Nace Rev 2 classifications of economic activities are not reported. OCE and R&DE are variables of entrepreneurial IC, see Table 1
Source(s): Created by author

Debt ratio	(1) Manufacturing	(2) Manufacturing	(3) KIS	(4) KIS
OC/L	−0.168*	−0.126	−0.248***	−0.287***
	(0.099)	(0.100)	(0.093)	(0.095)
R&D/L	−0.808***	−0.748***	−0.269***	−0.214**
	(0.107)	(0.108)	(0.094)	(0.097)
OCE		−0.361**		0.280*
		(0.147)		(0.152)
R&DE		−0.288***		−0.285***
		(0.090)		(0.104)
K/L	0.565***	0.565***	0.367***	0.365***
	(0.117)	(0.117)	(0.064)	(0.064)
ROA	−99.197***	−99.276***	−35.201***	−35.219***
	(2.344)	(2.345)	(1.315)	(1.314)
Firm risk	−38.474***	−38.461***	0.834	0.809
	(3.735)	(3.736)	(1.607)	(1.602)
Firm age	−0.147***	−0.145***	−0.166***	−0.165***
	(0.013)	(0.013)	(0.014)	(0.014)
HighTech	−23.832***	−24.156***		
	(1.030)	(1.034)		
L	−2.191***	−1.903***	−0.963***	−0.911***
	(0.162)	(0.177)	(0.155)	(0.165)
Constant	55.725***	54.994***	29.925***	29.746***
	(1.095)	(1.108)	(0.965)	(0.989)
N	44,685	44,685	34,362	34,362
R^2	0.060	0.060	0.093	0.094
C test *p* value	0.000	0.000	0.000	0.000
Hansen J *p* value	0.036	0.092	0.194	0.338

Note(s): Asterisks indicate the significance level, * <0.1, ** <0.05 and *** <0.01. The C test is also known as the difference-in-Sargan test. Heteroscedasticity robust standard errors are in parentheses. The results for year dummy variables and Nace Rev 2 classifications of economic activities are not reported. OCE and R&DE are variables of entrepreneurial IC, see Table 1
Source(s): Created by author

Table 4. Explaining the debt-to-total-assets ratio in manufacturing and knowledge-intensive services

leverage. This supports the theory of IC's weak pledgeability (see Rampini and Viswanathan, 2013) and asymmetric information between borrower and lender (see Hall and Lerner, 2010) in intangible-intensive firms. In column (2), entrepreneurial ICE is also included. The interpretations of employee-based IC remain the same. The negative coefficients of IC can be explained by the fact that the lender can find it hard to monitor intangible investments, in turn, emphasizing the problem of asymmetric information between borrower and lender. On top of IC often being weak collateral, it is possible that intangibles-intensive firms are more often associated with innovative and risky projects for which lenders might be reluctant to lend all the money the firm is seeking. The results support the assumption that intangibles-intensive firms have less debt capacity than other firms. The dichotomy between IC and tangible capital in terms of pledgeability is supported by the result showing that tangible capital indeed supports financial leverage. Firms with tangible capital thus have a higher debt capacity than intangibles-intensive firms.

All coefficients of entrepreneurial ICE are statistically significant. Entrepreneurs with managerial or financial (OCE) knowledge have positive impacts on the financial leverage of their firms, thereby causing these firms to have a higher debt capacity. These entrepreneurs probably have superior financial skills than other entrepreneurs and thus might be more competent in negotiating with lenders. This is supported by Cowling *et al.* (2016) who state that entrepreneurs with financial qualifications are more likely to have access to credit. Still, the impact of the R&DE has a negative impact on the debt ratio. The firms of entrepreneurs possessed with technical knowledge hence on average operate with less financial leverage than other firms. It is possible that these entrepreneurs are more focused on product development and may have limited financial skills (Revest and Sapio, 2012). This could lead to worse results in negotiations with lenders and higher risk aversion in financial issues.

High-tech firms have less financial leverage than other firms. This is likely an outcome of their risky projects and lack of collateral (Revest and Sapio, 2012). Younger and smaller firms seem to have greater financial leverage than older and larger firms. It is possible that young firms are forced to make large investments from the outset to be able to compete with market incumbents.

OLS estimations with industry- and time-FE are presented in columns (3) and (4), where the results mostly remain similar to those in columns (1) and (2). Thus, the results in columns (3) and (4) support our main conclusions: employee-based IC has a negative impact on financial leverage, the managerial or financial knowledge of entrepreneur's increases debt capacity, while the technical knowledge of entrepreneurs has the opposite impact. The OLS-FE estimations reveal that the main results are not sensitive to the estimation method.

According to the C and Hansen J test results shown in columns (1) and (2), the instrumental variables and the structural model appear valid.

5.2 Manufacturing and knowledge-intensive services

The results for different industries reveal some variation in interpretations of the IC variables. In Table 4, columns (1) and (2) show the results for manufacturing firms. Column (1) only includes employee-based IC. As in Table 3, both OC and R&D have negative impacts. Still, the coefficient of R&D is statistically more significant. The risky and venturous characteristics of R&D decrease debt capacity in manufacturing too, even though it is often an essential factor in new product development. However, R&D-related long-term projects usually suffer from asymmetric information between borrower and lender, while organization-related investments are likely easier to assess by the lender. This result supports our assumption that R&D investments rely on internal finance more than OC investments.

In column (2), we include entrepreneurial ICE to explain financial leverage. The results of employee-based R&D remain the same, although OC becomes nonsignificant with a p-value of 0.21. Yet, the impact of entrepreneurial OCE is now negative, unlike in Table 3. Therefore, entrepreneurs possessed with managerial or financial knowledge have a negative impact on financial leverage in manufacturing firms, where they are probably unable to exploit their financial knowledge to increase debt capacity. One explanation may be that they have limited technical skills, which could be needed in negotiations with lenders in the manufacturing industry. R&D entrepreneurs also have a negative impact on financial leverage. While they possess technical knowledge, they are likely more to be engaged in venturous long-term projects, which highlight the problem of asymmetric information.

In KIS in columns (3) and (4), the results remain similar for R&D and R&DE. The coefficient of OC is still negative but becomes statistically highly significant even when entrepreneurial factors are included. Despite KIS being a very intangibles-intensive industry where intangible knowledge is needed, IC still lowers the debt capacity of these firms. In KIS, the impact of entrepreneurial OCE is positive, unlike in manufacturing. Entrepreneurs with managerial or financial knowledge are, therefore, able to increase the debt capacity especially in KIS, while R&D entrepreneurs are still lowering it. In KIS, young tangible capital-intensive firms of entrepreneurs possessed with managerial or financial knowledge operate with the highest financial leverage.

As shown in columns (1) and (2) in Table 4, high-tech firms have strictly less debt capacity than other manufacturers. This is in harmony with Revest and Sapio (2012) who note that small high-tech firms face difficulties with raising debt. They typically lack collateral and their projects are often risky and venturous, in turn, emphasizing the problem of asymmetric information between borrower and lender. Although tangible capital has positive impacts in both manufacturing and KIS, the impact is bigger in manufacturing as it relies more on tangible investments.

The C and Hansen J tests support our structural model. Table A1 in Appendix 1 presents a robustness check run by OLS with industry- and time-FE. The interpretation of the main results remains similar to that for Table 4, thus giving support for our conclusions that the results are not sensitive to the estimation method used.

5.3 Discussion

The firms of entrepreneurs with managerial or financial knowledge have stronger financial leverage than other firms when considering all firms. They might be more competent in negotiating with lenders due to their superior financial skills. This is supported by Cowling *et al.* (2016) who state that entrepreneurs with financial qualifications are more likely to have access to credit. The results for entrepreneurs possessed with technical knowledge are quite the opposite because they show a negative impact on debt capacity in all industries. One explanation is that they are more related to venturous and risky projects, which emphasizes the problem of asymmetric information between borrower and lender. It is possible that they also have limited financial skills (Revest and Sapio, 2012).

The results support hypotheses 2 and 3. However, hypothesis 2 does not hold in manufacturing where the managerial or financial knowledge of entrepreneurs has a negative impact on the debt ratio. One explanation may be that entrepreneurs with managerial or financial knowledge possess limited technical skills that would be needed to convince lenders to fund technology investments.

In general, employee-based IC has a negative impact on financial leverage, likely an outcome of its weak pledgeability (Rampini and Viswanathan, 2013), which points to the importance of internal finance for intangible investments (see Thum-Thysen *et al.*, 2019). The results mostly support hypothesis 1 and our assumption that R&D has a stronger negative impact on financial leverage than OC due to its venturous and risky characteristics. This especially holds in manufacturing where high-tech firms operate.

R&D-intensive high-tech firms of entrepreneurs possessed with technical knowledge have the lowest debt capacity. This probably results from their venturous long-term projects, which lenders find to be hard to assess. Moreover, these firms usually have weak collateral (Revest and Sapio, 2012). Tangible capital, i.e. buildings and machinery, indeed increases debt capacity because it can be used as collateral more efficiently than IC. Higher profitability decreases financial leverage since it leads the firm to have more internal finance available. The volatility of profits also reduces financial leverage by increasing the uncertainty of future cash flows and thereby decreasing the debt servicing capacity. Younger firms have higher debt ratios, perhaps because they are forced to make large investments at the outset to be able to compete with market incumbents.

6. Conclusions

This paper examines the impacts of employee-based and entrepreneurial IC on financial leverage within Finnish SMEs. Although some earlier studies focused on IC and financial leverage, this is the first paper to include entrepreneurial IC in this context. It is important to know about the effects of entrepreneurial IC since entrepreneurs are often responsible for the main operational and financial decisions, especially in SMEs.

The results show that entrepreneurs with managerial or financial knowledge have higher financial leverage than other entrepreneurs, notably in KIS. They probably have superior financial skills than other entrepreneurs and thus might be more competent in negotiating with lenders resulting in higher debt capacity. Nevertheless, they have a negative impact on financial leverage in manufacturing. One explanation for this is that they suffer from limited technical knowledge, which may be needed to convince lenders to fund their technology investments. Entrepreneurs possessed with technical knowledge decrease debt capacity in all industries. They might have limited financial skills (see Revest and Sapio, 2012) and are more associated with venturous and risky long-term projects, which emphasize the problem of asymmetric information between borrower and lender.

While considering all firms, employee-based IC has a negative impact on financial leverage, likely an outcome of its weak pledgeability (Rampini and Viswanathan, 2013), which points to the importance of internal finance for intangible investments (see Thum-Thysen *et al.*, 2019). R&D-intensive high-tech firms of entrepreneurs possessed with technical knowledge have the lowest debt capacity. This probably results from their venturous long-term projects, which lenders find hard to assess, and the fact these firms generally have weak collateral (Revest and Sapio, 2012).

The importance of IC will presumably grow in the future due to digitalization and higher education levels among workers, among other factors. This makes it essential to increase understanding of the influence of IC on the economy and businesses. IC offers numerous fascinating areas for upcoming research. While this study focused on SMEs, future studies could examine how IC affects start-ups and micro-firm financing.

References

Amable, B., Chatelain, J.-B. and Ralf, K. (2010), "Patents as collateral", *Journal of Economic Dynamics and Control*, Vol. 34 No. 6, pp. 1092-1104, doi: 10.1016/j.jedc.2010.03.004.

Baum, C.F., Schaffer, M.E. and Stillman, S. (2003), "Instrumental variables and GMM: estimation and testing", *Stata Journal*, Vol. 3 No. 1, pp. 1-31, doi: 10.1177/1536867X0300300101.

Brüderl, J. and Preisendörfer, P. (2000), "Fast-growing businesses: empirical evidence from a German study", *International Journal of Sociology*, Vol. 30 No. 3, pp. 45-70, doi: 10.1080/15579336.2000.11770218.

Campello, M. and Giambona, E. (2013), "Real assets and capital structure", *Journal of Financial and Quantitative Analysis*, Vol. 48 No. 5, pp. 1333-1370, doi: 10.1017/S0022109013000525.

Carpenter, R.E. and Petersen, B.C. (2002), "Capital market imperfections, high-tech investment, and new equity financing", *The Economic Journal*, Vol. 112 No. 477, pp. F54-F72, doi: 10.1111/1468-0297.00683.

Corrado, C., Hulten, C. and Sichel, D. (2005), "Measuring capital and technology: an expanded Framework", in Corrado, C., Haltiwanger, J. and Sichel, D. (Eds), *Measuring Capital in the New Economy*, University of Chicago Press, National Bureau of Economic Research, Studies in Income and Wealth, Chicago, Vol. 65, pp. 11-45.

Corrado, C., Hulten, C. and Sichel, D. (2009), "Intangible capital and U.S. Economic growth", *Review of Income and Wealth*, Vol. 55 No. 3, pp. 661-685, doi: 10.1111/j.1475-4991.2009.00343.x.

Cowling, M., Liu, W. and Zhang, N. (2016), "Access to bank finance for UK SMEs in the wake of the recent financial crisis", *International Journal of Entrepreneurial Behaviour & Research*, Vol. 22 No. 6, pp. 903-932, doi: 10.1108/IJEBR-06-2015-0126.

Deakins, D. and North, D.J. (2013), "The role of finance in the development of technology-based SMEs: evidence from New Zealand", *Journal of Entrepreneurship, Business and Economics*, Vol. 1 Nos 1/2, pp. 82-100.

Dillen, Y., Laveren, E., Martens, R., De Vocht, S. and Van Imschoot, E. (2019), "From 'manager' to 'strategist'", *International Journal of Entrepreneurial Behaviour & Research*, Vol. 25 No. 1, pp. 2-28, doi: 10.1108/IJEBR-01-2017-0010.

Eklund, C.M. (2020), "Why do some SME's become high-growth firms? The role of employee competences", *Journal of Intellectual Capital*, Vol. 21 No. 5, pp. 691-707, doi: 10.1108/JIC-07-2019-0188.

Eurostat (2008), "NACE Rev. 2: statistical classification of economic activities in the European community", available at: https://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF

Giglio, S. and Severo, T. (2012), "Intangible capital, relative asset shortages and bubbles", *Journal of Monetary Economics*, Vol. 59 No. 3, pp. 303-317, doi: 10.1016/j.jmoneco.2012.03.004.

Gompers, P., Kovner, A., Lerner, J. and Scharfstein, D. (2010), "Performance persistence in entrepreneurship", *Journal of Financial Economics*, Vol. 96 No. 1, pp. 18-32, doi: 10.1016/j.jfineco.2009.11.001.

Graham, J.R., Leary, M.T. and Roberts, M.R. (2015), "A century of capital structure: the leveraging of corporate America", *Journal of Financial Economics*, Vol. 118 No. 3, pp. 658-683, doi: 10.1016/j.jfineco.2014.08.005.

Hair, J.F. Jr, Anderson, R.E., Tatham, R.L. and Black, W.C. (1995), *Multivariate Data Analysis*, 3rd ed., Macmillan, New York.

Hall, T.W. (2012), "The collateral channel: evidence on leverage and asset tangibility", *Journal of Corporate Finance*, Vol. 18 No. 3, pp. 570-583, doi: 10.1016/j.jcorpfin.2011.12.003.

Hall, B.H. and Lerner, J. (2010), "The financing of R&D and innovation", *Handbook of the Economics of Innovation*, Vol. 1 No. 1C, pp. 609-639.

Hall, B.H., Moncada-Paternò-Castello, P., Montresor, S. and Vezzani, A. (2016), "Financing constraints, R&D investments and innovative performances: new empirical evidence at the firm level for europe", *Economics of Innovation and New Technology*, Vol. 25 No. 3, pp. 183-196, doi: 10.1080/10438599.2015.1076194.

Hansen, L.P. (1982), "Large sample properties of generalized method of moments estimators", *Econometrica*, Vol. 50 No. 4, pp. 1029-1054, doi: 10.2307/1912775.

Harris, M. and Raviv, A. (1991), "The theory of capital structure", *Journal of Finance*, Vol. 46 No. 1, pp. 297-355, doi: 10.2307/2328697.

Hayashi, F. (2000), *Econometrics*, Princeton University Press, Princeton, NJ.

Horsch, P., Longoni, P. and Oesch, D. (2021), "Intangible capital and leverage", *Journal of Financial and Quantitative Analysis*, Vol. 56 No. 2, pp. 475-498, doi: 10.1017/S0022109020000071.

Jona-Lasinio, C. and Meliciani, V. (2018), "Productivity growth and international competitiveness: does intangible capital matter?", *Intereconomics*, Vol. 53 No. 2, pp. 58-62, doi: 10.1007/s10272-018-0722-y.

Koralun-Bereźnicka, J. (2013), "How does asset structure correlate with capital structure? – Cross-industry and cross-size analysis of the EU countries", *Universal Journal of Accounting and Finance*, Vol. 1 No. 1, pp. 19-28, doi: 10.13189/UJAF.2013.010103.

Lev, B., Radhakrishnan, S. and Evans, P.C. (2016), "Organizational capital", *Measuring and Managing Organizational Capital Series*, No. 1, pp. 1-40.

Li, Y. (2018), "Fragile new economy: intangible capital, corporate savings glut, and financial instability", working paper, Fisher College of Business Working Paper Series.

Lim, S.C., Macias, A.J. and Moeller, T. (2020), "Intangible assets and capital structure", *Journal of Banking and Finance*, Vol. 118, doi: 10.1016/j.jbankfin.2020.105873.

Long, M.S. and Malitz, I.B. (1985), "Investment patterns and financial leverage", in Friedman, B.M. (Ed.), *Corporate Capital Structures in the United States*, University of Chicago Press, Chicago, pp. 325-352.

Neter, J., Wasserman, W. and Kutner, M.H. (1989), *Applied Linear Regression Models*, Richard D. Irwin, Homewood, IL.

Piekkola, H. (2011), "Intangible capital: the key to growth in europe", *Intereconomics*, Vol. 46 No. 4, pp. 222-228, doi: 10.1007/s10272-011-0387-2.

Piekkola, H. (2020), "Intangibles and innovation-labor-biased technical change", *Journal of Intellectual Capital*, Vol. 21 No. 5, pp. 649-669, doi: 10.1108/JIC-10-2019-0241.

Rahko, J. and Piekkola, H. (2020), "Productivity of environmental innovations under the environmental regulation of firms", Globalinto, available at: https://globalinto.eu/productivity-of-environmental-innovations-under-the-environmental-regulation-of-firms-d5-12/

Rampini, A.A. and Viswanathan, S. (2013), "Collateral and capital structure", *Journal of Financial Economics*, Vol. 109 No. 2, pp. 466-492, doi: 10.1016/j.jfineco.2013.03.002.

Revest, V. and Sapio, S. (2012), "Financing technology-based small firms in europe: what do we know?", *Small Business Economics*, Vol. 39, pp. 179-205, doi: 10.1007/s11187-010-9291-6.

Squicciarini, M. and Le Mouel, M. (2012), "Defining and measuring investment in organizational capital using US microdata to develop a task-based approach", OECD Science, Technology and Industry, Paris, Working paper.

Sun, Q. and Xiaolan, M.Z. (2019), "Financing intangible capital", *Journal of Financial Economics*, Vol. 133 No. 3, pp. 564-588, doi: 10.1016/j.jfineco.2019.04.003.

Thum-Thysen, A., Voigt, P., Bilbao-Osorio, B., Maier, C. and Ognyanova, D. (2019), "Investment dynamics in europe: distinct drivers and barriers for investing in intangible versus tangible assets?", *Structural Change and Economic Dynamics*, Vol. 51, pp. 77-88, doi: 10.1016/j.strueco.2019.06.010.

Watson, W., Stewart, W.H. Jr and BarNir, A. (2003), "The effects of human capital, organizational demography, and interpersonal processes on venture partner perceptions of firm profit and growth", *Journal of Business Venturing*, Vol. 18 No. 2, pp. 145-164, doi: 10.1016/S0883-9026(01)00082-9.

Further reading

Davis, S.J., Faberman, R.J., Haltiwanger, J., Jarmin, R. and Miranda, J. (2010), "Business volatility, job destruction, and unemployment", *American Economic Journal: Macroeconomics*, Vol. 2 No. 2, pp. 259-287, doi: 10.1257/mac.2.2.259.

Lawless, M. (2014), "Age or size? Contributions to job creation", *Small Business Economics*, Vol. 42 No. 4, pp. 815-830, doi: 10.1007/s11187-013-9513-9.

Lopez, J.I. and Olivella, V. (2018), "The importance of intangible capital for the transmission of financial shocks", *Review of Economic Dynamics*, Vol. 30, pp. 223-238, doi: 10.1016/j.red.2018.04.004.

Myers, S.C. (1984), "The capital structure puzzle", *Journal of Finance*, Vol. 39 No. 3, pp. 575-592, doi: 10.2307/2327916.

Appendix 1

Estimations for the robustness check.

Table A1. Explaining the debt-to-total-assets ratio in manufacturing and knowledge-intensive services by using OLS with industry- and time-FE

Debt ratio	(1) Manufacturing	(2) Manufacturing	(3) KIS	(4) KIS
OC/L	−0.020	0.017	−0.117	−0.161*
	(0.082)	(0.084)	(0.082)	(0.084)
R&D/L	−0.665***	−0.589***	−0.229***	−0.179**
	(0.089)	(0.090)	(0.080)	(0.083)
OCE		−0.261**		0.349**
		(0.127)		(0.138)
R&DE		−0.401***		−0.265***
		(0.082)		(0.091)

(*continued*)

Debt ratio	(1) Manufacturing	(2) Manufacturing	(3) KIS	(4) KIS
K/L	0.845***	0.853***	0.394***	0.390***
	(0.100)	(0.100)	(0.060)	(0.060)
ROA	−48.209***	−48.211***	−18.560***	−18.551***
	(1.088)	(1.088)	(0.691)	(0.692)
Firm risk	−5.025**	−4.923**	9.956***	10.005***
	(2.256)	(2.256)	(1.347)	(1.347)
Firm age	−0.123***	−0.121***	−0.145***	−0.144***
	(0.012)	(0.012)	(0.014)	(0.014)
HighTech	−5.804***	−5.778***		
	(0.914)	(0.914)		
L	−1.787***	−1.455***	−1.169***	−1.146***
	(0.142)	(0.155)	(0.137)	(0.145)
Constant	30.356***	29.156***	33.914***	33.849***
	(0.802)	(0.835)	(1.376)	(1.392)
N	44,685	44,685	34,362	34,362
R^2	0.166	0.167	0.131	0.131

Note(s): Asterisks indicate the significance level, * <0.1, ** <0.05 and *** <0.01. The C test is also known as the difference-in-Sargan test. Heteroscedasticity robust standard errors are in parentheses. The results for year dummy variables and Nace Rev. 2 classifications of economic activities are not reported. OCE and R&DE are variables of entrepreneurial IC, see Table 1

Source(s): Created by author

Table A1.

Appendix 2

Below is a list of IC-related occupations split into the two different IC categories with a narrower OC definition without marketing workers by using the ISCO08 3-digit coding in Globalinto. The multipliers of IC variables are presented in Table A2.

Organizational work

(1) Business services and Administration managers 121;

(2) Sales and marketing managers 1,221 and advertising and public relations managers 1,222;

(3) Production managers in agriculture, forestry and fisheries 131;

(4) Manufacturing, mining, construction and distribution managers 132;

(5) Professional services managers 134 and

(6) Finance professionals 241 and administration professionals 242.

R&D work

(1) R&D managers 1,223;

(2) Physical and earth science professionals 211, engineering professionals 212, life science professionals 213, engineering professional (excluding electrotechnology) 214 and electrical engineering 215;

	OC	R&D
Employment share l^{IC}	0.45	0.9
Factor multiplier z^{IC}	1.56	1.24
Combined multiplier A^{IC}	0.7	1.1

Source(s): Created by author

Table A2. Multipliers for OC and R&D

(3) Architects, planners, surveyors and designers 216;

(4) Health professionals: medical doctors 221, nursing and midwifery professionals 222 and other health professionals 226 and

(5) Physical and engineering science technicians 311, life science technicians and related associate professionals 314 and medical and pharmaceutical technicians 321

Appendix 3

Below is a list of the Nace 2 Rev industries in different firm categories used in Tables 4 and A1. See Eurostat (2008) for a more detailed explanation of the divisions.

Table A3.
Firm categories

Category	Divisions
Manufacturing	Manufacture of food 10; beverages 11; tobacco 12; textiles 13; wearing apparel 14; leather 15; wood and wood products 16; paper, paper products 17; printings 18; manufacture coke and refined petroleum products 19; manufacture chemical 20; manufacture pharmacy 21; rubber and plastic products 22; other non-metallic mineral 23; basic metals 24; computer, electronic and optical products 26; electrical equipment 27; machinery and equipment 28; motor vehicles 29; other transport 30; furniture 31; other manufacturing 32; fabricated metal products repair and installation of machinery and equipment and energy 33 and 35, respectively
Knowledge-intensive services	Water transport 50; air transport 51; publishing 58; motion picture 59; programming; broadcasting 60; telecommunication 61; computer programming; consultancy 62, information service activities 63; legal 69; head office 70; architectural and engineering 71; R&D 72; advertising and market research 73; other professional activities 74; veterinary activities 75; employment 78; security and investigation 80; public administration O; education P; human health Q and arts, entertainment and recreation R

Source(s): Created by author

Corresponding author
Antti Norkio can be contacted at: antti.norkio@uwasa.fi