Antti Norkio

Generating and Financing Growth

Essays on Intangible Capital, Entrepreneurship, and Capital Structure in Finnish SMEs

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Tiivistelmä

Tämä väitöskirja koostuu kolmesta esseestä keskittyen aineettoman pääoman ja yrittäjien rooliin kasvuyrityksissä sekä niiden pääomarakenteen dynamiikkaan. Aineeton pääoma on laskettu käyttäen ammattiperusteista metodia. Ensimmäinen essee tutkii, kuinka aineeton pääoma ja yrittäjän koulutus ovat yhteydessä pienten ja keskisuurten yritysten kasvuun. Tulokset osoittavat, että aineeton pääoma on tärkeä tekijä kasvuyrityksissä. Lisäksi yrittäjän tekniikan alan ylempi korkeakoulutus on yhteydessä yrityksen kasvuun. Sen sijaan yrittäjän kaupallinen ylempi korkeakoulutus on negatiivisesti yhteydessä kasvuun. Muilla koulutusaloilla tai korkeakoulutuksella yleensä ei havaita olevan yhteyttä yrityksen kasvuun.

Toinen essee tarkastelee, kuinka aineeton pääoma selittää pk-yritysten velkaisuutta. Lisäksi väitöskirjan liitteissä olevissa estimoinneissa yrittäjän koulutus on lisätty selittäjäksi. Tulokset osoittavat, että aineettomalla pääomalla on negatiivinen yhteys yrityksen velkaisuuteen, mikä todennäköisesti johtuu sen huonosta panttauskelpoisuudesta. Tulorahoitus on siksi erityisen tärkeää aineettomille investoinneille. Lisäksi liitteissä esitetyt tulokset indikoivat, että teknisen korkeakoulutuksen omaavat yrittäjät toimivat keskimäärin matalammalla velka-asteella kuin muut, kun taas kaupallinen ylempi korkeakoulutus on yhteydessä korkeampaan velka-asteeseen.

Kolmas essee tutkii, kuinka pääomarakenne kehittyy, kun pk-yritys kasvaa ensimmäistä kertaa nopeasti kolmen vuoden ajan. Korkean kasvun ja pääomarakenteen kehityksen välinen suhde osoitetaan käyttämällä propensity score matching with difference-in-differences –metodia. Se mahdollistaa korkean kasvun yritysten vertaamisen samankaltaisiin kontrolliyrityksiin. Tulokset osoittavat, että lyhyen aikavälin laina on eniten käytetty rahoituslähde korkean kasvun pk-yrityksissä. Kun kontrolliyritykset vähentävät pitkän aikavälin velkaisuutta ja lisäävät omavaraisuusastetta, korkean kasvun yritykset vähentävät kumpaakin. Tämä korostaa lyhyen aikavälin lainan saatavuuden tärkeyttä korkean kasvun pk-yrityksille. Nämä löydökset alleviivaavat potentiaalisia riskejä korkean kasvun pk-yritysten pääomarakenteessa kiristyvien rahoitusmarkkinoiden aikana, mikäli pitkäaikaiset omaisuuserät on rahoitettu lyhyen aikavälin lainalla.

Asiasanat: Aineeton pääoma, korkean kasvun yritykset, yrittäjyys, yrittäjän koulutus, velkaisuus, pk-yritys

Abstract

This doctoral dissertation contains three essays focusing on both the role of intangible capital (IC) and entrepreneurship in growth firms and the dynamics of their capital structure. IC is measured using an occupation-based method. The first essay considers how IC and an entrepreneur's education are related to firm growth in small and medium-sized enterprises (SMEs). The results show that IC is an important factor for firm growth. In addition, an entrepreneur's higher tertiary technical education has a positive relationship with firm growth. Instead, an entrepreneur's higher tertiary business education is negatively related to growth. The other fields of education and higher education in general are unrelated to firm growth.

The second essay examines how IC is related to financial leverage in SMEs. In addition, there are supplemental estimations in appendix that include entrepreneurs' education as a regressor. The results show that IC has a negative relationship with financial leverage, likely caused by its weak pledgeability. This makes internal finance particularly important for intangible investments. The results also indicate that entrepreneurs possessing higher technical education operate with lower financial leverage than others, while higher tertiary business education is related to higher financial leverage.

The third essay investigates how the capital structure develops when an SME generates high growth for the first time over a 3-year period. Propensity score matching with difference-in-differences (PSM-DID) is used to reveal the relationship between high growth and development of the capital structure. This approach enables us to match high-growth firms (HGFs) with control firms that have similar covariates. The results indicate that short-term debt is the most frequently used source of finance in high-growth SMEs. While control firms decrease their long-term financial leverage and increase their equity ratio, HGFs decrease both their long-term financial leverage and equity ratio. This highlights the importance of short-term credit access for high-growth SMEs. These findings emphasize the potential risk in the capital structure of high-growth SMEs during a tightening credit market if long-term assets are being financed by short-term debt.

Keywords: Intangible capital, high-growth firms, entrepreneurship, entrepreneur's education, financial leverage, SME

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In Nokia, August 2024

Antti Norkio

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Figures

Abbreviations

HGF	High-growth firm
IC	Intangible capital
ICT	Information and communication technology
IV-GMM	Instrumental-variable regression with a generalized method of moments
KIS	Knowledge-intensive services
OLS	Ordinary least squares regression
OC	Organizational capital
PSM-DID	Propensity score matching with difference-in-differences
R&D	Research and development
SME	Small and medium-sized enterprise

Essays

This dissertation consists of an introductory chapter and the following three essays:

1. Norkio, A., & Piekkola, H. (2024). Intangible Capital, Entrepreneur's Education, and Firm Growth.

2. Norkio, A. (2024). Intangible Capital and Financial Leverage in SMEs. *Managerial Finance*, 50(2), 434–450. https://doi.org/10.1108/MF-10-2022-0488. CC BY 4.0.

3. Norkio, A. (2023). The Capital Structure of High-Growth SMEs.

1 INTRODUCTION

High-growth firms (HGFs) are crucial for the economy as they generate a large share of new jobs (Henrekson & Johansson, 2010), which also makes them an interest of policymakers. The European economy has suffered from slow productivity growth over the last decade. This highlights the importance of HGFs due to their important role in innovation, which is the backbone of productivity growth and a prosperous future. High growth often requires investments to increase productivity or the level of production that makes it important to understand the dynamics of capital structure. HGFs are closely linked to intangible capital (IC) (Coad & Srhoj, 2020), which may hamper financing their growth investments (Serrasqueiro et al., 2021). Although it is hard to predict which firms become HGFs, some characteristics clearly support high growth.

The importance of HGFs for creating jobs is reflected in the considerable attention paid to them in the scholarly literature. Many studies try to predict high growth and add to understanding of the dynamics of growth. The ample literature focuses on the role of IC in high growth, establishing that it mainly has a positive impact (e.g., Rossi-Hansberg & Wright, 2007; Denicolai et al., 2015). HGFs thus possess more IC than firms on average (Coad & Srhoj, 2020). Still, a high IC intensity leads to high fixed costs that restrain firm operations and hamper new market entrants (see De Ridder, 2021). The Finnish economy is becoming ever more knowledge-intensive where employees with a high level of human capital are essential for firms to be innovative. On the other hand, entrepreneurs are often behind the long-term planning and large operational decisions. Apart from highly skilled employees, firm growth calls for skilled entrepreneurs who possess a strong growth orientation and proper knowledge.

In order to grow, firms must make investments to increase their production capacity or improve the quality of their products and services, with these investments being financed by debt or equity. However, especially growth-oriented small and medium-sized enterprises (SMEs) often face tight credit constraints that force them to rely on their retained profits (see Myers & Majluf, 1984). As the amount of cash flow is always limited, credit constraints are linked to a smaller firm size (Meisenzahl, 2016). Namely, poor credit access hampers the making of profitable investments and thereby leads to slower growth. In addition, firm age is positively related to credit access (Beck et al., 2006) which explains firm growth, particularly for SMEs (Beck & Demirguc-Kunt, 2006).

While IC is closely related to innovation and firm growth (Corrado et al., 2016), it also has some special characteristics with respect to financing. Tangible capital, e.g., buildings and machinery, is something concrete and reusable and hence often quite efficiently pledgeable. On the contrary, IC is usually more abstract and frequently harder to reuse in other firms or to convert to cash, making it generally viewed by lenders as weak collateral. Weak pledgeability, that is, collaterability, can result in asymmetric information between borrower and lender that likely leads to tighter credit constraints (Serrasqueiro et al., 2021). The skills and orientations of entrepreneurs might also affect the firm's debt capacity as they are often behind the financial decisions and long-term planning, especially in SMEs. For instance, technology-oriented entrepreneurs are shown to have limited financial skills (Revest & Sapio, 2012). On the other hand, we may assume that entrepreneurs with better financial skills are able to increase the firm's debt capacity (see Cowling et al., 2016).

In this context, this doctoral dissertation contains three essays focusing on the role of IC in growth firms and on the dynamics of their capital structure (see Figure 1). These essays reveal the importance of IC and efficient financial markets for firm growth. Accordingly, the first essay studies how IC and entrepreneurs' education are related to firm growth in SMEs. The second essay examines how IC is related to financial leverage. Finally, the third essay investigates how the capital structure develops when an SME generates high growth for the first time over a 3-year period.

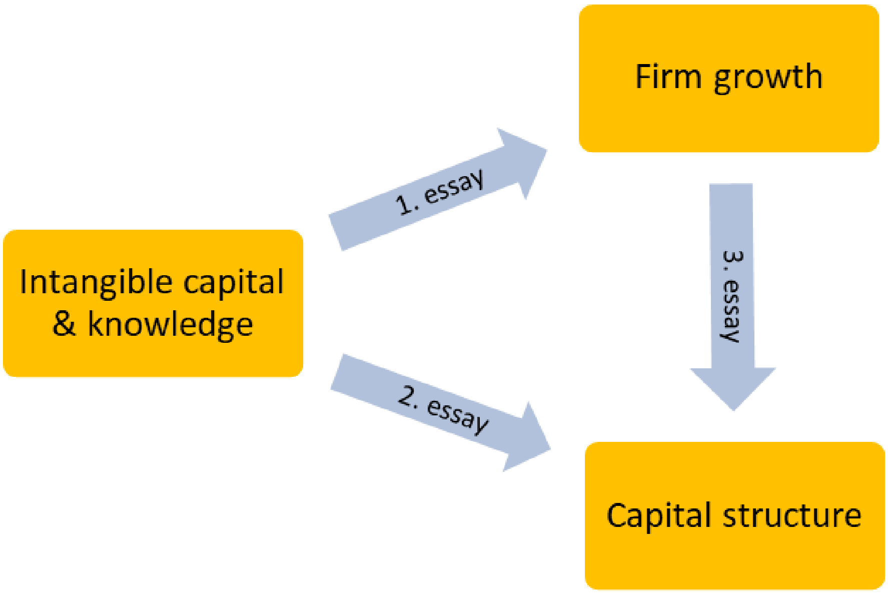

Figure 1. Structure of the dissertation

This dissertation proceeds as follows. The second section presents previous literature. Then, the third section describes the data and methodology. The fourth section summarizes the essays, while the fifth section concludes. All three essays are presented at the end of the dissertation.

2 OVERVIEW OF THE LITERATURE

2.1 Intangible capital and firm growth

HGFs are crucial for the economy because they create a large share of new jobs (Mason & Brown, 2013). This has led to HGFs receiving a lot of attention among scholars, for instance, trying to predict HGFs or explain their capital structure (e.g., Rahaman, 2011; Coricelli et al., 2012; Davidsson & Delmar, 2006; Daunfeldt et al., 2016). High growth is shown to require growth-oriented entrepreneurs (see Smallbone et al., 1995), high-quality human capital (Dillen et al., 2019), and adequate access to funding (Fagiolo & Luzzi, 2006). Namely, efficient financial markets along with highly skilled employees and entrepreneurs play a major role while pursuing growth. In Finland, only about one-fifth of new innovative firms are growth-oriented and a major share of them operate in knowledge-intensive, high-technology services (Autio et al., 2014). In times of weak economic growth and declining growth-orientation among Finnish firms (Ohlsbom et al., 2024), it is crucial to comprehend the factors that contribute to firm growth.

IC comprises a wide variety of immaterial assets, for instance, databases, software, goodwill, and human capital. As an ever larger share of firms are not based on tangible assets anymore, it is important to extend the concept of capital to include intangible assets too (Corrado et al., 2022). IC is closely related to innovation, which is a key factor in economic growth (Piekkola, 2011). IC is becoming ever more important for the Finnish economy as new technology requires a high level of human capital and the industrial structure is shifting towards services. In line with this, half of all investments made by U.S. firms is directed to IC (Corrado et al., 2009). Corrado and Hulten (2010) estimate that IC in fact covers around one-third of firms' total capital.

Intangibles are important factors for high growth. Eklund (2020) establishes that research and development (R&D), organizational capital (OC), and information and communication technology (ICT) positively impact the high growth of Danish firms. Coad and Srhoj (2020) add that IC is positively related to high growth, and find that also growth in the level of IC is positively associated with high growth in firms with more than 10 employees. Although Daunfeldt et al. (2016) argue that R&D-intensity–a key component of IC–is negatively related to HGF-density, they find that HGFs are overrepresented in knowledge-intensive services, which supports extending the consideration of intangibles to organizational knowledge. Stam and Wennberg (2009) find that R&D and high growth are positively related only among high-tech firms.

Despite the key role of IC in innovation, it also has some deficiencies in terms of market dynamics. Open markets and a dynamic economy are important for economic growth since new firms are more likely to generate high growth (Daunfeldt et al., 2014) and cull unproductive competitors. Yet, a high level of intangible-intensity incurs high fixed costs that can restrain new entrants coming into the market and limit their ability to compete with the market leaders (see De Ridder, 2021).

To be able to generate persistent growth, a firm also needs an entrepreneur possessing a high level of human capital. Accordingly, Lee (2014) lists poor management skills as a factor that hinders high growth. Consistently, Dillen et al. (2019) find that persistent growth requires strategic skills. Moreover, an entrepreneur's human capital increases the probability of firm survival (Bates, 1990; Coleman et al., 2013). Some studies also find that it has a positive relationship with firm growth (Almus 2002; Brüderl & Preisendörfer, 2000). Despite the ample literature considering human capital, the knowledge about the relationship between the field of education and firm growth remains limited. This study addresses the gap in the literature by including entrepreneurs' fields of education in the firm growth estimations.

2.2 Intangible capital and firm financing

Although IC is an important factor for productivity and firm growth, it can entail some challenging characteristics for creditors since IC is hard to redeploy (Rampini & Viswanathan, 2013). In addition, its valuation is typically more uncertain than for tangible capital (Lim et al., 2020). Thus, IC is weak collateral that increases the asymmetric information between borrower and lender (Hall & Lerner, 2010). Weak collateral adds to the risks the creditor faces, thereby leading to higher interest rates and possibly tighter credit constraints. Following weak pledgeability and asymmetric information, internal finance is an important source of finance for IC investments (see Thum-Thysen et al., 2019). However, while Sun and Xiaolan (2019) claim that there is no correlation between IC and debt issuance, Lim et al. (2020) find that identifiable IC is positively related to leverage. Accordingly, identifiable IC, such as patents, is more efficiently pledgeable (Amable et al., 2010), which likely increases debt capacity.

Given that IC consists of a large variety of assets, we may assume that some fundamental differences exist between them when it comes to finance. The problem of asymmetric information is likely to be highlighted with R&D investments, which are often venturous and related to long-term projects (see Hall

& Lerner, 2010). This is in line with Revest and Sapio (2012) and Deakins and North (2013) who state that technology-based small firms (R&D-intensive by definition) primarily rely on internal finance. In contrast, OC investments are usually targeted at existing operations, which are somewhat more easily perceived subjects for the lender. We may thus assume that the problem of asymmetric information more seriously concerns R&D investments. Long and Malitz (1985) hence find a negative relationship between debt and R&D investments.

Entrepreneurs are often behind the financing decisions, especially in SMEs. We may assume that different kinds of entrepreneurs' orientations relate in various ways to financing issues. Entrepreneurs with technical knowledge can namely be less competent in financing tasks than their peers possessed with business-related knowledge. Revest and Sapio (2012) note that technology-oriented entrepreneurs actually have limited financial skills, likely resulting in their firm's lower debt capacity. On the contrary, business-oriented entrepreneurs are probably more competent in negotiating with lenders, which could lead to higher debt capacity of the firm. Cowling et al. (2016) hence find that entrepreneurs with financial qualifications have better access to credit. Despite entrepreneurial factors being important for firm performance (see e.g., Dillen et al., 2019; Watson et al., 2003), knowledge about the relationship between an entrepreneur's education and financial leverage is still limited. This study aims to fill the gap by examining how an entrepreneur's education is related to debt financing. The estimations including an entrepreneur's education are presented in appendix in Table A1.

2.3 Financing firm growth

In order to grow, firms make investments to increase production capacity or improve the quality of their products or services. Naturally, these investments are financed by debt or equity (internal or external). The famous pecking order theory states that firms favor internal over external financing and debt over equity (Myers, 1984). On the other hand, firm characteristics can affect the financial choices available as some firms face tighter credit constraints or larger cash flows than others. Following from the importance of HGFs for employment (Henrekson & Johansson, 2010; Mason & Brown, 2013), the capital structure–high-growth relationship has been widely examined (e.g., Meisenzahl, 2016; Lopez-Garcia & Puente, 2012; Martínez-Sola et al., 2018). While some studies explain capital structure by growth, they only consider growth over a 1-year period. Degryse et al. (2012) find that growth in assets increases long-term debt, whereas Öhman and Yazdanfar (2017) note that growth in sales increases both short- and long-term financial leverage. Daskalakis and Psillaki (2008) establish that growth in earnings increases financial leverage in general.

We can assume that unlimited access to finance enables firms to exploit all profitable opportunities, whereas firms with reduced credit access are able to conduct more limited investments and are thus doomed to slower growth. Meisenzahl (2016) thus finds that credit constraints are negatively related to firm size. Yet, Lopez-Garcia and Puente (2012) argue that leverage is unrelated to high growth and even negatively related to 'normal' growth. Still, Coricelli et al. (2012) note that the effect of leverage on productivity might be nonlinear. In other words, leverage can be positively associated with productivity growth up until a certain threshold, after which the relationship becomes negative. This may be interpreted so that leverage can support productivity growth until the firm becomes over-indebted and unable to finance any new investments. Fagiolo and Luzzi (2006) state that firms generate higher growth once they achieve better access to credit, which is consistent with Beck and Demirguc-Kunt (2006). This indicates that lower debt capacity hampers growth investments, leaving firms unable to exploit all their growth opportunities. Debt capacity is the amount of debt the firm is able to incur.

Especially growth firms are linked to tight credit constraints. This is addressed by Coad and Srhoj (2020) and Brown et al. (2009) who show that a large share of growth investments is in fact based on retained profits. Rahaman (2011) studied how financial structure is related to firm growth in British and Irish firms, establishing that firms finance their growth investments using their retained profits but switch over to debt once the credit constraints have been loosened. Majluf (1984) hence finds that particularly SMEs retain profits for growth opportunities in the future. However, while cash in balance always incurs some opportunity costs, firms with great growth opportunities are more resilient to these opportunity costs if they assume that their growth investments outweigh their opportunity costs in the future (see Dittmar et al., 2003). The investments made by small firms are found to be sensitive to cash flow (Brown et al., 2009).

Naturally, different firm characteristics have an influence on firms' abilities to finance their growth investments. Small firms often encounter tighter credit constraints than larger firms (Beck et al., 2006; ECB, 2021), with Serrasqueiro et al. (2021) arguing that this is due to the asymmetric information between borrower and lender. In addition to size, a firm age affects credit access as young firms tend to face tighter credit constraints (Beck et al., 2006). Therefore, young growth-oriented SMEs mostly lean on their cash flow to finance their growth investments. Further, the characteristics of economic activities can also affect credit access.

Revest and Sapio (2012) establish that technology-based small firms face particularly tight credit constraints due to the weak pledgeability of their assets. This means that intangible assets are usually poor collateral, which increases the problem of asymmetric information between borrower and lender (e.g., Hall & Lerner, 2010; Rampini & Viswanathan, 2013).

Even though the literature on capital structure and high growth is substantial, most studies analyze how the capital structure predicts high growth. Some papers explain capital structure by growth; still, they only consider growth over a 1-year period and measure it by means other than employment (Degryse et al., 2012; Daskalakis and Psillaki, 2008; Öhman and Yazdanfar, 2017). This study takes a different approach and examines how the capital structure develops when a firm generates high employment growth over a 3-year period, thus providing more long term evidence than the prior studies.

3 DATA AND METHODOLOGY

The three essays in this dissertation analyze unbalanced panel data of Finnish limited companies. Microeconometric methods are employed to study high growth and the capital structure of firms. The data and methodology are described in more detail in the following subsections.

3.1 Data

All three essays use register-based linked employee-employer unbalanced panel data with remote access to it provided by Statistics Finland. The data include information about, for instance, balance sheets, occupations and salaries in Finnish firms. Construction, agriculture, financial, and insurance firms are not considered in the essays. This dissertation focuses on limited companies given their comprehensive accounting policies.

The essays all use some types of IC as regressors. They are measured from intangibles-related labor costs following the occupation-based method developed in the EU Horizon 2020 Globalinto project. Intangibles-related labor costs are multiplied by an approximation of the tangible capital and other intermediate inputs needed for intangible investments (for details, see Piekkola, 2020). IC is separated into OC, R&D, and ICT according to the occupation of an employee. Occupational ICT is closer to special-purpose ICT (e.g., control of production flows, business intelligence tools) especially required in implementing innovations rather than ICT facilities per se (see Piekkola, 2024).

The nominal IC investment is calculated as follows:

(1)
$$P_{i,t}^{N} N_{i,t}^{IC} = z^{IC} l^{IC} M_{i,t}^{IC}$$
$$= A^{IC} M_{i,t}^{IC},$$

where *IC* refers to different types of IC (OC, R&D, ICT). z^{IC} is the factor multiplier, which is an approximation of the tangible capital and other intermediate inputs needed for the IC investment. l^{IC} is the time-use share used for innovative work. $M_{i,t}^{IC}$ is the labor costs of IC employees and A^{IC} is the combined multiplier, which is simply measured by multiplying the factor multiplier by the time-use share. $P_{i,t}^{N}$ is the IC specific deflator. Once the nominal IC investments are calculated, the real stock of IC is measured using the following equation:

(2)
$$R_{i,t}^{IC} = R_{i,t-1}^{IC}(1 - \delta_{IC}) + N_{i,t}^{IC},$$

where $R_{i,t}^{IC}$ is the real stock of IC, δ_{IC} is the IC-specific depreciation rate, and $N_{i,t}^{IC}$ is the real IC investment in period t. The depreciation rate is 20% for OC, 15% for R&D, and 33% for ICT.

3.2 Methodology

This dissertation exploits microeconometrics to study high growth and the dynamics of firms' capital structure. The first essay examines how IC and entrepreneurs' education are related to firm growth. Despite the ample literature considering human capital, the role of an entrepreneur's field of education has hardly been studied. We consider different fields of education: higher tertiary business education, higher tertiary technical education, lower tertiary business education, lower tertiary technical education, lower business education, and lower technical education. An entrepreneur is defined as a person who holds an executive position and owns a significant share of the firm personally or with the family. Until 2010, the personal share of ownership had to be greater than 50%, or 50% with the family. In 2011, the threshold for personal ownership was lowered to 30% due to legal changes. However, this does not affect our conclusions, as we attempted to run the estimations also for the period 2011–2018, but the interpretation of the results remained the same. To prevent dilution of the entrepreneurial position and decision-making authority, the maximum number of entrepreneurs must not exceed five. This dissertation refers to firms with one to five entrepreneurs as *entrepreneurial firms*.

Firm growth is considered in terms of employment growth and measured by the Birch Index (see Birch, 1987), which facilitates the study of both relative HGFs and absolute HGFs together. Firms with the top 10% of the index values are considered to be HGFs. The Birch Index is measured simply as multiplying the absolute growth by the relative growth as follows:

(3) $$BirchIndex_{i,(t,s)} = (L_{i,s} - L_{i,t}) \times \frac{L_{i,s}}{L_{i,t}},$$

where L refers to the number of employees. The high growth is measured over a 3-year period. We estimate both general firm growth (the index value of the Birch Index) and high growth (the top 10% of the index values). General firm growth is estimated using an ordinary least squares regression (OLS) and binary high growth is estimated using a probit estimator.

The second essay considers how labor-based IC explains the debt-to-total-assets ratio in SMEs. In the essay, entrepreneurial IC is used as a regressor that is measured from entrepreneurial income. However, in the supplemental estimations in appendix in Table A1, it is replaced by an entrepreneur's education because there were some uncertainties in identifying the actual types of income included in entrepreneurial income. Thus, I could not completely exclude the possibility of double counting with salaries used for labor-based IC. In the essay, the estimations are run with an OLS and an instrumental-variable regression with a generalized method of moments (IV-GMM). The results are also estimated separately for manufacturing and knowledge-intensive services (KIS). Due to concerns about the instruments used in the IV-GMM estimations, supplemental estimations are run to test robustness against firm-fixed effects, simultaneity, and dynamics in the debt capacity by running an OLS with firm-fixed effects, difference GMM (Arellano and Bond, 1991), and system GMM (Blundell and Bond, 1998). The supplemental estimations and methodology are presented in more detail in appendix. In the essay, the correlation table shows the coefficients only for the dependent and IC variables, but the table including all variables is presented in Table A2 in appendix.

The third essay examines how the capital structure of a firm develops when it generates high growth over a 3-year period. High growth firms are measured similarly as in the first essay. Propensity score matching with difference-in-differences (PSM-DID) is employed to analyze the dynamics of the capital structure when a firm becomes an HGF for the first time. Becoming an HGF is the so-called 'treatment variable' and the short- and long-term debt ratios are used as outcome variables. While estimating the propensity scores with a probit estimation, the lagged values of the outcome variables are not included as covariates to avoid the bias due to the regression to the mean (see Daw & Hatfield, 2018). PSM-DID enables us to match HGFs with control firms that have similar probabilities of becoming an HGF and analyze how the development of the capital structure differs from the matched firms. The matching is done within individual years to control production shocks. The results are also analyzed separately for manufacturing and KIS.

4 SUMMARY OF THE ESSAYS

This section summarizes all three essays. The essays look at how IC and an entrepreneur's education predict firm growth and financial leverage. Moreover, the essays analyze how the capital structure develops once a firm generates high growth over a number of years.

4.1 Essay 1: Intangible capital, entrepreneur's education, and firm growth

The first essay examines how IC and an entrepreneur's education are related to firm growth. HGFs are vital for the economy because they create a considerable share of new jobs (Mason & Brown, 2013). Further, it is important to have a dynamic economy since new firms are more likely to generate high growth (Daunfeldt et al., 2014). Existing literature provides evidence that IC fosters high growth (e.g., Eklund, 2020; Coad & Srhoj, 2020). This essay contributes to the HGF literature by including an entrepreneur's education given that entrepreneurs often lie behind the long-term planning and large operational decisions of the firm. It is written in cooperation with Hannu Piekkola.

The sample includes Finnish limited firms with at least 5 and no more than 250 employees for the period between 2006 and 2018. Linked employee-employer data provide information about, for example, balance sheets, annual salaries, and occupations. IC is measured from intangibles-related labor costs multiplied by the intermediaries needed for IC investments, following the methodology used in the Horizon 2020 Globalinto project (for details, see Piekkola, 2020). An entrepreneur's human capital has been found to have a positive relationship with firm growth (Almus, 2002; Brüderl & Preisendörfer, 2000), but knowledge about the role of the field of education is limited. This essay contributes to the firm growth literature by including an entrepreneur's field of education along with labor-based IC. HGFs are defined by applying a size-neutral Birch Index (Birch, 1987).

The results show that labor-based IC is a crucial factor in firm growth. R&D provides new innovations, e.g., creating new products and increasing productivity, while OC provides tools for restructuring and flexibility. Also, entrepreneurs' higher tertiary technical education is positively related to firm growth, while entrepreneurs' higher tertiary business education has a negative relationship. The results for entrepreneurs' education are non-significant when focusing on high growth.

4.2 Essay 2: Intangible capital and financial leverage in SMEs

The second essay presents how IC explains financial leverage in Finnish SMEs. Since the share of IC has risen in the last few decades (Corrado & Hulten, 2010), it has received a lot of attention from scholars. Compared to tangible capital, IC acts as poor collateral and thus increases the asymmetric information between borrower and lender (Rampini & Viswanathan, 2013). IC also causes large adjustment costs because it is usually related to long-term projects (see Hall & Lerner, 2010). In line with Revest and Sapio (2012) and Cowling et al. (2016), we can assume that entrepreneurs with different types of orientations and knowledge possess varying skill levels with respect to financing issues. Despite the ample literature, the role of an entrepreneur's education has hardly been studied in firm financing. This dissertation makes a contribution by analyzing how the field of an entrepreneur's education along with IC is related to debt financing. In the essay, entrepreneurial IC is also included in the estimations, but it is replaced by an entrepreneur's education in the supplemental estimations presented in appendix in Table A1, as discussed in section 3.

Labor-based ICs are measured from intangibles-related labor costs using the same measurement method as in the first essay. The sample includes Finnish limited SMEs for the period 2000–2018 in the essay and for the period 2006–2018 in the supplemental estimations, because the variables for an entrepreneur's education are more reliable since 2006. In the essay, the estimations are run with OLS with industry-fixed effects and with IV-GMM. Due to concerns about the instruments and potential endogeneity issues, supplemental estimations are run with OLS with firm-fixed effects, difference GMM, and system GMM to test robustness against firm-fixed effects, simultaneity, and dynamics in the debt capacity.

The results in the essay indicate that labor-based ICs have significant and negative relationships with debt capacity that is likely explained by their weak pledgeability, which raises the problem of asymmetric information between borrower and lender. Internal finance is thus particularly important for intangible investments. R&D has a stronger negative relationship with financial leverage than organizational capital due to its venturous and risky nature.

The supplemental estimations in appendix show that the fixed-effects panel estimation supports the findings that labor-based ICs have negative relationships with debt capacity. While the fixed-effects model helps to reduce potential omitted variable bias, it does not eliminate potential simultaneity bias. The difference GMM and system GMM can address this issue, but results are non-significant.

Hence, the estimations may not reveal the causal effect of IC on debt capacity. This may be linked to the persistence of IC and the poor explanatory power of the instruments. Due to limitations in computation capacity, I was unable to estimate the weak instrument statistics. In addition, the theory for detecting weak instruments under heteroskedasticity is still very limited.

The system GMM shows that entrepreneurs possessing lower tertiary technical education operate with lower financial leverage than others. This can be explained by the limited financial skills of the technically-oriented entrepreneurs (Revest & Sapio, 2012). Also the coefficient of higher tertiary technical education is negative but non-significant. Moreover, the system GMM indicates that entrepreneurs with higher tertiary business education operate with higher financial leverage, which could be explained by their superior financial knowledge. These findings are in line with the results of entrepreneurial IC in the essay. The supplemental estimations are discussed in more detail in appendix.

4.3 Essay 3: The capital structure of high-growth SMEs

The third essay investigates how the capital structure of a firm develops when it generates high growth over a 3-year period. Given that finance plays a key role in growth investments, many studies try to predict high growth with capital structure. Credit access is found to be an important factor for firm growth (Fagiolo & Luzzi, 2006; Beck & Demirguc-Kunt, 2006). As HGFs often face tight credit constraints, many of their growth investments are financed by their retained profits (e.g., Coad & Srhoj, 2020; Brown et al., 2009). However, an excess of debt is also not good since leverage has a negative effect on productivity growth beyond a certain threshold (Coricelli et al., 2012). Even though the literature is quite voluminous, understanding is lacking about the dynamics of the capital structure during periods of high growth lasting several years. This essay contributes by seeking to close this gap.

Linked employee-employer unbalanced panel data of Finnish limited SMEs are used to estimate the development of the capital structure. PSM-DID is used to reveal the relationship between high growth and development of the capital structure. HGFs are matched with control firms that have similar covariates. They may be seen as potential HGFs that for some unobservable reason have been unable to generate high growth.

The results indicate that short-term debt is the most frequently used source of finance in high-growth SMEs. The short-term debt ratio increases by 3 percentage points on average during the 3-year high-growth period whereas the long-term debt ratio falls almost by the same extent. This highlights the importance of short-term credit access for high-growth SMEs. While control firms decrease their long-term financial leverage and increase their equity ratio, HGFs decrease both their long-term financial leverage and equity ratio. Despite some papers arguing that small HGFs mostly use retained profits for investments, this paper shows that they—at least Finnish high-growth SMEs—use relatively more short-term debt. The results are similar for manufacturing firms. These findings emphasize the potential risk in the capital structure of high-growth SMEs during a tightening credit market if long-term assets are being financed by short-term debt.

Still, the results are non-significant when considering HGFs operating in KIS. One explanation for this may be that in service industries growth is more easily scalable than in manufacturing, where production capacity depends more on tangible investments, i.e., buildings and machinery. Therefore, firms in the service industry may be able to generate high growth without large investments. On other hand, firms in the service industry might have weaker collateral available than manufacturing firms, in turn increasing their asymmetric information problems and thereby decreasing their debt capacity.

5 CONCLUSIONS

Although IC is an important factor in productivity growth, it may entail some financial challenges for innovative firms. Digitalization and rapidly developing technology mean that skilled entrepreneurs and employees are crucial for innovative firms. This dissertation studies how IC and entrepreneurs' education predict high growth, and how they are related to financial leverage. In addition, the dynamics of the capital structure are examined during periods of high growth.

The first essay examines how IC and entrepreneurs' education are related to firm growth. The estimations show that the organizational and technical knowledge of employees is particularly important for firm growth. In addition, entrepreneurs possessing higher tertiary technical education are positively related to firm growth, while entrepreneurs possessing higher tertiary business education have a negative relationship. The results for entrepreneurs' education are non-significant when focusing on high growth. A potential selection bias towards higher tertiary education was not controlled.

Intangible investments can be challenging to finance due to their weak pledgeability. The second essay analyzes how IC and entrepreneurs' education are related to financial leverage in Finnish SMEs. It contributes to the literature also by including the fields of education, which signal the entrepreneurs' orientations. The results show that the firms of entrepreneurs possessing higher technical education have lower financial leverage, which may be explained by their limited financial skills and their relationship with venturous and risky long-term projects. Moreover, entrepreneurs with higher tertiary business education operate with higher financial leverage. In addition, IC has a negative relationship with financial leverage, likely caused by its weak pledgeability.

The fact that many HGFs depend on sufficient funding for their growth investments makes it important to fully understand the dynamics of their capital structure during high-growth periods. Although internal finance is found to predict firm growth, the results of the third essay indicate that short-term debt is the most commonly used source of finance during periods of high growth. The short-term debt ratio increases by 3 percentage points on average during the 3-year high-growth period, whereas the long-term debt ratio decreases by almost the same extent. Namely, high growth is positively linked to short-term financial leverage. The results emphasize the importance of short-term credit access for high-growth SMEs since they use more short-term debt than retained profits when growing over several years. However, the results are non-significant for HGFs operating in knowledge-intensive services where the development of the capital structure does not differ between HGFs and control firms during the 3-year high-growth period. One explanation here is that services are more easily scalable than manufacturing and thus could be able to grow without large investments. Still, firms in services are likely to have weaker collateral than manufacturing firms, which would act to tighten their debt capacity.

As an implication of this dissertation, the results point to the importance of higher education for the Finnish economy because high-growth firms need talented entrepreneurs and employees. Moreover, it is necessary to have efficient and open financial markets to enable the funding of profitable growth investments.

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Appendices

Appendix A

The supplemental estimations to essay 2 are run to test the robustness against firm-fixed effects, simultaneity, and dynamics in the debt capacity.

In panel data, unobserved time-invariant individual effects might be correlated with observable variables (Hausman & Taylor, 1981). They can be controlled with the fixed effects estimator, where the firm averages are removed from the basic equation. The basic equation and the equation with the firm-averages are as follows:

(A1) $$y_{i,t} = a + x_{i,t}\beta + \eta_i + \varepsilon_{i,t}$$

(A2) $$\overline{y}_i = a + \overline{x}_i\beta + \eta_i + \overline{\varepsilon}_i,$$

where $\overline{y}_i = \sum_t y_{i,t}/T_i$, $\overline{x}_i = \sum_t x_{i,t}/T_i$, and $\overline{\varepsilon}_i = \sum_t \varepsilon_{i,t}/T_i$. η_i is the time-invariant firm-specific effect and $\varepsilon_{i,t}$ is the error term. When equation A2 is subtracted from A1, it gives the fixed effects estimator:

(A3) $$(y_{i,t} - \overline{y}_i) = (x_{i,t} - \overline{x}_i)\beta + (\varepsilon_{i,t} - \overline{\varepsilon}_i).$$

An alternative way to remove the unobserved firm-specific effect would be to first-difference the data. This can be combined with instruments to restrain potential endogeneity issues. As the data often lack proper external instruments, Arellano and Bond (1991) suggest to instrument the first-differenced variables with their lagged levels. When the lagged dependent variable is included in the equation, it becomes the renowned difference GMM estimator:

(A4) $$\Delta y_{i,t} = \pi\Delta y_{i,t-1} + \beta\Delta x_{i,t} + \Delta\varepsilon_{i,t},$$

where $\Delta y_{i,t-1} = y_{i,t-1} - y_{i,t-2}$. The first lag of an endogenous variable cannot be used as an instrument since it is correlated with the error term $\varepsilon_{i,t-1}$ in $\Delta\varepsilon_{i,t}$. Thus, lags *t-2* or longer can be used. However, fixed effects and first-differenced estimators can be inefficient when data is highly persistent and the within-firm variation is relatively small (Blundell & Bond, 2000). In such data, the effect of within-firm variation can be impossible to identify after the firm-specific effect is removed (Hill et al., 2020; Gunasekara et al., 2014). Then, the lagged levels can be poor predictors for the first-differenced regressors leading to weak instruments. Since the estimator considers only the variation in the regressor caused by instruments, poorly predicting instruments result in biased estimators (see Stock and Yogo, 2005). Blundell and Bond (1998) discuss this problem and propose including also the levels of the variables instrumented with their lagged first-differences. This leads to a system estimator including equations for both first-differenced and level regressors, when the basic form is as follows:

(A5) $$\begin{bmatrix} y_{i,t} \\ \Delta y_{i,t} \end{bmatrix} = \pi \begin{bmatrix} y_{i,t-1} \\ \Delta y_{i,t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{i,t} \\ \Delta \varepsilon_{i,t} \end{bmatrix}, \quad Z_i = \begin{bmatrix} \Delta y_{i,t-1} & 0 \\ 0 & y_{i,t-2} \end{bmatrix},$$

where Z_i is the matrix of instruments. Blundell and Bond argue that with persistent data the level equation improves the GMM estimator, since the lagged differences are likely more related to the levels than the lagged levels to the first-differences. However, with persistent data also the level regressors can suffer from weak instruments. Bun and Windmeijer (2010) show that when the variation of the firm-specific effect is large relative to the variation of the idiosyncratic error, the instruments can be uninformative also in the level equation leading to inefficient estimator.

This may also be the case in this sample, since the lagged levels of the IC variables predict the variation in the first-differences poorly, and the lagged first-differences also predict the variation in the levels poorly. In addition to the fact that capital variables are often relatively persistent, the persistence of IC variables follows also from their measuring method since they are calculated from the intangibles-related labor costs, which tend to be persistent over time. In addition, the variation of the firm-specific effect is large compared to the variation of the idiosyncratic error. Accordingly, the level of IC is dispersed between firms. Some firms operate in knowledge-intensive sectors and invest in IC, while some firms focus on simple and routine business activities, where competitive advantage is based on inexpensive labor rather than their knowledge. This is in accordance with the increased productivity dispersion (Corrado et al., 2021).

Since the IV-estimator only considers the variation in the regressor caused by the instruments, it is also necessary that the instruments are able to explain a sufficient share of it. The conventional method to test the weakness of the instruments is to run F statistics (e.g., Sanderson and Windmeijer, 2016; Kleibergen and Paap, 2006). While the Cragg-Donald (1993) Wald F statistic assumes homoskedasticity, the Wald F statistic of Kleibergen and Paap (2006) rk statistic and Sanderson and Windmeijer (2016) F statistics are robust to heteroskedasticity and clustering. Nevertheless, the critical values of the F statistics by Stock and Yogo (2005) are invalid under heteroskedasticity (Bun and de Haan, 2010). I tried to estimate the variable-specific F statistics after difference and system GMM estimations, but unfortunately I was unable to estimate them due to the limitations in computation capacity. In addition, the theory for detecting weak instruments under heteroskedasticity is still very limited.

In the instrument matrix, the lag depth is limited to five lags to avoid instrument proliferation. Thus, lags *t-2* to *t-5* are used. All other explanatory variables are treated as endogenous except *firmage* and entrepreneur and education dummies. It is important to control for profitability because higher profitability lowers preferences for debt due to higher internal finance. Therefore, return on assets (ROA) is included to control for this. However, there are potential simultaneity issues because higher financial leverage increases interest expenses resulting in lower net income. Although the potential simultaneity should be handled with difference and system GMM estimators, and its magnitude is likely to be limited, the calculation method of ROA is revised in these supplemental estimations so that I use the income before interest expenses and interest income. In addition, it is now multiplied by 100 to adjust it to the same scale as the debt ratio. Accordingly, the formula is (*net income + interest expenses - interest income)/total assets×100*. In addition, the entrepreneurial IC variables are replaced by the entrepreneur's education, as there were some uncertainties in identifying the actual types of income included in entrepreneurial income. Thus, I could not completely exclude the possibility of double counting with salaries used for labor-based IC. The supplemental estimations are run for the period 2006–2018 because the measurement of the entrepreneur variables is more reliable since 2006.

Table A1 presents results for OLS with industry-fixed effects (column (1)), OLS with firm-fixed effects (column (2)), difference GMM (column (3)), and system GMM (column (4)). The difference and system GMM estimations are two-step estimators with bias-corrected robust standard errors (see Windmeijer, 2005). Column (1) replicates the OLS results presented in the second essay, except that here the calculation of ROA is revised and entrepreneurial IC is replaced by an entrepreneur's education as discussed earlier. The results in Table A1 show that the coefficients of the IC variables become less statistically significant when controlling for the time-invariant firm-specific effects in column (2). In columns (3) and (4), the coefficients of IC become non-significant. However, the Hansen (1982) J statistics and the difference-in-Hansen statistics indicate a misspecified model, which may lead to biased estimates. The difference and system GMM were also run with instruments with lags *t-3* to *t-5* and *t-4* to *t-5*, but the overidentification tests remained statistically significant. Thus, these supplemental estimations do not strictly reject the original results in the second essay, but they also do not support the causal interpretation. The system GMM estimations suggest that entrepreneurs with higher technical education have lower financial leverage than others. This partly supports the interpretation in essay 2 that technically oriented entrepreneurs have lower debt capacity because they are more involved in risky projects and may suffer from limited financial knowledge. Moreover, entrepreneurs with higher tertiary business education operate with higher financial leverage, which could be explained by their superior financial knowledge. Moreover, the results show that entrepreneurial firms in general have higher debt capacities.

Table A1. Supplemental estimations of debt capacity. Testing robustness against firm-level effects and dynamics in the debt capacity

$\text{debt ratio}_{i,t}$	(1) OLS industry FE	(2) OLS firm FE	(3) difference GMM	(4) system GMM
$\text{debt ratio}_{i,t-1}$			0.531***	0.601***
			(0.021)	(0.015)
$\text{debt ratio}_{i,t-2}$			0.083***	0.094***
			(0.009)	(0.008)
$\ln(OC_{i,t}/L_{i,t})$	-0.239***	-0.180*	0.038	-0.002
	(0.056)	(0.106)	(0.493)	(0.244)
$\ln(R\&D_{i,t}/L_{i,t})$	-0.132**	-0.176*	-0.223	0.179
	(0.053)	(0.097)	(0.601)	(0.303)
$\text{EntrepreneurEdu}^{HTBus}_{i,t}$	1.447***	0.554	0.286	0.828
	(0.450)	(0.552)	(0.705)	(0.515)
$\text{EntrepreneurEdu}^{HTTech}_{i,t}$	-0.708	-0.175	-0.064	-0.471
	(0.431)	(0.455)	(0.634)	(0.554)
$\text{EntrepreneurEdu}^{HTOth}_{i,t}$	0.328	-0.151	-0.055	-0.236
	(0.398)	(0.423)	(0.503)	(0.429)
$\text{EntrepreneurEdu}^{LTBus}_{i,t}$	-1.007***	0.097	0.423	0.052
	(0.253)	(0.310)	(0.390)	(0.313)
$\text{EntrepreneurEdu}^{LTTech}_{i,t}$	-0.223	-0.580*	-0.546	-0.609*
	(0.283)	(0.341)	(0.413)	(0.332)
$\text{EntrepreneurEdu}^{LTOth}_{i,t}$	-0.201	-0.261	0.731*	0.293
	(0.299)	(0.308)	(0.408)	(0.322)
$\text{EntrepreneurEdu}^{LowBus}_{i,t}$	0.135	-0.454	-0.125	0.087
	(0.313)	(0.362)	(0.481)	(0.357)
$\text{EntrepreneurEdu}^{LowTech}_{i,t}$	1.446***	0.035	-0.255	-0.057
	(0.263)	(0.253)	(0.324)	(0.275)
$\text{Entrepreneur in the firm}_{i,t}$	0.680***	0.148	0.450*	0.284
	(0.216)	(0.191)	(0.265)	(0.211)
$\ln(K_{i,t}/L_{i,t})$	0.892***	0.707***	0.747**	0.375*
	(0.048)	(0.125)	(0.307)	(0.194)
$\ln(L_{i,t})$	-1.783***	-1.880***	-2.528	-1.551*
	(0.097)	(0.329)	(2.035)	(0.824)
$ROA_{i,t}$	-0.251***	-0.126***	-0.116***	-0.151***
	(0.006)	(0.006)	(0.031)	(0.021)

(Table A1 continued)

Firm $risk_{i,t}$	11.746***	11.904***	-4.095	1.977
	(1.219)	(1.364)	(3.406)	(2.484)
Firm $age_{i,t}$	-0.121***	0.001	0.355	-0.024
	(0.008)	(0.032)	(0.634)	(0.033)
constant	26.497***	18.540***		36.424
	(0.679)	(3.211)		(163.040)
N	103,941	103,941	82,894	96,354
R^2	0.145	0.037		
Instruments			385	499
AR(1)			0.000	0.000
AR(2)			0.431	0.912
Hansen (p)			0.000	0.000
diff-in-Hansen, difference equation (p)				0.000
diff-in-Hansen, level equation (p)				0.287

Asterisks indicate the significance level, * <0.1, ** <0.05, *** <0.01. Column (1) with heteroskedasticity robust standard errors. Other columns with clustered standard errors. The results for time- and industry-fixed effects are not reported. Industry-fixed effects are used only in columns (1) and (4). FE refers to fixed effects. *debt ratio* is calculated as *long-term debt/total assets×100*. *OC* is organizational capital and *R&D* is research and development. *ln()* refers to natural logarithm. *EntrepreneurEdu* is a dummy variable for entrepreneurs' education and the superscripts refer to the level and field of education. The superscripts *HTBus, HTTech,* and *HTOth* refer to *higher tertiary business, higher tertiary technical, and higher tertiary other,* respectively. The superscripts *LTBus, LTTech, LTOth, LowBus, and LowTech* refer to *lower tertiary business, lower tertiary technical, lower tertiary other, low business, and low technical,* respectively (see subsection 3.2 or the first essay for details). Low education in other fields than business or technical is the reference education. *Entrepreneur in the firm* is a dummy variable for firms which have at least one entrepreneur (An executive role and a personal ownership of over 50% until 2010, or over 30% since 2011. Or over 50% with the family.). *L* is the number of employees. *K* is tangible capital. *ROA* refers to return on assets calculated as *(net income+interest expenses-interest income)/total assets×100*. *Firm risk* is the standard deviation of net income covering periods *t*, *t-1*, and *t-2*. In columns (3) and (4), lags t-(2-5) are used as instruments. All variables except *Firm age* and entrepreneur dummies are treated as endogenous.

While Table 2 in the second essay presents the correlation coefficients only for the dependent and intangible variables, Table A2 presents the coefficients for all variables used to estimate debt capacity in the supplemental estimations.

Table A2. Correlation table of all variables in the debt capacity estimations

	debt ratio$_{i,t}$	ln(OC$_{i,t}$/L$_{i,t}$)	ln(R&D$_{i,t}$/L$_{i,t}$)	Entrepreneur Edu$^{HTBus}_{i,t}$	Entrepreneur Edu$^{HTTech}_{i,t}$	Entrepreneur Edu$^{HTOth}_{i,t}$	Entrepreneur Edu$^{LTBus}_{i,t}$	Entrepreneur Edu$^{LTTech}_{i,t}$	Entrepreneur Edu$^{LTOth}_{i,t}$
ln(OC$_{i,t}$/L$_{i,t}$)	-0.049*								
ln(R&D$_{i,t}$/L$_{i,t}$)	-0.011*	0.290*							
EntrepreneurEdu$^{HTBus}_{i,t}$	-0.005	0.008*	-0.049*						
EntrepreneurEdu$^{HTTech}_{i,t}$	-0.021*	0.009*	0.091*	0.006					
EntrepreneurEdu$^{HTOth}_{i,t}$	-0.020*	0.029*	-0.022*	0.029*	0.018*				
EntrepreneurEdu$^{LTBus}_{i,t}$	-0.020*	-0.090*	-0.148*	0.013*	-0.018*	0.003			
EntrepreneurEdu$^{LTTech}_{i,t}$	0.006	-0.085*	0.087*	-0.017*	0.011*	-0.021*	-0.015*		
EntrepreneurEdu$^{LTOth}_{i,t}$	-0.008*	-0.048*	-0.084*	0.014*	-0.007*	0.041*	0.021*	-0.014*	
EntrepreneurEdu$^{LowBus}_{i,t}$	-0.001	-0.107*	-0.118*	-0.009*	-0.020*	-0.009*	0.043*	-0.012*	0.012*
EntrepreneurEdu$^{LowTech}_{i,t}$	0.035*	-0.125*	-0.039*	-0.020*	-0.021*	-0.029*	-0.013*	0.011*	-0.007*
Entrepreneur in the firm$_{i,t}$	0.006	-0.223*	-0.179*	0.164*	0.170*	0.209*	0.349*	0.302*	0.280*
ln(K$_{i,t}$/L$_{i,t}$)	0.070*	0.155*	0.218*	-0.035*	-0.017*	-0.051*	-0.067*	-0.004	-0.064*
ln(L$_{i,t}$)	-0.069*	0.193*	0.181*	0.005	-0.002	0.030*	-0.014*	-0.028*	0.029*
ROA$_{i,t}$	-0.247*	-0.005	0.013*	0.012*	0.019*	0.013*	-0.003	0.013*	-0.002
Firm risk$_{i,t}$	0.086*	-0.015*	-0.037*	-0.003	0.008*	0.031*	-0.017*	-0.008*	0.031*
Firm age$_{i,t}$	-0.004	0.036*	0.103*	-0.004	-0.010*	-0.039*	0.020*	0.007*	-0.048*

The asterisk indicate the significance level of 0.05. *debt ratio* is calculated as *long-term debt/total assets×100*. *OC* is organizational capital and *R&D* is research and development. *ln()* refers to natural logarithm. *EntrepreneurEdu* is a dummy variable for entrepreneurs' education and the superscripts refer to the level and field of education. The superscripts *HTBus, HTTech,* and *HTOth* refer to *higher tertiary business*, *higher tertiary technical*, and *higher tertiary other*, respectively. The superscripts *LTBus, LTTech, LTOth, LowBus*, and *LowTech* refer to *lower tertiary business, lower tertiary technical, lower tertiary other, low business*, and *low technical*, respectively (see subsection 3.2 or the first essay for details). Low education in other fields than business or technical is the reference education. *Entrepreneur in the firm* is a dummy variable for firms which have at least one entrepreneur (An executive role and a personal ownership of over 50% until 2010, or over 30% since 2011. Or over 50% with the family.). *L* is the number of employees. *K* is tangible capital. *ROA* refers to return on assets calculated as *(net income+interest expenses-interest income)/total assets×100*. *Firm risk* is the standard deviation of net income covering periods *t, t-1,* and *t-2*.

(Table A2 continued)

	Entrepreneur $Edu^{LowBus}_{i,t}$	Entrepreneur $Edu^{LowTech}_{i,t}$	Entrepreneur in the $firm_{i,t}$	$ln(K_{i,t}/L_{i,t})$	$ln(L_{i,t})$	$ROA_{i,t}$	Firm $risk_{i,t}$
$EntrepreneurEdu^{LowTech}_{i,t}$	0.009*						
Entrepreneur in the $firm_{i,t}$	0.250*	0.360*					
$ln(K_{i,t}/L_{i,t})$	-0.056*	-0.017*	-0.130*				
$ln(L_{i,t})$	-0.006*	0.014*	-0.010*	0.206*			
$ROA_{i,t}$	-0.005	0.004	0.002	-0.039*	0.023*		
Firm $risk_{i,t}$	-0.005	-0.017*	0.014*	-0.150*	-0.075*	-0.234*	
Firm $age_{i,t}$	-0.014*	-0.005	-0.047*	0.285*	0.115*	-0.043*	-0.215*

The asterisk indicate the significance level of 0.05. debt ratio is calculated as long-term debt/total assets×100. OC is organizational capital and R&D is research and development. ln() refers to natural logarithm. EntrepreneurEdu is a dummy variable for entrepreneurs' education and the superscripts refer to the level and field of education. The superscripts HTBus, HTTech, and HTOth refer to higher tertiary business, higher tertiary technical, and higher tertiary other, respectively. The superscripts LTBus, LTTech, LTOth, LowBus, and LowTech refer to lower tertiary business, lower tertiary technical, lower tertiary other, low business, and low technical, respectively (see subsection 3.2 or the first essay for details). Low education in other fields than business or technical is the reference education. Entrepreneur in the firm is a dummy variable for firms which have at least one entrepreneur (An executive role and a personal ownership of over 50% until 2010, or over 30% since 2011. Or over 50% with the family.). L is the number of employees. K is tangible capital. ROA refers to return on assets calculated as (net income+interest expenses-interest income)/total assets×100. Firm risk is the standard deviation of net income covering periods t, t-1, and t-2.

Essays

This dissertation consists of an introductory chapter and the following three essays:

1. Norkio, A., & Piekkola, H. (2024). Intangible Capital, Entrepreneur's Education, and Firm Growth.

2. Norkio, A. (2024). Intangible Capital and Financial Leverage in SMEs. *Managerial Finance*, 50(2), 434–450. https://doi.org/10.1108/MF-10-2022-0488. CC BY 4.0.

3. Norkio, A. (2023). The Capital Structure of High-Growth SMEs.

Intangible Capital, Entrepreneur's Education, and Firm Growth

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Abstract

The paper examines how entrepreneurs' education and intangible capital (IC) are related to firm growth in SMEs. Register-based linked employee-employer data concerning Finnish firms are used to measure labor-based IC, covering R&D, organizational capital (OC), and information and communication technology (ICT). The results show that organizational and technical knowledge of employees is an essential factor in firm growth. Moreover, entrepreneurs' higher tertiary technical education is positively related to employment growth, while entrepreneurs' higher tertiary business education has a negative relationship. The results for entrepreneurs' education are non-significant when focusing on high growth. Having just one entrepreneur in the firm is negatively related to growth. In addition, the estimations indicate that firm growth persists as past growth is positively related to growth in the following years.

Keywords: Intangible capital, entrepreneur's education, firm growth, R&D, innovation management

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1 INTRODUCTION

High-growth firms (HGFs) are essential for the jobs they create (Hölzl, 2013; Littunen & Tohmo, 2003), making them important for the economy. The importance HGFs hold for job creation is reflected in the substantial amount of literature on firm growth (e.g., Almus, 2002; Hölzl, 2009; Mohr et al., 2014). The fact entrepreneurs often lie behind the firm's long-term planning decisions to increase its growth means that it is important to properly understand the relations held by entrepreneurial factors. Some papers thus focus on entrepreneurs in an attempt to explain firm growth. While Dillen et al. (2019) state that the strategic skills possessed by entrepreneurs are important for firm growth, Delmar and Wiklund (2008) establish that entrepreneurs' growth motivation predicts growth. In addition, Baum and Locke (2004) note the self-efficacy of an entrepreneur fosters venture growth, whereas Vivarelli and Audretsch (1998) find that the firm founders' motivation to innovate is positively linked to growth. One might assume that the necessary skills are related to the level of education, as shown in Unger et al. (2009). Accordingly, Almus (2002), Barringer et al. (2005), and Watson et al. (2003) show that entrepreneurs' higher education has a positive relationship with firm growth. Moreover, Unger et al. (2011) find that educational attainment is positively related to firm success in general. In addition to growth, van der Sluis et al. (2008) find that the probability of firm survival increases with years of schooling. Despite the important contributions made by the mentioned papers, understanding about the role of entrepreneurial factors, especially of the fields of entrepreneurs' education, remains limited. This paper fills this gap by studying how the fields of entrepreneurs' education together with intangible capital (IC) are related to firm growth. To this end, the paper uses register-based linked employee-employer data (LEED) for the period 2006–2018 that include data on balance sheets, occupations, and entrepreneurs' education.

In this paper, IC refers to R&D, organizational capital (OC), and information and communication technology (ICT) – all established, important determinants of growth (Corrado et al., 2016; Roth & Sen, 2021). These three elements are measured by following the methods developed in the EU projects Innodrive (EU 7th framework) and Globalinto (Piekkola, 2020) using different occupations for intangible-capital work, which are related to creating new intangibles. The dichotomy between different intangibles is important because an employee possessing R&D knowledge can be expected to create capital accumulation over a longer time horizon, while those with management and marketing knowledge are the most highly paid and able to lead the organizational change and marketing of products and services.

Innovation capacities are firmly associated with entrepreneurs' possession of animal spirits to take risks and decide on new technical development to take the advantage of growth opportunities (Chandler & Jansen, 1992). The education of an entrepreneur potentially provides valuable human capital that can be exploited in the innovations and business development. An entrepreneur's knowledge also ensures the firm's strategic agility or absorptive capacity in innovation value chains (Kuilboer et al., 2016). In addition to higher education, we also separate business and technical educations of both higher and lower levels, which provide skills that can be used in the business. Business studies provide financial, managerial, and general business knowledge that potentially help an entrepreneur in developing business and applying for funding. Technical education is expected to provide knowledge that can be used in innovations and product development.

This paper accordingly offers new information about how entrepreneurs and their educations explain firm growth along with labor-based IC in Finnish small and medium-sized enterprises (SMEs). The results show that firm growth is especially linked to labor-based R&D and OC. Moreover, an entrepreneur's higher tertiary technical education has a positive relationship with firm growth.

Section 2 of this paper presents a literature overview and hypotheses. Section 3 presents the data and methodology, while section 4 analyzes the results and section 5 concludes.

2 LITERATURE AND HYPOTHESES

2.1 Literature review

It is important that the entrepreneur is committed to achieving high growth (Smallbone et al., 1995). The efficient management of HGFs does not simply depend on the entrepreneur's characteristics, but the commitment to growth must be implemented across the whole firm (Barringer & Jones, 2004). Entrepreneurial skills are considered in many ways in the literature. Eesley and Roberts (2012) view talent as generating higher revenues, while Amit et al. (1990) describe entrepreneurial ability as the capacity 'to combine tangible and intangible assets in new ways and to deploy them to meet customer needs in a manner that could not easily be imitated'. Ferrante (2005) understands talent as an allocation of working time, and Evans and Jovanovic (1989) as entrepreneurial income per capital invested.

Van der Sluis et al. (2008) and Unger et al. (2011) have summarized the entrepreneurship literature regarding the connection between education and entrepreneurship entry and outcomes. The findings suggest that possessing strong entrepreneurial skills with higher education positively correlates with firm performance, regardless of the performance measure (e.g., survival, profit, firm growth, or income—with income being the most commonly used measure). However, Hamilton (2000) finds that financial incentives are not necessarily the primary motivation for individuals to shift from wage employment to entrepreneurship.

The literature about growth persistence is ambiguous as some papers find persistence (Eklund, 2020) and others do not (Daunfeldt & Halvarsson, 2015). Dillen et al. (2019) establish that growth persistence is positively associated with the strategic skills of the entrepreneur and the firm's human capital. Managers of HGFs are better educated and have longer work experience than managers of non-HGFs, and the same factors also support the persistence of high growth over time (Barringer et al., 2005). Almus (2002) notes that the human capital possessed by founders is positively linked to firm growth. While Baum and Locke (2004) find that the self-efficacy of an entrepreneur fosters venture growth, Delmar and Wiklund (2008) and Davidsson (1991) state that a desire to grow is also needed. We may assume based on these earlier findings on entrepreneurial factors that proper knowledge and skills are needed to make robust long-term decisions and exploit business opportunities. Such factors can also be more important for growth than IC in general because intangible investments create fixed costs that make it harder for the 'the ship to change course', which calls for competent entrepreneurs and management. In this paper, we concentrate on growth attained over 3 years.

Intangibles have also been shown to be a significant factor in creating HGFs (Rossi-Hansberg & Wright, 2007; Eklund, 2020). Rossi-Hansberg and Wright (2007) note that firm-specific human capital—of which intangible capital is a prime example—is a significant factor in the creation of HGFs. Still, one can find opposite arguments as well, with Daunfeldt et al. (2016) stating that R&D intensity does not have a positive effect on the density of HGFs. According to Stam and Wennberg (2009), R&D is positively associated with HGFs only among high-tech firms. One explanation for these results is the high level of fixed costs entailed in creating new innovations, and that the R&D of SMEs might not be measured precisely given that information is typically obtained from surveys that only cover a subset of SMEs.

A knowledge-intensive environment leads to higher fixed costs for market participants which can act to restrain firm activities. Morris et al. (2010) define different forms of "strategic entrepreneurship" associated with innovations, such as new products or a business model. Innovativeness can thus also be related to many aspects other than just new products or services (Covin & Wales, 2019). For instance, new business models or organizational structures may be seen as innovations since they develop the firm activities or the way the work is organized.

This paper views intangibles more broadly than simply innovation assets (mainly R&D, software, database) covered in the national accounting. Organizational capital (OC) is found to be important for high-productivity firms (Corrado et al., 2017). Such broad intangibles have been shown to increase productivity through both capital deepening and its complementarity with other assets.

2.2 Hypotheses

Higher education can support, e.g., computational and communication skills (Sapienza & Grimm, 1997), which can be beneficial for entrepreneurs in networking and analytical tasks. Accordingly, an entrepreneur's higher education has a positive relationship with firm survival (Bates, 1990; Coleman et al., 2013). Moreover, some studies find that an entrepreneur's human capital is positively related to firm growth (Almus, 2002; Brüderl & Preisendörfer, 2000). Hence, our first hypothesis is as follows:

1) An entrepreneur's tertiary education has a positive relationship with firm growth, and the relationship is stronger for higher tertiary education.

There are many studies discussed here that consider entrepreneurs' human capital in terms of years of schooling or level of education. However, knowledge is still limited with respect to the field of entrepreneur's education. Although higher education is found to support, e.g., communication and imagination skills (Sapienza & Grimm, 1997), it can be argued that some fields of education provide more business-related skills than others. We might expect business studies to provide financial, managerial, and general business knowledge that is valuable in business activities. On the other hand, higher technical education is likely to enhance computational and analytical skills, which are often needed in innovation and product development. Both of these skills can be hypothesized to support firm growth. Hence, we hypothesize that the field of education is a significant factor leading to the second hypothesis:

2) Tertiary business and technical educations of entrepreneurs are positively related to firm growth.

Intangible capital is highly necessary for innovation, which allows the firm to grow and develop its business. Accordingly, using Danish data, Eklund & van Criekingen (2022) find that OC and R&D increase the probability of high growth. Moreover, innovative entrants are likely to survive longer than non-innovative entrants (Colombelli et al., 2016), which helps them to grow persistently over the years. Following these findings and the literature discussed in subsection 2.1., the third hypothesis is as follows:

3) Intangible capital is positively related to firm growth.

The hypotheses are expected to apply to both general firm growth and high growth.

3 DATA AND METHODOLOGY

This paper focuses on SMEs with at least 5 but not more than 250 employees. In general, over 90% of firms are micro firms, namely, those with less than 10 employees (Deschryvere, 2008). Thus, if we were to omit firms with fewer than 10 employees to avoid the distortion of micro firms (Nassar et al., 2014), we would be omitting a large share of firms from the study. The different growth factors of smallest micro firms compared to small and medium-sized firms (see Yazdanfar & Salman, 2012) make it rational to consider them in a separate study.

3.1 Data description

We use a full register-based unbalanced private sector panel dataset of Finnish SMEs for the period 2006–2018 from Statistics Finland. The data include information about balance sheets, annual salaries, part-time work (assuming 70% working time), occupations, and education.[1] We focus on the general growth and high growth in employment of Finnish SMEs and include only limited liability companies with at least five and no more than 250 employees. During the growth period, the number of employees is allowed to exceed 250. The data also include information about entrepreneurs and their field and level of education. There are different definitions of entrepreneurs in the literature. Levine and Rubinstein (2017) define them simply as business owners through incorporations. Hvide and Panos (2014) find them to be owners who own more than 50% of a young incorporation. Berglann et al. (2011) define an entrepreneur as a sole proprietor or a person who owns at least 30% of the firm, or alternatively at least 10% if s/he is a board member or CEO. In contrast to Levine and Rubinstein, Berglann et al. do not require the firm to be young. Furthermore, van Praag and Raknerud (2022) define entrepreneurs as self-employed sole proprietors or incorporation employees, CEOs or board members with more than 33% ownership. They also require that the firm is new. In this paper, we have a somewhat similar definition to Berglann et al. and van Praag and Raknerud, except that we focus only on limited liability companies and include older firms too. Here, an owner is considered an entrepreneur if s/he has an executive role and owns a significant share of the firm personally or with the family. Until 2010, the personal share of ownership had to be greater than 50%, or 50% with the family. In 2011, the threshold for personal ownership was lowered to 30% due to legal changes. In the sample, the average number of entrepreneurs increased from 0.68 to 0.84 from 2010 to 2011. This does not affect our conclusions, as we attempted to run the estimations also for the period 2011–2018, but the interpretation of the results remained the same.

[1] Private sector data exclude agriculture; forestry and mining (NACE A, B), water supply, sewerage, waste management and remediation activities (E), finance (K), construction (F), education (P), other services (S, T, U, X).

To prevent dilution of the entrepreneurial position and decision-making authority, the maximum number of entrepreneurs must not exceed five. Firms with at least one but not more than five entrepreneurs are called *entrepreneurial firms* in this paper. The number of entrepreneurs is controlled in the estimations.

Since education provides valuable human capital for entrepreneurs, we include eight variables of the field and level of their education in the estimations, covering higher tertiary, lower tertiary, and lower educations in business, technical, and other fields. Lower education in other fields serves as a reference in the estimations. Business education provides general business and financial knowledge, while higher technical education in particular can provide a skill set that could be exploited in innovation and product development. The ISCED codes of educations are presented in appendix in Table A3.

The measurement of intangibles[2] follows the method developed in the Globalinto project and is based on several steps that follow several statistically important principles to enable the analysis to fit with the wider context of established statistical classifications. The measurement of intangible investment is based on LEED where in particular, as explained below, the occupations serve as the main criteria for identifying IC work. It refers to the work time involved in generating intangible investments. ICs are aggregated annually on the level of core occupational groups (ICT, R&D, organizational work) in firms (see Appendix Table A2 for the occupations compiled). The shares of total working time that contribute to IC work are 90% for R&D occupations, 60% for ICT occupations, and 45% for organizational capital occupations. For each type of intangible capital (R&D, ICT, OC), we identify a group of occupations that are involved in creating intangible assets. Factor multipliers estimate the use of tangible capital and intermediate inputs in the generation of IC per unit of labor costs in the production of respective IC. Factor multipliers are based on the distribution of value added in labor costs, tangibles, and intermediate inputs in KIS industries that are major providers of external intangibles for other industries (the multiplier includes tangibles and intermediate inputs required for one unit of labor costs); for details, see Piekkola (2020) and Piekkola (2024). The depreciation rates of IC stocks are 33% for ICT, 20% for OC, and 15% for R&D. In this paper, ICT is considered together with OC, since labor-based ICT represents organizational knowledge more than ICT software and facilities per se. In the estimations, the IC variables refer to stock variables. We excluded low-skilled R&D employees who have below-average wages compared to the average level in the firm. This correction mainly

[2] In the Globalinto project, harmonized LEED were constructed for Finland, Denmark, Norway, and Slovenia (Piekkola et al., 2022). Harmonization of the ISCO occupational coding required the greatest effort to ensure comparable intangible occupations across time. As a limitation, the data cannot be disseminated since they are based on separate remote access in each country.

affects small firms with 5–10 employees, while microfirms with less than 5 employees are excluded from the analysis.

Given that HGFs in absolute terms are different firms than HGFs in relative terms (Daunfeldt et al., 2014), we would have to examine these two groups separately. Still, we can combine them by using the Birch Index, as used for example by Birch (1987), Schreyer (2000), and Eklund (2020). By using the Birch Index, we multiply the absolute change in employment (*L*) by the relative change, and can thereby examine both relative HGFs and absolute HGFs together.

(1) $$Birch\,Index_{i,(t,s)} = (L_{i,s} - L_{i,t}) \times \frac{L_{i,s}}{L_{i,t}}.$$

This can also correct some of the distortion of small firms that reduces the validity of Gibrat's Law (see Nassar et al., 2014). Therefore, we use the Birch Index to determine the HGFs when we can test both small and medium-sized firms in the same analysis. This paper examines a 3-year growth period. Hence, when using the Birch Index to measure the dependent variables, the growth is calculated from period *t* to *t+3* (*t, t+3*). When the Birch Index is used as a regressor, it is calculated from period *t-1* to *t* to control past growth. The estimations are run in period *t*. The Birch Index is used as a continuous variable when estimating general growth and as a binary variable for the top 10% of index values when estimating high growth.

The variable definitions are presented in the notes of Table 1 and in appendix in Table A1. A correlation table of all variables is shown in appendix in Table A4.

Descriptive statistics for all firms are presented in Table 1. The mean value of the Birch Index (*t, t+3*) is 4.89, with a right skewed distribution. 53% of the sample firms have no entrepreneur, while 28% have one, 18% have two or three, and 2% have four or five entrepreneurs. In entrepreneurial firms, 18% of firms have an entrepreneur with higher tertiary education and 44% have an entrepreneur with lower tertiary education. 4% of entrepreneurial firms have an entrepreneur with higher tertiary business education and 6% have an entrepreneur with higher tertiary technical education. For lower tertiary business and technical educations the shares are 16% and 18%, respectively. 23% of entrepreneurial firms have an entrepreneur with lower technical education, while only 8% have an entrepreneur with lower business education.

About one-third of all firms have at least some labor-based R&D. In these firms, the mean value per employee is 68,800€ and the median 38,300€. 40% of firms have at least some OC&ICT and in these firms the mean value per employee is 28,600€ and the median 13,000€. These values are measured in 2015 euros. The average firm age is 21 years and the average number of employees is 32. The mean value of tangible capital per employee is 198.000€. 17% of the firms are located in the county of Uusimaa.

Table 1. Descriptive statistics for all firms (N = 47,348)

	Mean	p25	p50	p75	p90	sd
$HGF_{i,(t, t+3)}$	0.100	0	0	0	1	0.30
$birch_{i,(t, t+3)}$	4.9	-2.2	0	5.3	17.0	21.1
$birch_{i,(t-1, t)}$	1.8	-1.6	0	3.2	8.3	7.9
$Entrepreneur^{1}_{i,t}$	0.276	0	0	1	1	0.447
$Entrepreneurs^{2-3}_{i,t}$	0.176	0	0	0	1	0.381
$Entrepreneurs^{4-5}_{i,t}$	0.017	0	0	0	0	0.130
$EntrepreneurEdu^{HT}_{i,t}$	0.084	0	0	0	0	0.277
$EntrepreneurEdu^{LT}_{i,t}$	0.204	0	0	0	1	0.403
$EntrepreneurEdu^{HTBus}_{i,t}$	0.019	0	0	0	0	0.136
$EntrepreneurEdu^{HTTech}_{i,t}$	0.029	0	0	0	0	0.168
$EntrepreneurEdu^{HTOth}_{i,t}$	0.039	0	0	0	0	0.193
$EntrepreneurEdu^{LTBus}_{i,t}$	0.075	0	0	0	0	0.263
$EntrepreneurEdu^{LTTech}_{i,t}$	0.086	0	0	0	0	0.280
$EntrepreneurEdu^{LTOth}_{i,t}$	0.057	0	0	0	0	0.232
$EntrepreneurEdu^{LowBus}_{i,t}$	0.038	0	0	0	0	0.191
$EntrepreneurEdu^{LowTech}_{i,t}$	0.109	0	0	0	1	0.311
$R\&D_{i,t}/L_{i,t}$	23.7	0	0	18.7	71.3	62.8
$R\&D_{i,t}/L_{i,t}$ when > 0 (N = 16,326)	68.8	16.7	38.3	84.3	175.9	91.2
$OC\&ICT_{i,t}/L_{i,t}$	11.4	0	0	8.6	31.1	30.2
$OC\&ICT_{i,t}/L_{i,t}$ when > 0 (N = 18,807)	28.6	5.5	13.0	31.4	75.3	42.5
$K_{i,t}/L_{i,t}$	198.0	30.4	136.0	282.0	447.0	329.0
$L_{i,t}$	31.7	10.0	17.0	36.0	74.0	38.1
Firm $age_{i,t}$	20.7	12.0	20.0	30.0	35.0	10.4
$HHI_{i,t}$	0.100	0.022	0.044	0.123	0.235	0.139
Uusimaa $dummy_{i,t}$	0.172	0	0	0	1	0.377
The descriptive statistics of education variables in entrepreneurial firms (N = 22,240).						
$EntrepreneurEdu^{HT}_{i,t}$	0.178					
$EntrepreneurEdu^{LT}_{i,t}$	0.435					
$EntrepreneurEdu^{HTBus}_{i,t}$	0.04					
$EntrepreneurEdu^{HTTech}_{i,t}$	0.062					
$EntrepreneurEdu^{HTOth}_{i,t}$	0.082					
$EntrepreneurEdu^{LTBus}_{i,t}$	0.159					
$EntrepreneurEdu^{LTTech}_{i,t}$	0.183					
$EntrepreneurEdu^{LTOth}_{i,t}$	0.121					
$EntrepreneurEdu^{LowBus}_{i,t}$	0.081					
$EntrepreneurEdu^{LowTech}_{i,t}$	0.232					

HGF is a dummy variable for the top 10% of firms in creating jobs in the 3-year period as evaluated using the Birch Index (*birch*) (see Equation 1). $Entrepreneur^{1}$ is a dummy variable for firms with one entrepreneur. $Entrepreneurs^{2\text{-}3}$ is a dummy variable for firms with two or three entrepreneurs, and $Entrepreneurs^{4\text{-}5}$ is a dummy variable for firms with four or five entrepreneurs. *EntrepreneurEdu* is a dummy variable for entrepreneurs' education. The superscripts *HT*, *LT*, *HTBus*, *HTTech*, and *HTOth* refer to higher tertiary, lower tertiary, higher tertiary business, higher tertiary technical, and higher tertiary other, respectively. The superscripts *LTBus*, *LTTech*, *LTOth*, *LowBus*, and *LowTech* refer to lower tertiary business, lower tertiary technical, lower tertiary other, low business, and low technical, respectively (see section 3 for details). *R&D* is labor-based research and development, *OC* is labor-based organizational capital, and *ICT* is labor-based information and communication technology. All IC variables are stock variables. *L* is the number of employees. *K* refers to tangible capital. *HHI* is the Herfindahl Index that measures the market concentration. *Uusimaa dummy* is a dummy variable for firms located in the county of Uusimaa. *Entrepreneurial firms* refer to firms with at least one but not more than five entrepreneurs (see section 3 for details).

Table 2 presents descriptive statistics only for HGFs. The distribution of the number of employees shows that they are clearly larger than other firms on average. The mean is 58 and the median is 37 for HGFs, while for all firms it is only 32 and 17, respectively. HGFs' past growth is clearly faster than other firms' as the mean value of $birch_{(t-1,\,t)}$ is 4.76, while it is only 1.75 in Table 1. HGFs are also less likely to have one entrepreneur but more likely to have at least two entrepreneurs than other firms. The share of firms with IC is also higher in HGFs. They are also three years younger on average. Also, HGFs are more likely to have an entrepreneur with higher tertiary education.

Table 2. Descriptive statistics for HGFs (N = 4,746)

	Mean	p25	p50	p75	p90	sd
$HGF_{i,(t, t+3)}$	1	1	1	1	1	0
$birch_{i,(t, t+3)}$	49.1	22.3	33.1	56.4	105.0	42.8
$birch_{i,(t-1, t)}$	4.8	-1.7	2.1	8.1	18.6	12.6
$Entrepreneur^{1}_{i,t}$	0.226	0	0	0	1	0.418
$Entrepreneurs^{2-3}_{i,t}$	0.186	0	0	0	1	0.390
$Entrepreneurs^{4-5}_{i,t}$	0.038	0	0	0	0	0.192
$EntrepreneurEdu^{HT}_{i,t}$	0.099	0	0	0	0	0.298
$EntrepreneurEdu^{LT}_{i,t}$	0.191	0	0	0	1	0.393
$EntrepreneurEdu^{HTBus}_{i,t}$	0.019	0	0	0	0	0.135
$EntrepreneurEdu^{HTTech}_{i,t}$	0.033	0	0	0	0	0.178
$EntrepreneurEdu^{HTOth}_{i,t}$	0.052	0	0	0	0	0.222
$EntrepreneurEdu^{LTBus}_{i,t}$	0.073	0	0	0	0	0.260
$EntrepreneurEdu^{LTTech}_{i,t}$	0.065	0	0	0	0	0.246
$EntrepreneurEdu^{LTOth}_{i,t}$	0.067	0	0	0	0	0.249
$EntrepreneurEdu^{LowBus}_{i,t}$	0.043	0	0	0	0	0.203
$EntrepreneurEdu^{LowTech}_{i,t}$	0.095	0	0	0	0	0.294
$R\&D_{i,t}/L_{i,t}$	30.1	0	0	30.5	88.9	76.9
$R\&D_{i,t}/L_{i,t}$ when > 0 (N = 2,251)	63.5	10.7	32.6	72.8	165.4	101.8
$OC\&ICT_{i,t}/L_{i,t}$	18.1	0	3.1	17.4	55.2	36.7
$OC\&ICT_{i,t}/L_{i,t}$ when > 0 (N = 2,962)	28.9	4.1	12.2	32.3	83.6	42.9
$K_{i,t}/L_{i,t}$	213.0	28.8	165.0	285.0	453.0	277.0
$L_{i,t}$	58.0	18.0	37.0	78.0	141.0	54.8
Firm $age_{i,t}$	18.1	8.0	17.0	27.0	34.0	11.0
$HHI_{i,t}$	0.099	0.024	0.043	0.126	0.231	0.132
Uusimaa $dummy_{i,t}$	0.173	0	0	0	1	0.378
The descriptive statistics of education variables in entrepreneurial firms (N = 1,476).						
$EntrepreneurEdu^{HT}_{i,t}$	0.219					
$EntrepreneurEdu^{LT}_{i,t}$	0.425					
$EntrepreneurEdu^{HTBus}_{i,t}$	0.041					
$EntrepreneurEdu^{HTTech}_{i,t}$	0.073					
$EntrepreneurEdu^{HTOth}_{i,t}$	0.116					
$EntrepreneurEdu^{LTBus}_{i,t}$	0.162					
$EntrepreneurEdu^{LTTech}_{i,t}$	0.144					
$EntrepreneurEdu^{LTOth}_{i,t}$	0.148					
$EntrepreneurEdu^{LowBus}_{i,t}$	0.096					
$EntrepreneurEdu^{LowTech}_{i,t}$	0.211					

HGF is a dummy variable for the top 10% of firms in creating jobs in the 3-year period as evaluated using the Birch Index (*birch*) (see Equation 1). $Entrepreneur^{1}$ is a dummy variable for firms with one entrepreneur. $Entrepreneurs^{2\text{-}3}$ is a dummy variable for firms with two or three entrepreneurs, and $Entrepreneurs^{4\text{-}5}$ is a dummy variable for firms with four or five entrepreneurs. *EntrepreneurEdu* is a dummy variable for entrepreneurs' education. The superscripts *HT*, *LT*, *HTBus*, *HTTech*, and *HTOth* refer to higher tertiary, lower tertiary, higher tertiary business, higher tertiary technical, and higher tertiary other, respectively. The superscripts *LTBus*, *LTTech*, *LTOth*, *LowBus*, and *LowTech* refer to lower tertiary business, lower tertiary technical, lower tertiary other, low business, and low technical, respectively (see section 3 for details). *R&D* is labor-based research and development, *OC* is labor-based organizational capital, and *ICT* is labor-based information and communication technology. All IC variables are stock variables. *L* is the number of employees. *K* refers to tangible capital. *HHI* is the Herfindahl Index that measures the market concentration. *Uusimaa dummy* is a dummy variable for firms located in the county of Uusimaa. Entrepreneurial firms refer to firms with at least one but not more than five entrepreneurs (see section 3 for details).

Table 3 shows the distribution of growth and size of HGFs. The size is measured after the high growth period. The number of employees in HGFs in period *t+3* seems to be quite well distributed and there is no clear size distortion. Thus, the Birch Index appears to be sufficiently size neutral and allows us to analyze both small and medium-sized firms in the same analysis. Employment growth over the three-year growth period is 15% at the 5th percentile and 108% at the 95th percentile, while the median is 48%. Since the Birch Index is measured by multiplying the absolute change by the relative change in employment, small firms need higher relative growth than larger firms to be determined as HGFs.

Table 3. The distribution of growth and size of HGFs

	p5	p25	p50	p75	p95
$\ln(L_{i,t+3})-\ln(L_{i,t})$	0.146	0.301	0.479	0.693	1.082
$L_{i,t+3}$	19	36	62	114	233

3.2 Estimated equations

We estimate both general firm growth and the occurrence of being an HGF. The dependent variable for the general growth is simply the continuous value of the Birch Index. High growth is considered as the top 10% of firms (HGFs) in creating jobs in the 3-year period as evaluated using the Birch Index. There are also firm growth indicators other than job creation, such as sales or profit (see Daunfeldt et al., 2014), yet job creation can be seen as more future-oriented because a new employee is an investment for the future. The regression models do not control for firm-fixed effects, because the variables for entrepreneurs' education have very little variation over time. We are interested in the role of entrepreneurs' education, and thus we would not be able to study our research questions using firm-fixed effect regression. The linear regression for general growth (Equations 2 and 3) and the probit model for high growth (Equations 4 and 5) are estimated as follows:

(2)
$$Birch_{i,(t,t+3)} = \beta_0 + \beta_b Birch_{i,(t-1,t)} + \beta_{E1} Entrepreneur^{1}{}_{i,t} + \beta_{E2} Entrepreneurs^{2-3}{}_{i,t} + \beta_{E3} Entrepreneurs^{4-5}{}_{i,t} + \beta_{HT} EntrepreneurEdu^{HT}_{i,t} + \beta_{LT} EntrepreneurEdu^{LT}_{i,t} + \beta_{rd} \ln\left(\frac{R\&D_{i,t}}{L_{i,t}}\right) + \beta_{oc} \ln\left(\frac{OC\&ICT_{i,t}}{L_{i,t}}\right) + \beta C'_{i,t} + v_{i,t}.$$

(3)
$$Birch_{i,(t,t+3)} = \beta_0 + \beta_b Birch_{i,(t-1,t)} + \beta_{E1} Entrepreneur^{1}{}_{i,t} + \beta_{E2} Entrepreneurs^{2-3}{}_{i,t} + \beta_{E3} Entrepreneurs^{4-5}{}_{i,t} + \beta EntrepreneurEdu'_{i,t} + \beta_{rd} \ln\left(\frac{R\&D_{i,t}}{L_{i,t}}\right) + \beta_{oc} \ln\left(\frac{OC\&ICT_{i,t}}{L_{i,t}}\right) + \beta C'_{i,t} + v_{i,t}.$$

(4)
$$HGF_{i,(t,t+3)} = 1 \; if \; \beta_0 + \beta_b Birch_{i,(t-1,t)} + \beta_{E1} Entrepreneur^{1}_{i,t} + \beta_{E2} Entrepreneurs^{2-3}_{i,t} + \beta_{E3} Entrepreneurs^{4-5}_{i,t} + \beta_{HT} EntrepreneurEdu^{HT}_{i,t} + \beta_{LT} EntrepreneurEdu^{LT}_{i,t} + \beta_{rd} \ln\left(\frac{R\&D_{i,t}}{L_{i,t}}\right) + \beta_{oc} \ln\left(\frac{OC\&ICT_{i,t}}{L_{i,t}}\right) + \beta C'_{i,t} + v_{i,t} > 0 \; and \; zero \; otherwise.$$

(5)
$$HGF_{i,(t,t+3)} = 1 \; if \; \beta_0 + \beta_b Birch_{i,(t-1,t)} + \beta_{E1} Entrepreneur^{1}_{i,t} + \beta_{E2} Entrepreneurs^{2-3}_{i,t} + \beta_{E3} Entrepreneurs^{4-5}_{i,t} + \beta EntrepreneurEdu'_{i,t} + \beta_{rd} \ln\left(\frac{R\&D_{i,t}}{L_{i,t}}\right) + \beta_{oc} \ln\left(\frac{OC\&ICT_{i,t}}{L_{i,t}}\right) + \beta C'_{i,t} + v_{i,t} > 0 \; and \; zero \; otherwise.$$

The dependent variables and regressors are discussed earlier in section 3 and in Table A1 in appendix. Equations 2 and 3 are estimated in Table 4 and Equations 4 and 5 in Table 5. *Entrepreneur*^{1}, *Entrepreneurs*$^{2-3}$, and *Entrepreneurs*$^{4-5}$ refers to the number of entrepreneurs. *EntrepreneurEdu* refers to the entrepreneurs' education. The superscripts *HT* and *LT* refer to higher tertiary education and lower tertiary education, respectively. In Equations 3 and 5, *EntrepreneurEdu'* represents a vector for dummy variables of fields of education: higher tertiary business education, higher tertiary technical education, higher tertiary other education, lower tertiary business education, lower tertiary technical education, lower tertiary other education, lower business education, and lower technical education. All the entrepreneur-related variables are dummy variables. The ISCED codes of educations are shown in appendix in Table A3. *C'* represents controls for the logarithm of tangible capital per employee, the logarithm of the number of employees, firm age, the Herfindahl Index, the county of Uusimaa dummy, year dummies, and 22 NACE industry (2-digit) dummies. v is the error term. The Herfindahl Index measures the market concentration (Herfindahl, 1950).

3.3 Endogeneity

The estimations are unable to unveil any causal effects due to potential endogeneity issues arising from measurement errors, omitted variables, and simultaneity. Therefore, the results should only be interpreted as simple relationships.

Firm growth may be affected by some unobservable factors, such as the willingness to grow, which we cannot observe. Also, selection into higher education may be partly explained by some unobservable factors such as social network or perseverance, which may also affect growth. In addition, there is potential simultaneity bias, as the entrepreneur is likely to face more challenging tasks as the firm grows, thus supporting the entrepreneurs' ability to pursue more growth. High growth can also induce more owners to join the firm, reducing the ownership share of the original entrepreneur and leading to a non-entrepreneurial firm. Also, after generating high growth, the firm may be seen as a more attractive employer by highly talented employees. Moreover, there is a potential measurement error as we measure IC from the related labor costs and multiply them by an approximate factor multiplier of capital and intermediate inputs.

4 RESULTS AND DISCUSSION

This section considers and discusses the estimations of general growth regression model (Table 4) and binary high growth regression model (Table 5). Both are measured by the Birch Index (see Equation 1) which is size neutral, and thus it enables us to consider both small and medium-sized firms in the same analysis. The growth is determined in terms of employment and measured over a 3-year period. Table 4 considers the continuous Birch Index while Table 5 considers a binary variable for the top 10% of firms in creating jobs. Time and industry fixed effects are controlled in the estimations.

4.1 General growth

Table 4 shows the results for firm growth as measured by the Birch Index. The estimations are run by ordinary least squares (OLS) regression with clustered standard errors. Columns (1) and (2) include all firms, while columns (3) and (4) include only entrepreneurial firms (see section 3 for details).

The results show that having one entrepreneur is negatively related to employment growth that is in line with the literature (e.g. Jin et al. 2017; Agarwal et al., 2015; Chandler et al., 2005). Having more than one entrepreneur is statistically unrelated to growth. The results suggest that firms benefit from distributed ownership (non-entrepreneurial firms), which potentially provides a variety of skills for the decision making.

Even though some studies find that entrepreneur's human capital has a positive relationship with firm growth (Almus, 2002; Brüderl & Preisendörfer, 2000), our results in columns (1) and (3) do not support this for Finnish SMEs. Even though the coefficients of the entrepreneurs' higher and lower tertiary educations are positive, they all are non-significant. Hypothesis 1 is therefore not supported by the results.

Although business skills are certainly important in running a business, the results in columns (2) and (4) show that an entrepreneur's higher tertiary business education has a negative relationship with employment growth, while the results for lower tertiary business education are non-significant. However, higher tertiary technical education has positive and significant coefficients. Thus, the results indicate that higher tertiary technical education may provide skills that the entrepreneurs can use to grow their businesses. Thus, the results partially support hypothesis 2. Moreover, the diverged results for business and technical educations partly explain the non-significant results of higher tertiary education in general. However, it is important to note here that we cannot control potential selection bias, if certain personal characteristics are correlated with both applying for higher technical education and general entrepreneurial skills.

Unlike higher tertiary technical education, lower tertiary and lower technical educations are unrelated to firm growth. Also, lower tertiary and lower business educations have non-significant coefficients. It is possible that lower levels of education do not provide the necessary skills for business development, or it may also be partly related to personal characteristics behind the selection into lower tertiary and lower education. While previous literature shows that entrepreneurial factors contribute to firm growth, the results here suggest that these entrepreneurial factors or skills may mainly be created through channels other than formal education.

In addition to having the right owners, a growth-oriented firm also needs skilled employees. The results of labor-based IC show that labor-based R&D and OC&ICT are positively related to firm growth. Both variables have positive and statistically highly significant coefficients in all columns, which supports hypothesis 3. The results indicate that employees with organizational and technical knowledge are important for growth-oriented firms. Therefore, labor-based IC has a positive relationship with employment growth despite the high fixed costs that intangibles entail.

The coefficients of the Herfindahl Index are negative and statistically significant. This indicates that competition is positively related to firm growth. We find support for the claim that young firms are more likely to grow than older firms (see Daunfeldt et al., 2014; Lawless, 2014). This highlights the importance of ensuring a dynamic economy in which new innovative entrants enter the market. The positive coefficient of the number of employees may be influenced by the characteristics of the Birch Index, which attempts to fit both small and medium-sized firms into the same index.

Growth tends to be persistent, as growth over the past year is positively related to growth over the next three years.

Table 4. Estimating the Birch Index with OLS

$birch_{i,(t, t+3)}$	All firms (1)	All firms (2)	Entrepreneurial firms (3)	Entrepreneurial firms (4)
$birch_{i,(t-1, t)}$	0.229***	0.228***	0.237***	0.237***
	(0.030)	(0.030)	(0.041)	(0.041)
$Entrepreneur^{1}_{i,t}$	-0.782**	-0.877**		
	(0.307)	(0.373)		
$Entrepreneurs^{2-3}_{i,t}$	-0.564	-0.707	0.066	0.032
	(0.378)	(0.490)	(0.329)	(0.343)
$Entrepreneurs^{4-5}_{i,t}$	1.488	1.245	1.653	1.526
	(1.506)	(1.563)	(1.487)	(1.502)
$EntrepreneurEdu^{HT}_{i,t}$	0.482		0.691	
	(0.538)		(0.556)	
$EntrepreneurEdu^{LT}_{i,t}$	0.281		0.331	
	(0.355)		(0.366)	
$EntrepreneurEdu^{HTBus}_{i,t}$		-2.017***		-1.899***
		(0.706)		(0.708)
$EntrepreneurEdu^{HTTech}_{i,t}$		1.871*		2.084**
		(1.017)		(1.047)
$EntrepreneurEdu^{HTOth}_{i,t}$		1.092		1.287
		(0.781)		(0.789)
$EntrepreneurEdu^{LTBus}_{i,t}$		0.23		0.283
		(0.535)		(0.547)
$EntrepreneurEdu^{LTTech}_{i,t}$		0.512		0.504
		(0.494)		(0.518)
$EntrepreneurEdu^{LTOth}_{i,t}$		-0.068		-0.104
		(0.641)		(0.643)
$EntrepreneurEdu^{LowBus}_{i,t}$		0.729		0.695
		(0.727)		(0.720)
$EntrepreneurEdu^{LowTech}_{i,t}$		0.066		-0.106
		(0.451)		(0.459)
$\ln(R\&D_{i,t}/L_{i,t})$	0.285***	0.265***	0.323***	0.273**
	(0.079)	(0.080)	(0.111)	(0.117)
$\ln(OC\&ICT_{i,t}/L_{i,t})$	0.676***	0.688***	0.539***	0.569***
	(0.107)	(0.107)	(0.154)	(0.154)
$\ln(K_{i,t}/L_{i,t})$	0.031	0.03	-0.128	-0.128
	(0.122)	(0.122)	(0.177)	(0.176)
$\ln(L_{i,t})$	1.716***	1.730***	2.363***	2.387***
	(0.255)	(0.255)	(0.341)	(0.341)

(Table 4 continued)

Firm age$_{i,t}$	-0.168***	-0.168***	-0.183***	-0.183***
	(0.016)	(0.016)	(0.020)	(0.020)
HHI$_{i,t}$	-4.978***	-4.924***	-7.620***	-7.495***
	(1.119)	(1.122)	(1.637)	(1.660)
Uusimaa dummy$_{i,t}$	-1.222***	-1.242***	-1.658***	-1.709***
	(0.389)	(0.390)	(0.498)	(0.500)
constant	2.006	1.955	3.158	3.041
	(2.175)	(2.171)	(3.164)	(3.174)
N	47,348	47,348	22,240	22,240
R^2	0.043	0.044	0.056	0.057

Asterisks indicate the significance level, * <0.1, ** <0.05, *** <0.01. Clustered standard errors in parentheses. The results for year and industry dummy variables are not reported. The dependent variable is the Birch Index (see Equation 1). *ln()* refers to a natural log transformation. *Entrepreneurial firms* refer to firms with at least one but not more than five entrepreneurs (see section 3 for details). *Entrepreneur*^{1} is a dummy variable for firms with one entrepreneur. *Entrepreneurs*$^{2\text{-}3}$ is a dummy variable for firms with two or three entrepreneurs, and *Entrepreneurs*$^{4\text{-}5}$ is a dummy variable for firms with four or five entrepreneurs. *EntrepreneurEdu* is a dummy variable for entrepreneurs' education. The superscripts *HT, LT, HTBus, HTTech,* and *HTOth* refer to higher tertiary, lower tertiary, higher tertiary business, higher tertiary technical, and higher tertiary other, respectively. The superscripts *LTBus, LTTech, LTOth, LowBus,* and *LowTech* refer to lower tertiary business, lower tertiary technical, lower tertiary other, low business, and low technical, respectively (see section 3 for details). Low education in other fields than business or technical is the reference education. *R&D* is labor-based research and development, *OC* is labor-based organizational capital, and *ICT* is labor-based information and communication technology. All IC variables are stock variables. *L* is the number of employees. *K* refers to tangible capital. *HHI* is the Herfindahl Index that measures the market concentration. *Uusimaa dummy* is a dummy variable for firms located in the county of Uusimaa.

In Table 5, the dependent variable is a dummy for the top 10% of firms in creating jobs in the 3-year period as evaluated using the Birch Index. As in Table 4, the first three columns consider all firms and the last two columns include only entrepreneurial firms (see section 3 for details). In Table 5, the estimations are run by a probit estimator with clustered standard errors.

When estimating HGFs, the coefficients of having one entrepreneur in the firm are still negative and statistically significant in columns (5) and (6). In line with Table 4, having more than one entrepreneur is statistically unrelated to high growth. However, in entrepreneurial firms in columns (7) and (8), the coefficients of having two or three entrepreneurs are positive with p-values of 0.12 and 0.13, respectively. Thus, HGFs may benefit from having at least two entrepreneurs, although the results are statistically uncertain. However, when all firms are included in columns (5) and (6), the coefficients are clearly non-significant.

In columns (5) and (7), the results of higher and lower tertiary educations are still non-significant, which is in line with Table 4. Also, the results for different fields of education are non-significant. Although higher tertiary technical education is positively related to general firm growth, the relationship is non-significant when focusing on HGFs. Also, the coefficients of higher tertiary business education are non-significant. Thus, the entrepreneurs' education is unrelated to high growth.

Consistent with Table 4, labor-based ICs remain positively and significantly related to firm growth in Table 5. The coefficients of both R&D and OC&ICT are positive and statistically highly significant in all columns. Thus, skilled employees are crucial for growth even when focusing only on high growth. Skilled employees are potentially able to innovate and create new business opportunities that enable the firm to develop its business and exploit growth opportunities. Hence, hypothesis 3 is supported also with respect to high growth.

As in Table 4, growth is persistent in Table 5. Growth from period *t-1* to *t* is positively related to high growth over the next 3-year period. The coefficients of the Herfindahl Index remain negative and statistically significant.

Overall, we can conclude that labor-based knowledge is important for firm growth. Higher tertiary technical education of an entrepreneur has a positive relationship with general firm growth, but it is unrelated to high growth. Therefore it may provide skills, e.g. innovation capacities, which the entrepreneurs can use to grow their businesses. Higher tertiary business education of an entrepreneur is negatively related to general firm growth, but it is unrelated to high growth. Otherwise, lower tertiary and lower business and technical educations of entrepreneurs are non-significant factors in firm growth. Also, having one entrepreneur is negatively related to growth that supports dispersed ownership in growth-oriented firms.

Table 5. Estimating the occurrence of being an HGF with a probit estimator

$HGF_{i,(t, t+3)}$	All firms (5)	All firms (6)	Entrepreneurial firms (7)	Entrepreneurial firms (8)
$birch_{i,(t-1, t)}$	0.007***	0.007***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
$Entrepreneur^{1}_{i,t}$	-0.058**	-0.057*		
	(0.028)	(0.031)		
$Entrepreneurs^{2-3}_{i,t}$	0.001	0.002	0.048	0.048
	(0.033)	(0.039)	(0.031)	(0.031)
$Entrepreneurs^{4-5}_{i,t}$	0.066	0.064	0.091	0.087
	(0.066)	(0.072)	(0.063)	(0.066)
$EntrepreneurEdu^{HT}_{i,t}$	0.014		0.032	
	(0.041)		(0.043)	
$EntrepreneurEdu^{LT}_{i,t}$	-0.028		-0.021	
	(0.032)		(0.033)	
$EntrepreneurEdu^{HTBus}_{i,t}$		-0.091		-0.076
		(0.075)		(0.076)
$EntrepreneurEdu^{HTTech}_{i,t}$		0.038		0.057
		(0.065)		(0.067)
$EntrepreneurEdu^{HTOth}_{i,t}$		0.055		0.077
		(0.055)		(0.056)
$EntrepreneurEdu^{LTBus}_{i,t}$		-0.021		-0.012
		(0.045)		(0.045)
$EntrepreneurEdu^{LTTech}_{i,t}$		-0.034		-0.022
		(0.047)		(0.049)
$EntrepreneurEdu^{LTOth}_{i,t}$		-0.037		-0.037
		(0.046)		(0.047)
$EntrepreneurEdu^{LowBus}_{i,t}$		0.052		0.053
		(0.055)		(0.056)
$EntrepreneurEdu^{LowTech}_{i,t}$		-0.022		-0.024
		(0.038)		(0.039)
$\ln(R\&D_{i,t}/L_{i,t})$	0.035***	0.035***	0.041***	0.040***
	(0.006)	(0.007)	(0.009)	(0.009)
$\ln(OC\&ICT_{i,t}/L_{i,t})$	0.057***	0.057***	0.053***	0.054***
	(0.008)	(0.008)	(0.012)	(0.012)
$\ln(K_{i,t}/L_{i,t})$	-0.009	-0.009	-0.01	-0.009
	(0.008)	(0.008)	(0.011)	(0.011)
$\ln(L_{i,t})$	0.431***	0.431***	0.476***	0.477***
	(0.015)	(0.015)	(0.019)	(0.019)

(Table 5 continued)

Firm age$_{i,t}$	-0.017***	-0.017***	-0.019***	-0.019***
	(0.001)	(0.001)	(0.002)	(0.002)
HHI$_{i,t}$	-0.356***	-0.360***	-0.365**	-0.374**
	(0.104)	(0.104)	(0.149)	(0.150)
Uusimaa dummy$_{i,t}$	-0.072**	-0.073**	-0.128***	-0.131***
	(0.035)	(0.035)	(0.049)	(0.049)
constant	-2.161***	-2.163***	-2.344***	-2.347***
	(0.068)	(0.068)	(0.087)	(0.089)
N	47348	47348	22240	22240
R^2 pseudo	0.124	0.125	0.152	0.152

Asterisks indicate the significance level, * <0.1, ** <0.05, *** <0.01. Clustered standard errors in parentheses. The results for year and industry dummy variables are not reported. The dependent variable is a dummy variable for the top 10% of firms in creating jobs in the 3-year period as evaluated using the Birch Index (see Equation 1). *ln()* refers to a natural log transformation. *Entrepreneurial firms refer to firms with at least one but not more than five entrepreneurs (see section 3 for details). Entrepreneur1 is a dummy variable for firms with one entrepreneur. Entrepreneurs2-3 is a dummy variable for firms with two or three entrepreneurs, and Entrepreneurs4-5 is a dummy variable for firms with four or five entrepreneurs. EntrepreneurEdu is a dummy variable for entrepreneurs' education. The superscripts HT, LT, HTBus, HTTech, and HTOth refer to higher tertiary, lower tertiary, higher tertiary business, higher tertiary technical, and higher tertiary other, respectively. The superscripts LTBus, LTTech, LTOth, LowBus, and LowTech refer to lower tertiary business, lower tertiary technical, lower tertiary other, low business, and low technical, respectively (see section 3 for details). Low education in other fields than business or technical is the reference education. R&D is labor-based research and development, OC is labor-based organizational capital, and ICT is labor-based information and communication technology. All IC variables are stock variables. L is the number of employees. K refers to tangible capital. HHI is the Herfindahl Index that measures the market concentration. Uusimaa dummy is a dummy variable for firms located in the county of Uusimaa.*

5 CONCLUSIONS

This paper analyzes how entrepreneurs and their education along with labor-based IC are related to firm growth. Despite the ample literature considering entrepreneurs' education and firm performance (e.g., Almus, 2002; Barringer et al. 2005; Watson et al., 2003), understanding remains limited about the relationship between firm growth and the fields of entrepreneurs' education. The educations of entrepreneurs are measured separately for different levels of business and technical educations. The labor-based IC is derived from the related labor costs using a full, register-based unbalanced panel dataset of Finnish SMEs for the period 2006–2018 from Statistics Finland. Our approach measures broad intangibles by using the measurement methods developed in the EU Horizon 2020 Globalinto project (for details, see Piekkola, 2020). Although some studies analyze annual growth (e.g., Rahaman, 2011; Lopez-Garcia & Puente, 2012), we focus on long-term growth over a 3-year period. We measure growth by employment change, which is also a good indicator of willingness to invest in the future, whereas sales growth is more volatile and sensitive to production shocks.

This paper shows that organizational and technical knowledge of employees is an essential factor for firm growth. Persistent growth requires strong restructuring capabilities and flexibility provided by organizational capital, while R&D potentially provides new innovations that enable the firm, for instance, to create new markets. In addition, an entrepreneur's higher tertiary technical education is positively related to employment growth, although the results are statistically non-significant when focusing on HGFs. Higher technical education may provide skills that the entrepreneurs can use to grow their business. However, a potential selection bias towards higher technical education was not controlled for. Somewhat surprisingly, an entrepreneur's higher tertiary business education has a negative relationship with firm growth. Having just one entrepreneur in the firm is negatively related to employment growth.

Piekkola et al. (2022) find that Finnish firms are among the intangible-intensive Nordic countries that use intangibles efficiently to improve marginal factor productivity (MFP), but this also leads to higher MFP dispersion. This paper supports the findings that labor-based IC not only improves productivity but also drives growth. As a practical implication, in the future, emphasis should be placed on having talented employees with organizational knowledge to foster higher growth at the economy-wide level. As a limitation, only Finnish firms were considered in this paper. To gain a deeper understanding of the role of intangibles and entrepreneurial factors in SMEs, it would be necessary to study them in other countries as well.

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Appendices

Appendix A. Definitions of the variables, occupations, and educations.

Table A1. Definitions of the variables

Variable	Explanation
$HGF_{(t, t+3)}$	A dummy variable takes a value of 1 if a firm belongs to the top 10% of job creators in a 3-year period. The ranking is based on the Birch Index.
$birch_{(t, s)}$	$=L_{t+3}/L_t \times (L_{t+3}-L_t)$ when determining HGFs $=L_t/L_{t-1} \times (L_t-L_{t-1})$ when using it as a control variable for past growth
$Entrepreneur^{1}$, $^{2\text{-}3}$, and $^{4\text{-}5}$	1: A dummy variable takes a value of 1 if a firm has one entrepreneur. 2-3: A dummy variable takes a value of 1 if a firm has two or three entrepreneurs. 4-5: A dummy variable takes a value of 1 if a firm has four or five entrepreneurs.
$EntrepreneurEdu^{HT}$ and ^{LT}	HT: A dummy variable takes a value of 1 if a firm has at least one entrepreneur with higher tertiary education. LT: A dummy variable takes a value of 1 if a firm has at least one entrepreneur with lower tertiary education.
$EntrepreneurEdu^{HTBus}$	A dummy variable takes a value of 1 if a firm has at least one entrepreneur with higher tertiary business education.
$EntpreneurEdu^{HTTech}$	A dummy variable takes a value of 1 if a firm has at least one entrepreneur with higher tertiary technical education.
$EntrepreneurEdu^{HTOth}$	A dummy variable takes a value of 1 if a firm has at least one entrepreneur with higher tertiary education in other fields than business or technical.
$EntrepreneurEdu^{LTBus}$	A dummy variable takes a value of 1 if a firm has at least one entrepreneur with lower tertiary business education.
$EntrepreneurEdu^{LTTech}$	A dummy variable takes a value of 1 if a firm has at least one entrepreneur with lower tertiary technical education.
$EntrepreneurEdu^{LTOth}$	A dummy variable takes a value of 1 if a firm has at least one entrepreneur with lower tertiary education in other fields than business or technical.
$EntrepreneurEdu^{LowBus}$ and ^{LowTech}	Low bus: A dummy variable takes a value of 1 if a firm has at least one entrepreneur with lower business education. Low tech: A dummy variable takes a value of 1 if a firm has at least one entrepreneur with lower technical education.
R&D	Labor-based R&D. The measurement method is described in more depth in section 3.
OC&ICT	Labor-based organizational capital and ICT. The measurement method is described in more depth in section 3.
K	Tangible capital, i.e., buildings and machinery
L	Number of employees
Firm age	Calculated from the year the firm appeared on the VAT register or the year the establishment was founded, where the one that is earlier was used.
HHI	The Herfindahl Index, which measures market concentration as a proxy for the level of competition.
Uusimaa dummy	A dummy variable takes a value of 1 if a firm is located in the county of Uusimaa.

Table A2. ISCO-08 occupations for OC, R&D, and ICT

Organizational work	• Business services and Administration managers 121 • Sales and marketing managers 1221, Advertising and public relations managers 1222 • Production managers in agriculture, forestry, and fisheries 131 • Manufacturing, mining, construction and distribution managers 132 • Professional services managers 134 • Finance professionals 241, Administration professionals 242
R&D work	• Research and development managers 1223 • Physical and earth science professionals 211, Engineering professionals 212, Life science professionals 213, Engineering professional (excluding electrotechnology) 214, Electrical engineering 215 • Architects, planners, surveyors, and designers 216 • Health professionals: Medical doctors 221, Nursing and midwifery professionals 222, Other health professionals 226 • Physical and engineering science technicians 311, Life science technicians and related associate professionals 314, Medical and pharmaceutical technicians 321
ICT work	• Information and communications technology services managers 133 • Information and communications technology professionals 25 (software and applications developers and analysts 251 and database and network professionals 252) • Information and communications technology professionals 35 (Information and communications technology operations and user support 351, telecommunications and broadcasting technicians 352)

Table A3. Levels and fields of education used in the education variables, based on ISCED 2011

Higher tertiary education	Level of education: 7 Master's or equivalent level or 8 doctoral or equivalent level
Lower tertiary education	Level of education: 5 Short-cycle tertiary education or 6 bachelor's or equivalent level
Higher tertiary business education	Field of education: 041 Business and administration Level of education: 7 Master's or equivalent level or 8 doctoral or equivalent level
Higher tertiary technical education	Field of education: 07 Engineering, manufacturing or construction Level of education: 7 Master's or equivalent level or 8 doctoral or equivalent level
Higher tertiary other education	Field of education: Other than 041 or 07. Level of education: 7 Master's or equivalent level or 8 doctoral or equivalent level
Lower tertiary business education	Field of education: 041 Business and administration Level of education: 5 Short-cycle tertiary education or 6 bachelor's or equivalent level
Lower tertiary technical education	Field of education: 07 Engineering, manufacturing or construction Level of education: 5 Short-cycle tertiary education or 6 bachelor's or equivalent level
Lower tertiary other education	Field of education: Other than 041 or 07. Level of education: 5 Short-cycle tertiary education or 6 bachelor's or equivalent level
Lower business education	Field of education: 041 Business and administration Level of education: 4 Post-secondary non-tertiary education, or lower
Lower technical education	Field of education: 07 Engineering, manufacturing or construction Level of education: 4 Post-secondary non-tertiary education, or lower

Table A4. Correlation table of variables

	$HGF_{i,(t, t+3)}$	$birch_{i,(t, t+3)}$	$birch_{i,(t-1, t)}$	$Entrepreneur^{1}_{i,t}$	$Entrepreneurs^{2-3}_{i,t}$	$Entrepreneurs^{4-5}_{i,t}$	Entrepreneur $Edu^{HT}_{i,t}$	Entrepreneur $Edu^{LT}_{i,t}$	Entrepreneur $Edu^{HTBus}_{i,t}$	Entrepreneur $Edu^{HTTech}_{i,t}$
$birch_{i,(t, t+3)}$	0.699*									
$birch_{i,(t-1, t)}$	0.127*	0.117*								
$Entrepreneur^{1}_{i,t}$	-0.038*	-0.022*	-0.011*							
$Entrepreneurs^{2-3}_{i,t}$	0.009	0.008	0.040*	-0.286*						
$Entrepreneurs^{4-5}_{i,t}$	0.054*	0.036*	0.057*	-0.082*	-0.061*					
$EntrepreneurEdu^{HT}_{i,t}$	0.018*	0.017*	0.028*	0.159*	0.208*	0.078*				
$EntrepreneurEdu^{LT}_{i,t}$	-0.011*	-0.003	0.014*	0.276*	0.338*	0.129*	-0.016*			
$EntrepreneurEdu^{HTBus}_{i,t}$	-0.001	-0.009*	0.012*	0.066*	0.102*	0.027*	0.458*	0.005		
$EntrepreneurEdu^{HTTech}_{i,t}$	0.007	0.015*	0.012*	0.114*	0.098*	0.026*	0.573*	-0.021*	-0.007	
$EntrepreneurEdu^{HTOth}_{i,t}$	0.023*	0.022*	0.023*	0.071*	0.166*	0.088*	0.663*	-0.009*	0.015*	0.008
$EntrepreneurEdu^{LTBus}_{i,t}$	-0.002	-0.001	0.013*	0.117*	0.222*	0.104*	-0.007	0.561*	0.018*	-0.026*
$EntrepreneurEdu^{LTTech}_{i,t}$	-0.025*	-0.012*	-0.010*	0.201*	0.178*	0.037*	-0.035*	0.604*	-0.026*	0.000
$EntrepreneurEdu^{LTOth}_{i,t}$	0.014*	0.009*	0.026*	0.069*	0.215*	0.135*	0.017*	0.485*	0.018*	-0.008
$EntrepreneurEdu^{LowBus}_{i,t}$	0.009*	0.010*	0.023*	0.053*	0.176*	0.110*	-0.028*	0.019*	-0.016*	-0.025*
$EntrepreneurEdu^{LowTech}_{i,t}$	-0.015*	-0.011*	0.010*	0.164*	0.258*	0.104*	-0.069*	-0.033*	-0.032*	-0.040*
$R\&D_{i,t}/L_{i,t}$	0.034*	0.028*	-0.032*	-0.045*	-0.072*	-0.027*	0.045*	-0.045*	-0.031*	0.117*
$OC\&ICT_{i,t}/L_{i,t}$	0.074*	0.058*	0.003	-0.058*	-0.065*	-0.012*	0.049*	-0.054*	0.034*	0.011*
$K_{i,t}/L_{i,t}$	0.015*	0.013*	-0.075*	-0.066*	-0.065*	-0.006	-0.051*	-0.058*	-0.013*	-0.030*
$L_{i,t}$	0.230*	0.088*	0.193*	-0.076*	0.000	0.129*	0.002	-0.017*	0.002	-0.009*
Firm $age_{i,t}$	-0.084*	-0.099*	-0.121*	-0.031*	-0.048*	-0.032*	-0.070*	-0.013*	-0.026*	-0.028*
$HHI_{i,t}$	-0.004	-0.028*	-0.015*	-0.046*	-0.049*	-0.018*	-0.037*	-0.039*	-0.008	-0.032*
Uusimaa $dummy_{i,t}$	0.001	-0.014*	-0.022*	-0.036*	-0.037*	0.011*	0.057*	-0.043*	0.006	0.036*

(Table A4 continued)

	Entrepreneur $Edu^{HTOth}_{i,t}$	Entrepreneur $Edu^{LTBus}_{i,t}$	Entrepreneur $Edu^{LTTech}_{i,t}$	Entrepreneur $Edu^{LTOth}_{i,t}$	Entrepreneur $Edu^{LowBus}_{i,t}$	Entrepreneur $Edu^{LowTech}_{i,t}$	$R\&D_{i,t}/L_{i,t}$	$OC\&ICT_{i,t}/L_{i,t}$	$K_{i,t}/L_{i,t}$	$L_{i,t}$	Firm $age_{i,t}$	$HHI_{i,t}$
$EntrepreneurEdu^{LTBus}_{i,t}$	0.000											
$EntrepreneurEdu^{LTTech}_{i,t}$	-0.034*	-0.025*										
$EntrepreneurEdu^{LTOth}_{i,t}$	0.020*	0.004	-0.012*									
$EntrepreneurEdu^{LowBus}_{i,t}$	-0.009*	0.028*	-0.009*	0.013*								
$EntrepreneurEdu^{LowTech}_{i,t}$	-0.045*	-0.022*	-0.010*	-0.022*	0.015*							
$R\&D_{i,t}/L_{i,t}$	-0.017*	-0.071*	0.035*	-0.044*	-0.054*	-0.077*						
$OC\&ICT_{i,t}/L_{i,t}$	0.043*	-0.032*	-0.052*	-0.002	-0.043*	-0.093*	0.088*					
$K_{i,t}/L_{i,t}$	-0.042*	-0.041*	-0.031*	-0.023*	-0.025*	-0.035*	0.185*	0.165*				
$L_{i,t}$	0.010*	-0.009	-0.040*	0.033*	0.003	-0.002	0.107*	0.115*	0.112*			
Firm $age_{i,t}$	-0.066*	0.015*	0.005	-0.043*	-0.022*	-0.004	0.019*	-0.069*	0.137*	0.162*		
$HHI_{i,t}$	-0.025*	-0.018*	-0.037*	-0.005	-0.011*	-0.028*	-0.003	0.035*	0.098*	0.135*	0.131*	
Uusimaa $dummy_{i,t}$	0.053*	-0.012*	-0.058*	-0.001	-0.026*	-0.077*	0.078*	0.148*	0.035*	0.041*	0.103*	-0.001

The asterisk indicates the significance level of 0.05. *HGF* is a dummy variable for the top 10% of firms in creating jobs in the 3-year period as evaluated using the Birch Index (*birch*) (see Equation 1). $Entrepreneur^1$ is a dummy variable for firms with one entrepreneur. $Entrepreneurs^{2\text{-}3}$ is a dummy variable for firms with two or three entrepreneurs, and $Entrepreneurs^{4\text{-}5}$ is a dummy variable for firms with four or five entrepreneurs. *EntrepreneurEdu* is a dummy variable for entrepreneurs' education. The superscripts *HT*, *LT*, *HTBus*, *HTTech*, and *HTOth* refer to higher tertiary, lower tertiary, higher tertiary business, higher tertiary technical, and higher tertiary other, respectively. The superscripts *LTBus*, *LTTech*, *LTOth*, *LowBus*, and *LowTech* refer to lower tertiary business, lower tertiary technical, lower tertiary other, low business, and low technical, respectively (see section 3 for details). *R&D* is labor-based research and development, *OC* is labor-based organizational capital, and *ICT* is labor-based information and communication technology. All IC variables are stock variables. *L* is the number of employees. *K* refers to tangible capital. *HHI* is the Herfindahl Index that measures the market concentration. *Uusimaa dummy* is a dummy variable for firms located in the county of Uusimaa. Entrepreneurial firms refer to firms with at least one but not more than five entrepreneurs (see section 3 for details).

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Intangible capital and financial leverage in SMEs

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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

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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.

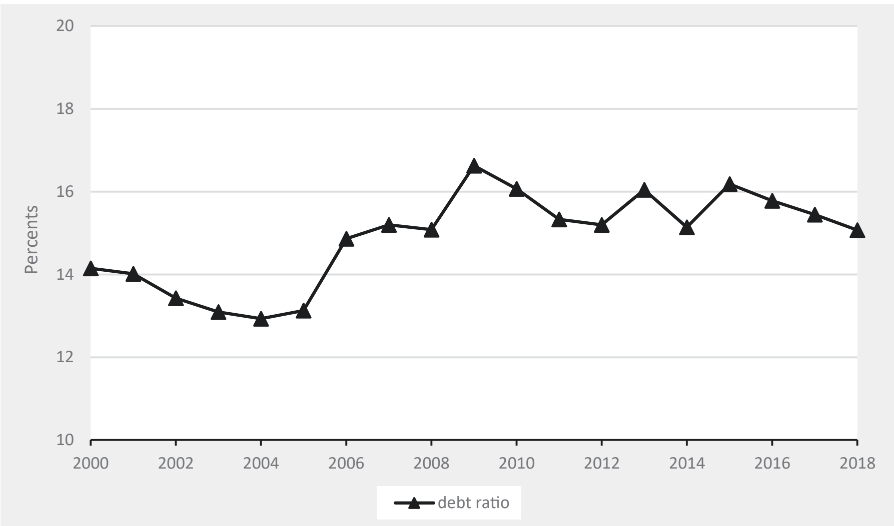

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Figure 1. Yearly averages of debt ratio weighted by sales

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:

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

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

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

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

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.

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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

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The Capital Structure of High-Growth SMEs

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Abstract

Small and medium-sized enterprises (SMEs) with high growth are responsible for a large share of new jobs. To create them, they must make investments financed with debt or equity. This paper considers how the capital structure develops when a firm becomes a high-growth firm (HGF) and maintains high growth over several years. Using unbalanced panel data for Finnish SMEs, the relationship between high growth and development of the capital structure is estimated by conducting propensity score matching with difference-in-differences. The results show that high growth has a positive relationship with short-term financial leverage. While control firms decrease their long-term financial leverage and increase their equity ratio, HGFs reduce both their long-term financial leverage and equity ratio. Although the results are similar in manufacturing, in knowledge-intensive services the relationship between high growth and the capital structure is not statistically significant.

Keywords: high growth, SME, capital structure, leverage, internal finance

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1 INTRODUCTION

This paper considers how the capital structure of high-growth firms (HGFs) develops. HGFs are crucial for the economy as they create a large share of new jobs (Henrekson & Johansson, 2010; Mason & Brown, 2013). However, firms must invest to increase their production or improve the quality of their products. These investments, which may be called growth investments, need to be financed by debt, retained profits, or external equity. Nevertheless, especially growth-oriented firms often face tight credit constraints, forcing them to retain profits to be able to make necessary investments in the future (see Brown et al., 2009). The importance of HGFs for employment is reflected in the considerable literature on the capital structure of HGFs. The existing literature mostly examines how capital structure predicts high growth, yet development of the capital structure during an actual period of high growth has hardly been considered. We thus do not know how the capital structure develops when a firm generates high growth over several years, with the aim of this paper hence being to address this gap in the literature. The relationship between the development of capital structure and high growth reveals the importance of the credit market for HGFs and their potential vulnerability during credit crunches.

The literature on the capital structure–growth relationship is not unanimous. Some papers state that credit access is an important factor for high growth (Fagiolo & Luzzi, 2006; Beck & Demirgüç-Kunt, 2006), while others note that financial leverage might even have a negative impact on growth (Lopez-Garcia & Puente, 2012). Moreover, it is possible that the effect of financial leverage on growth is in fact nonlinear (Coricelli et al., 2012). Many studies show that small and medium-sized enterprises (SMEs) and HGFs finance a considerable share of their investments using internal funds given that they face tight credit constraints (e.g., Coad & Srhoj, 2020; Myers & Majluf, 1984; Beck et al., 2006; Brown et al., 2009), a situation typically caused by asymmetric information between borrower and lender because SMEs and HGFs often lack proper collateral (Serrasqueiro et al., 2021). Some papers study how growth is related to the capital structure, but they only examine growth over a 1-year period. Daskalakis and Psillaki (2008) and Öhman and Yazdanfar (2017) note that growth in earnings increases financial leverage in general, while Degryse et al. (2012) find that growth increases only long-term debt.

Yet, to the best of our knowledge, no study has examined how the capital structure develops once a firm becomes an HGF and maintains high growth over several years. The purpose of this paper is accordingly to study the development of the capital structure when a firm becomes an HGF and maintains high growth over a 3-year period. The estimations show how HGFs' use of finance differs from that by other firms with similar characteristics, which may be considered potential HGFs that for some reason have been unable to achieve high growth. Propensity score matching with difference-in-differences is conducted to reveal the relationship between high growth and development of the capital structure. This paper is unable to unveil any causal effect between high growth and the capital structure since it considers only observational data and naturally lacks randomized controlled trials. However, this methodology enables us to control for the selection process in high growth and compare how the development of capital structure differs between the HGFs and control firms with similar characteristics over several years. The results show that high growth has a positive relationship with short-term financial leverage, namely, the source of finance most commonly used by HGFs.

The following parts of the paper are: section 2 presents previous literature on the capital structure and credit constraints of HGFs, section 3 describes the data, section 4 outlines the methodology, section 5 provides the results and a discussion, and section 6 concludes.

2 LITERATURE REVIEW

High-growth firms (HGFs) generate a major share of new jobs (Henrekson & Johansson, 2010; Mason & Brown, 2013). In Finland, SMEs account for about 40% of both employment and value added, despite their share among all firms being less than 10% (European Commission, 2019). Although micro firms (less than 10 employees) represent over 90% of all firms, their share of employment is only around one-quarter. High-growth SMEs are therefore highly important for the economy and also an interest of policymakers. A considerable share of SMEs operates in service industries that provide a favorable environment for innovating firms due to their intangible nature that supports scaling and, in turn, high growth. Firms in knowledge-intensive services are consequently overrepresented among HGFs. Still, it is not enough to simply know how firms finance their growth investments prior to achieving high growth, but it is also vital to better understand the kinds of financial decisions firms make once they become HGFs. The relationship between the development of capital structure and high growth reveals the importance of the credit market for HGFs and their potential vulnerability during credit crunches. This paper therefore studies the development of the capital structure of firms that become HGFs and achieve a high level of growth over a 3-year period, and compares it to the development of the capital structure of potential HGFs with similar characteristics.

To be able to grow, firms must make investments to increase the level of production or improve the quality of their products or services, with these investments being financed by debt or equity (internal or external). This has led to literature considering the capital structure–growth relationship. According to Meisenzahl (2016), credit constraints affect a firm’s size since constrained firms tend to be smaller. This may be interpreted as meaning that unconstrained firms can finance their investments easier, and hence grow faster. However, Lopez-Garcia and Puente (2012) find that leverage does not have a significant impact on high growth and the impact is even negative for “normal employment growth”.

Under the famous pecking-order theory, firms favor internal over external financing, and debt over equity (Myers, 1984). Myers and Majluf (1984) note that especially SMEs must retain profits to prepare for future growth opportunities. Rahaman (2011) studied the impact of the financial structure on firm growth in British and Irish firms. He finds that firms finance their growth investments with internal finance, but then switch over to debt finance once the credit constraints loosen. This indicates that firms would rely on debt finance if only they had better access to it. This paper controls access to credit by including financial slack while estimating the probability of high growth. Yet, Coricelli et al. (2012) note that the effect of leverage on productivity growth would actually be nonlinear because the leverage increases growth up until a certain leverage threshold, while above this threshold the effect is negative.

Martínez-Sola et al. (2018) state that firms with better growth opportunities adjust their levels of cash faster to the optimal level. Namely, they accumulate cash to ensure they can make the necessary growth investments. SMEs also suffer more often from tight credit constraints as a result of, for instance, asymmetric information between borrower and lender (Serrasqueiro et al., 2021). According to Revest and Sapio (2012), the problem of asymmetric information is emphasized in technology-based small firms due to the weak pledgeability of their assets. Apart from size or industry, age can explain financial frictions, with Beck et al. (2006) stating that firm age proxies credit constraints. This would force small and young firms to rely mostly on internal finance.

Cash in balance usually has some opportunity costs in terms of a lower return on assets. However, firms with great investment opportunities in the future are more resilient to the high opportunity costs created by cash holdings as the benefits from the investment opportunities are supposed to outweigh the opportunity costs (see Dittmar et al., 2003). This suggests that firms looking for new investments would first prepare by accumulating internal finance. This is supported by several studies showing that the investments of small firms are very sensitive to cash flow (e.g., Beck et al., 2006; Brown et al., 2009), even though such sensitivity can sometimes be overstated (D'espallier & Guariglia, 2015). Hence, high-growth SMEs would rely in particular on internal finance as they are looking for growth opportunities.

The increasing share of intangibles-related business adds to the uncertainty of future cash flows, which also explains the retaining of profits to avoid financial distress (Bates et al., 2009). In addition, intangible capital (IC) often has weak pledgeability that further tightens the credit constraints (Giglio & Severo, 2012) since weak pledgeability highlights the problem of asymmetric information between borrower and lender (Hall & Lerner, 2010). We may thus expect knowledge-intensive HGFs to use relatively more internal finance than other HGFs. Knowledge-intensive firms may also have relatively more short-term debt than other firms (see Li, 2018). According to the literature, while IC likely tightens credit constraints, it also positively impacts high growth (see, e.g., Eklund, 2020). Coad and Srhoj (2020) therefore state that HGFs possess more IC than other firms. IC is thus included as a covariate while estimating propensity scores.

Even though small firms fund a large share of their investments by internal funds, their growth is still limited by the tight credit constraints they face. Fagiolo and Luzzi (2006) note that small firms achieve higher growth once they gain better access to credit. Beck and Demirgüç-Kunt (2006) believe that access to credit explains firm growth for SMEs. Accordingly, many firms' growth investments are based on retained profits (see Coad & Srhoj, 2020; Beck et al., 2006; Brown et al., 2009). Honjo and Harada (2006) studied employment growth in Japanese SMEs in the manufacturing industry and show that cash flow is actually a significant source of finance only for young SMEs. Further, SMEs in fact encounter tighter credit constraints than larger firms (ECB, 2021). Although many growth investments are based on retained profits, HGFs may have problems with balancing costs and the cash flow. HGFs hence often have a shortage of cash (Churchill & Mullins, 2001).

Notwithstanding that the literature on capital structure and high growth is substantial, most studies examine the capital structure at the start of the growth period and analyze how the capital structure predicts high growth. Some studies explain capital structure by growth, but they only consider growth over a 1-year period. Degryse et al. (2012) find that growth in assets increases long-term debt, whereas Öhman and Yazdanfar (2017) note that growth in sales increases both short- and long-term financial leverage. Daskalakis and Psillaki (2008) find that growth in earnings increases financial leverage in general. Firms generating persistent high growth have a much stronger economy-wide impact than firms able to achieve high growth only for one year at a time. This makes it important to have a better grasp of how HGFs able to maintain their high growth finance their investments during the periods of high growth. We identify potential HGFs based on observable covariates and look at how their financial decisions differ from actual HGFs.

3 DATA

This paper uses a register-based linked employer-employee unbalanced panel dataset from Statistics Finland for the period 2000–2018 in the Globalinto 2019–2022 project as part of EU Horizon 2020. This paper focuses on SMEs which are known to be important job creators (European Commission, 2019). The sample includes Finnish limited companies with at least 10 employees but less than 251 employees before the high-growth period. After the matching, the upper limit of a firm's size is not restricted to ensure that the fastest-growing firms are included while estimating changes in the capital structure. The data include, for instance, balance-sheet information and employees along with their occupations. Agricultural, construction, finance, and insurance firms are excluded.

In this paper, HGFs are defined as the top job creators. They could also be described, for instance, in terms of sales or assets, but a new employee is a more future-oriented factor and is also in the interest of policymakers. This paper concentrates on the top 10% of job creators (HGFs) over a 3-year period. Just 4.6% of observations are considered HGFs because high-growth observations are only included when a firm becomes an HGF for the first time. Namely, about half the HGFs had already held a high-growth status in the past and such observations are therefore not included in this sample. Hence, after a firm is determined as an HGF for the first time, subsequent observations of this firm are omitted in the analysis. HGFs are measured using the Birch Index (Birch, 1987) which enables to consider HGFs in absolute growth together with HGFs in relative growth. This additionally makes it more feasible to consider firms of varying sizes in the same analysis, unlike with Gibrat's Law (see Nassar et al., 2014; Moreno & Casillas, 2007) which assumes that growth is independent of firm size. Observations with the highest 10% of the Birch Index are considered to be HGFs, as determined within years to control production shocks. The formula of the index is as follows:

(1) $$Birch\ Index_{i,(t,s)} = \frac{L_{i,s}}{L_{i,t}} \times \left(L_{i,s} - L_{i,t}\right).$$

When using the index to determine HGFs (dependent variable in Table 2), the growth is calculated from period *t* to *t+3*. Hence, we measure growth during a 3-year period ($Birch\ Index_{i,(t,\ t+3)}$). This allows us to examine firms able to grow over several years. The propensity scores and matching are conducted in period *t*. Therefore, we measure growth from period *t* to *t+3*, not from *t-3* to *t*. Moreover, when the Birch Index is used as a covariate to control past growth, it is calculated from period *t-1* to *t* ($Birch\ Index_{i,(t-1,\ t)}$). In this case, we use the index value itself as a covariate and do not convert it to a dummy variable.

The dependent variable in the propensity score estimation is *HGF* discussed in the previous paragraph. Short- and long-term debt ratios are the outcome variables measured as *short-term debt/total assets* and *long-term debt/total assets*, respectively. The control variables include several firm characteristics: the past growth from period *t-1* to *t* measured by the Birch Index, internal finance measured as $ln(equity_{i,t}/equity_{i,t-1})$, and IC. IC is measured from intangibles-related labor costs, which are multiplied by the tangible and intermediate inputs needed for IC investments. This methodology follows the approaches developed in the EU Horizon 2020 Globalinto project (for details see Piekkola, 2020). In addition, we include the amount of total assets, financial slack measured as *tangible capital/total debt*, *profitmargin* measured as *net income/sales*, the amount of sales, firm age, and the number of employees (*L*). Due to the increasing productivity dispersion (see Corrado et al., 2021), firm-level productivity is controlled by including *value added/employee*. Definitions of variables are compiled in Table A1 in the appendix.

Table 1 shows descriptive statistics of the variables. Panel A presents the statistics for all firms and panel B for only the HGFs in the year they were determined as HGFs. Just 4.6% of observations are considered HGFs as we solely include HGFs achieving high growth for the first time. In Table 1, the Birch Index is measured from *t-1* to *t* and is used in the probit estimation in Table 2 as a covariate to control past growth. Its mean value is 1.11. The median values of long- and short-term debt ratios are 0.231 and 0.352, respectively. Firms annually increase the level of their equity by 16.2% on average. The median value of IC is €581,000. The profit margin is relatively low as it is only 0.5% on average with a median value of 1.8%. Median sales are €3,923,000, although there is considerable deviation between firms. The mean value of *valueadded/L* is €76,300. The median firm age is 22 years while the median number of employees is 20.

If we compare the numbers to Panel B, some prominent differences emerge. The Birch Index ($Birch_{i,(t-1, t)}$) has higher values in Panel B and thus HGFs grow faster already before the actual high-growth period than firms on average. However, the debt ratios are quite similar between Panel A and B. On the other hand, HGFs increase their level of equity much faster than firms on average. HGFs have more IC and their levels of total assets are also higher. In addition, they have more financial slack on average. It is worth noting that HGFs have much more heterogeneity in the profit margins among firms. HGFs also have higher productivity than other firms on average. Although they are younger, they have more employees. Accordingly, these observed characteristics strongly distinguish HGFs from the rest of the sample. Thus, the HGFs need to be matched with control firms with similar characteristics before the capital structure analysis to balance the covariates between these two groups. The methodology is described in more detail in section 4.

Table 1. Descriptive statistics

Panel A: All firms (N 31,291; number of firms 7,146)

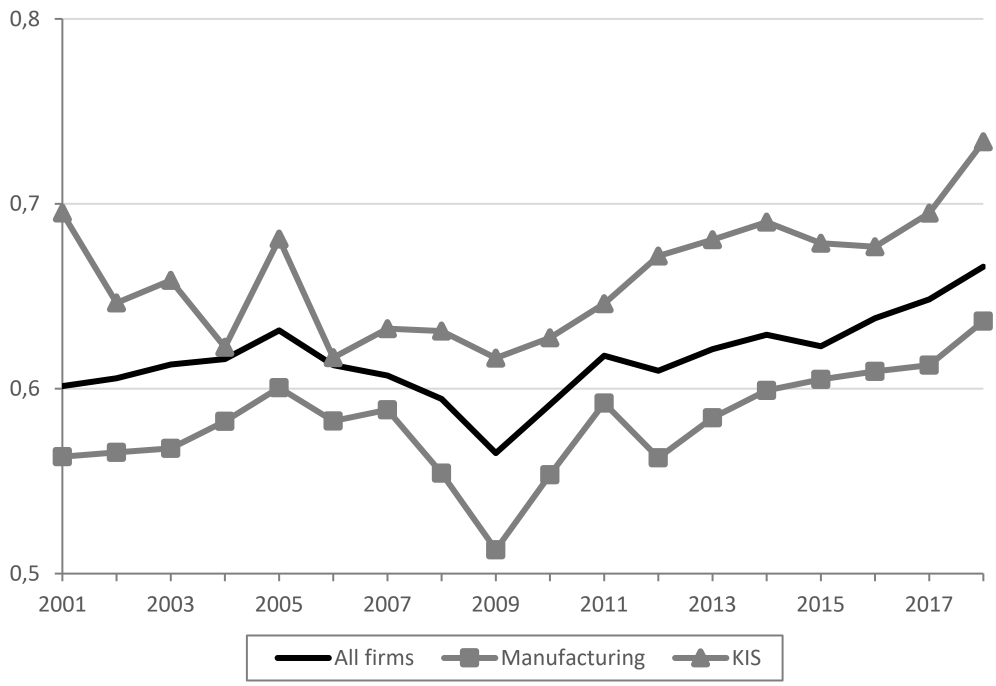
Variable	Mean	p25	p50	p75	SD
$HGF_{i,(t, t+3)}$	0.046	0.0	0.0	0.0	0.209
$Birch_{i,(t-1, t)}$	1.11	-1.78	0.0	2.40	15.8
long debt $ratio_{i,t}$	0.260	0.122	0.231	0.369	0.173
short debt $ratio_{i,t}$	0.368	0.239	0.352	0.479	0.174
$ln(E_{i,t}/E_{i,t-1})$	0.162	-0.052	0.046	0.209	0.614
$IC_{i,t}$	1,679	189	581	1,432	18,381
$totalassets_{i,t}$	12,891	1,162	2,360	5,597	142,678
$slack_{i,t}$	3.71	0.844	2.09	4.45	8.36
$profitmargin_{i,t}$	0.005	-0.007	0.018	0.050	0.177
$sales_{i,t}$	9,992	2,022	3,923	8,530	37,451
$valueadded_{i,t}/L_{i,t}$	76.3	46.5	62.3	83.6	142
$firmage_{i,t}$	21.2	14.0	22.0	29.0	9.55
$L_{i,t}$	30.8	15.0	20.0	33.0	30.5

Panel B: HGFs (N 1,429; number of firms 1,429)

Variable	Mean	p25	p50	p75	SD
$HGF_{i,(t, t+3)}$	1.00	1	1	1	0
$Birch_{i,(t-1, t)}$	4.90	-3.16	0.0	3.53	64.6
long debt $ratio_{i,t}$	0.253	0.115	0.223	0.368	0.173
short debt $ratio_{i,t}$	0.381	0.241	0.359	0.497	0.182
$ln(E_{i,t}/E_{i,t-1})$	0.306	-0.030	0.088	0.334	0.856
$IC_{i,t}$	3,225	327	916	2,790	7,255
$totalassets_{i,t}$	29,228	1,469	3,710	11,271	156,510
$slack_{i,t}$	4.89	0.785	1.96	4.23	21.5
$profitmargin_{i,t}$	-0.007	-0.004	0.023	0.057	0.262
$sales_{i,t}$	21,702	2,656	6,409	16,314	81,028
$valueadded_{i,t}/L_{i,t}$	105.0	49.1	67.8	92.4	403
$firmage_{i,t}$	18.0	9.0	19.0	26.0	10.2
$L_{i,t}$	51.0	17.0	29.0	62.0	51.9

Panel B presents the statistics of HGFs in the year when they were determined as HGFs. *IC*, *totalassets*, and *sales* in thousands of 2015 euros. *HGF* is a dummy variable for firms with the highest 10% of the Birch Index measured from period *t* to *t+3* (see Equation 1). It is measured within years to control production shocks. The calculation method for *Birch* is also given in Equation 1. *long debt ratio* refers to long-term debt ratio and is measured as *long-term debt/total assets. short debt ratio* refers to short-term debt ratio and is measured as *short-term debt/total assets. E* is equity. *ln()* refers to logarithmic transformation. *IC* refers to intangible capital. *L* refers to a number of employees. *slack* refers to financial slack measured as *tangible capital/total debt*. *E* refers to equity. *profitmargin* is calculated as net *income/sales*.

In the last 20 years, the share of short-term debt has risen in Finnish SMEs (Figure 1). During the financial crisis, there was a distinct decline, likely the result of the tighter credit market when many firms probably struggled to roll their debt over. Yet, the increasing share of short-term debt may be explained by the fact that IC has taken on a bigger role in firms' assets (Corrado, 2021). Since IC is generally viewed as weak collateral, it leads to shorter debt maturities as debt maturity is positively related to collateral (see Demirgüç-Kunt et al., 2020). On the other hand, this development of short-term debt could increase risks for SMEs because problems might arise during a tightening credit market if long-term assets are being financed with short-term debt.



Note: KIS refers to knowledge-intensive services.

Figure 1. Median values of short-term debt/total debt

4 METHODOLOGY

The purpose of this paper is to study the development of the capital structure when a firm generates high growth over a 3-year period. We thus observe how important the different sources of finance are for high-growth entrants. In particular, the estimations show how HGFs' use of finance differs from that of other firms with similar covariates. The latter could be considered potential HGFs that for some reason have been unable to achieve high growth. Propensity score matching (PSM) with difference-in-differences (DID) is used to reveal the relationship between high growth and development of the capital structure. Becoming an HGF is the so-called ‘treatment variable’, even though there is not an actual treatment per se in the analysis. By using PSM with DID, self-selection bias is also controlled. The matching is done within years to control production shocks. Accordingly, we concentrate especially on the equation following Heckman et al. (1997):

(2) $$E\left(y^1_{i,t+s} - y^0_{i,t+s} \middle| HGF_i = 1, x_{i,t}\right) = E\left(y^1_{i,t+s} \middle| HGF_i = 1, x_{i,t}\right) - E(y^0_{i,t+s} | HGF_i = 0, x_{i,t}),$$

where y is the outcome variable (the change in the short- or long-term debt ratio), *HGF* is the treatment variable, and the superscript indicates whether a firm is an HGF (1) or not (0). x represents the matching covariates. Naturally, we cannot observe what the effect on the outcome variable in treated firms would have been had they not become HGFs. To solve this problem, HGFs are matched with control firms with similar covariates. Thus, the equation means we are measuring the change in the outcome variable and examining how it differs between the treated and control firms, i.e., HGFs and potential HGFs that have the same probabilities of becoming HGFs based on the probit estimations, but for some unobservable reason the control firms have been unable to generate high growth. Yet, HGFs and control firms are strictly separate groups. In other words, an HGF can only be matched with firms which do not become HGFs in the whole sample period.

Before matching, we run a probit estimation to estimate the probability of becoming an HGF for each firm based on different covariates of firm characteristics. The probit estimates the propensity score that is used for the matching. The HGF variable is a binary variable that is given a value of one if a firm becomes an HGF for the first time. Once a firm has become an HGF, later observations of the firm are omitted because this paper’s focus is on high-growth entrants. The probit model to estimate the probability of becoming an HGF is estimated as follows:

(3) $$HGF_{i,(t,t+3)} = 1\ if\ \delta_0 + \delta_b Birch_{i,(t-1,t)} + \delta_{ef} \ln\left(\frac{E_{i,t}}{E_{i,t-1}}\right) + \delta_{IC} \ln\left(IC_{i,t}\right) + \delta_a ln\left(totalassets_{i,t}\right) + \delta_s slack_{i,t} + \delta_{pm} profitmargin_{i,t} + \delta_s \ln\left(sales_{i,t}\right) +$$

$$\delta_v \ln\left(\frac{valueadded_{i,t}}{L_{i,t}}\right) + \delta_{age} firmage_{i,t} + \delta_L \ln(L_{i,t}) + \delta_i industry_{i,t} + \delta_y year_t + \varepsilon_{i,t} > 0 \; and \; zero \; otherwise,$$

where *HGF* is a dummy variable for firms with the highest 10% of the Birch Index measured from period *t* to *t+3* (see Equation 1). Definitions of variables are discussed in section 3 and compiled in Table A1 in the appendix. *industry* and *year* are dummy variables. *industry* represents 59 industries based on the Nace Rev. 2 classification of economic activities. ε is the error term. $valueadded/L$ is transformed by *sign(x)×ln(abs(x)+1)* due to negative values. From the probit estimation, we estimate the probability of becoming an HGF which is used as a propensity score in the matching. Outcome variables are not included in the probit estimations because they could cause bias due to regression to the mean if the mean values of the outcome variables differ between the HGFs and the control firms (Daw & Hatfield, 2018). In the whole sample (see Table 1) and in manufacturing, the mean values are mostly similar, but in knowledge-intensive services (KIS) the HGFs have a 3.7 percentage points higher mean short-term debt ratio than the control firms. Additional estimations were thus run, including short- and long-term debt ratios as covariates to test for possible bias. The results were more significant for the short-term debt ratio than in Table 4, which is likely due to the bias of the regression to the mean. The additional estimations are available from the author upon request.

The matching is conducted with a radius of 0.005 for the whole sample and 0.01 while estimating only manufacturing or KIS firms. The small radius enable us to match firms with similar probabilities of becoming HGFs. When analyzing particular industries, the larger radius of 0.01 is used due to a smaller sample of control firms. The same radii are used in the robustness tests discussed in subsection 5.3. The matching is done within years to control production shocks, and restricted to the common support such that HGFs whose propensity scores are higher than the maximum or lower than the minimum scores of the control firms are excluded from the DID. This improves the balance and sufficiency of matching by dropping HGFs with extreme covariate values. There are about 20 times more observations of non-HGFs than HGFs in the sample, which enables us to match each HGF with many control firms with similar covariates. Moreover, the large control group improves the efficiency of the matching. The extent of balancing is shown in Table 3, which reports the average values of the covariates of both the HGFs and the control firms. The extent of balancing can be measured by the standardized bias in the covariates between the two groups. Following Rosenbaum and Rubin (1985) and as described in section 5, the extent of balancing appears to be sufficient.

In DID, we focus on the so-called 'average treatment on the treated' (ATT), which is practically the difference in the outcome variable between the treated and matched control firms. Using PSM with DID enables us to measure the difference only between the matched firms, i.e., firms with a similar probability to become an HGF based on the covariates. The ATT is examined for changes in the debt ratios in periods (*t, t+1*), (*t+1, t+2*), (*t+2, t+3*), and (*t, t+3)*. Period *t* is the year before the 3-year growth period. Further, the matching is conducted in period *t*. We thus study the development of the capital structure in each year during the 3-year high-growth period.

5 RESULTS AND DISCUSSION

This paper examines how the capital structure develops when a firm maintains high growth over a 3-year period. In particular, we consider how high-growth entrants' use of finance differs from that of other firms with similar covariates. They could be seen as potential HGFs that for some reason have not achieved high growth. The results are considered separately for manufacturing and KIS firms. The typical asset structure differs between these two industries, since firms in manufacturing often have more tangible assets, which serve as better collaterals than intangibles do. This indicates that HGFs in KIS might have to rely relatively more on internal finance during the high-growth periods. To determine how high growth is linked to the capital structure's development and to control the self-selection bias, propensity score matching is used with the DID estimation. By using PSM, we match HGFs with non-HGFs with similar covariates. Then, DID estimates how the change in short- and long-term debt ratios differ between these two groups during a 3-year period of high growth.

5.1 Estimating propensity scores

Table 2 shows the probit model estimations of the probability of becoming an HGF that are used to match high-growth entrants with similar non-HGFs. In column (1), an increase in equity is positively related to becoming an HGF. This is in line with the literature stressing the importance of internal finance for firm growth (e.g., see Martínez-Sola et al., 2018; Dittmar et al., 2003; Bates et al., 2009). Although IC has a positive coefficient, the result is non-significant with a p-value of 0.104. One reason for the non-significant result is that a high level of IC causes high fixed costs that restrain business activities. The results support the persistence of growth as past high growth from period *t-1* to *t* is positively related to high growth in the next 3 years, which is in harmony with Rossi-Hansberg and Wright (2007) and Eklund (2020) but contradicts Daunfeldt and Halvarsson (2015). Financial slack has a non-significant relationship with high growth. Surprisingly, profit margin is negatively related to growth. One explanation may be that growth-oriented firms are exploiting growth opportunities at the expense of profitability.

The results for various industries show that manufacturing (column (2)) has partly different growth factors than KIS (column (3)). In both columns (2 and 3), equity finance is positively related to high growth, while sales are positively related to high growth only in column (2). The coefficient of profit margin is negative in manufacturing but non-significant in KIS. One explanation for this is that internal finance is more important in KIS where firms need to retain profits. However, growth is persistent solely in manufacturing as the coefficient of the Birch Index is positive and statistically significant.

Table 2. The results of the propensity score estimation

$HGF_{i,(t, t+3)}$	(1) All firms	(2) Manufacturing	(3) KIS
$Birch_{i,(t-1, t)}$	0.002**	0.001**	0.003
	(0.001)	(0.001)	(0.002)
$\ln(E_{i,t}/E_{i,t-1})$	0.236***	0.223***	0.307***
	(0.035)	(0.055)	(0.072)
$\ln(IC_{i,t})$	0.012	0.014	0.038
	(0.008)	(0.017)	(0.023)
$\ln(totalassets_{i,t})$	-0.007	-0.014	0.011
	(0.021)	(0.038)	(0.043)
$slack_{i,t}$	0.002	0.003	0.001
	(0.001)	(0.005)	(0.001)
$profitmargin_{i,t}$	-0.283**	-0.476***	-0.085
	(0.113)	(0.168)	(0.202)
$\ln(sales_{i,t})$	0.175***	0.261***	0.099
	(0.028)	(0.049)	(0.074)
$\ln(valueadded_{i,t}/L_{i,t})$	0.020	0.027	-0.015
	(0.022)	(0.028)	(0.042)
firm $age_{i,t}$	-0.018***	-0.016***	-0.032***
	(0.002)	(0.002)	(0.005)
$\ln(L_{i,t})$	0.204***	0.140***	0.281***
	(0.033)	(0.052)	(0.082)
constant	-3.411***	-4.688***	-3.021***
	(0.162)	(0.287)	(0.320)
Observations	31,291	14,682	3,739
R^2 pseudo	0.088	0.093	0.121

Standard errors in parentheses. Asterisks indicate the significance level, *<0.1, **<0.05, ***<0.01. The results for year and industry dummies are not reported. KIS refers to knowledge-intensive services. The estimated function is given in Equation 3. *ln()* refers to logarithmic transformation. The dependent variable is a dummy variable for the top 10% of job creators in a 3-year period (see Equation 1). It is measured within years. The calculation methods for *Birch* is given in Equation 1. *E* is equity. *IC* is intangible capital. *slack* is measured as *tangible capital/total debt*. *profitmargin* is calculated as *net income/sales*. *L* is the number of employees.

Next, we conduct the matching by using the propensity score as estimated by probit. The matching is done within years to control production shocks. While estimating all firms, the matching is conducted with a radius of 0.005 to balance the covariates, while in manufacturing and KIS the radius is 0.01 due to the smaller sample. Common support is used to drop observations of HGFs whose propensity scores are higher than the maximum or lower than the minimum of the control firms. To test the balance of the covariates, we evaluate the standardized bias between the HGFs and the matched control firms. The extent of balancing with the matched firms is shown in Table 3, which reports the average values of the covariates of both the treated and matched control firms. Following Rosenbaum and Rubin (1985), the balancing appears to be sufficient since the mean standardized bias is below 5% in all estimations, while the standardized biases of individual covariates are also always under 10%.

Table 3. Balancing test between HGFs and matched control firms based on group averages and standardized biases

	All firms				Manufacturing				KIS			
	Treated	Control	Bias	P-value	Treated	Control	Bias	P-value	Treated	Control	Bias	P-value
$Birch_{i,(t-1, t)}$	1.72	2.19	-1.0	0.442	0.491	0.977	-0.7	0.443	4.23	4.91	-2.7	0.768
$ln(E_{i,t}/E_{i,t-1})$	0.144	0.154	-2.3	0.556	0.112	0.113	-0.2	0.972	0.185	0.227	-8.4	0.361
$ln(IC_{i,t})$	6.37	6.32	2.0	0.589	7.30	7.27	2.0	0.708	7.17	7.12	2.3	0.774
$ln(totalassets_{i,t})$	8.38	8.30	5.3	0.186	8.87	8.79	5.7	0.335	7.90	7.94	-2.4	0.809
$slack_{i,t}$	3.76	4.91	-7.2	0.024	3.66	3.78	-2.9	0.633	4.72	6.17	-4.1	0.297
$profitmargin_{i,t}$	-0.004	-0.003	-0.3	0.942	0.001	0.005	-1.7	0.788	-0.047	-0.068	7.6	0.476
$ln(sales_{i,t})$	8.83	8.79	3.1	0.443	9.19	9.14	4.7	0.434	8.13	8.08	4.5	0.649
$ln(valueadded_{i,t}/L_{i,t})$	4.14	4.15	-0.6	0.891	4.26	4.26	-0.3	0.953	3.90	3.90	-0.5	0.959
$firm\ age_{i,t}$	18.19	18.00	1.9	0.608	20.60	20.21	4.0	0.502	12.98	13.06	-0.9	0.922
$ln(L_{i,t})$	3.50	3.47	4.8	0.243	3.70	3.68	3.6	0.566	3.41	3.38	3.6	0.710

The columns 'Treated' and 'Control' represent covariate means after matching. 'Treated' refers to HGFs. 'Control' refers to matched control firms. KIS refers to knowledge-intensive services. The calculation method for *Birch* is given in Equation 1. *E* is equity. *IC* is intangible capital. *slack* is measured as *tangible capital/total debt*. *profitmargin* is calculated as *net income/sales*. *L* is a number of employees.

5.2 Difference-in-differences

After conducting the matching, we estimate the differences in the change in the short- and long-term debt ratios between the treated and matched control groups by using DID. The differences between the two groups are estimated separately for the first ($t+1$), second ($t+2$), and third year ($t+3$), and for the whole high-growth period ($t, t+3$). In Table 4, we can see that HGFs are relying relatively more on short- than long-term debt. In column (4), HGFs increase their short-term debt ratios more than non-HGFs in all periods over the 3-year growth period. In period $t+1$, the difference is 1.5 percentage points, while it is 0.9 of a percentage point in period $t+2$, and 0.6 of a percentage point in period $t+3$. HGFs increase their short-term debt ratios by 3.1 percentage points more than the non-HGFs do during the 3-year period. Short-term credit access thus seems to be an important factor for high-growth entrants. However, the ATT in the long-term debt ratio is non-significant, although the coefficient is significant and negative while considering the change in period $t+1$. We may conclude that short-term credit access is especially important for HGFs, while the development of long-term leverage follows almost the same pattern as with control firms. Short-term debt appears to be a more used source of finance than equity for HGFs. Even though internal finance predicts growth, as shown in Table 2, short-term debt has in any case a more important role during a high-growth period lasting several years.

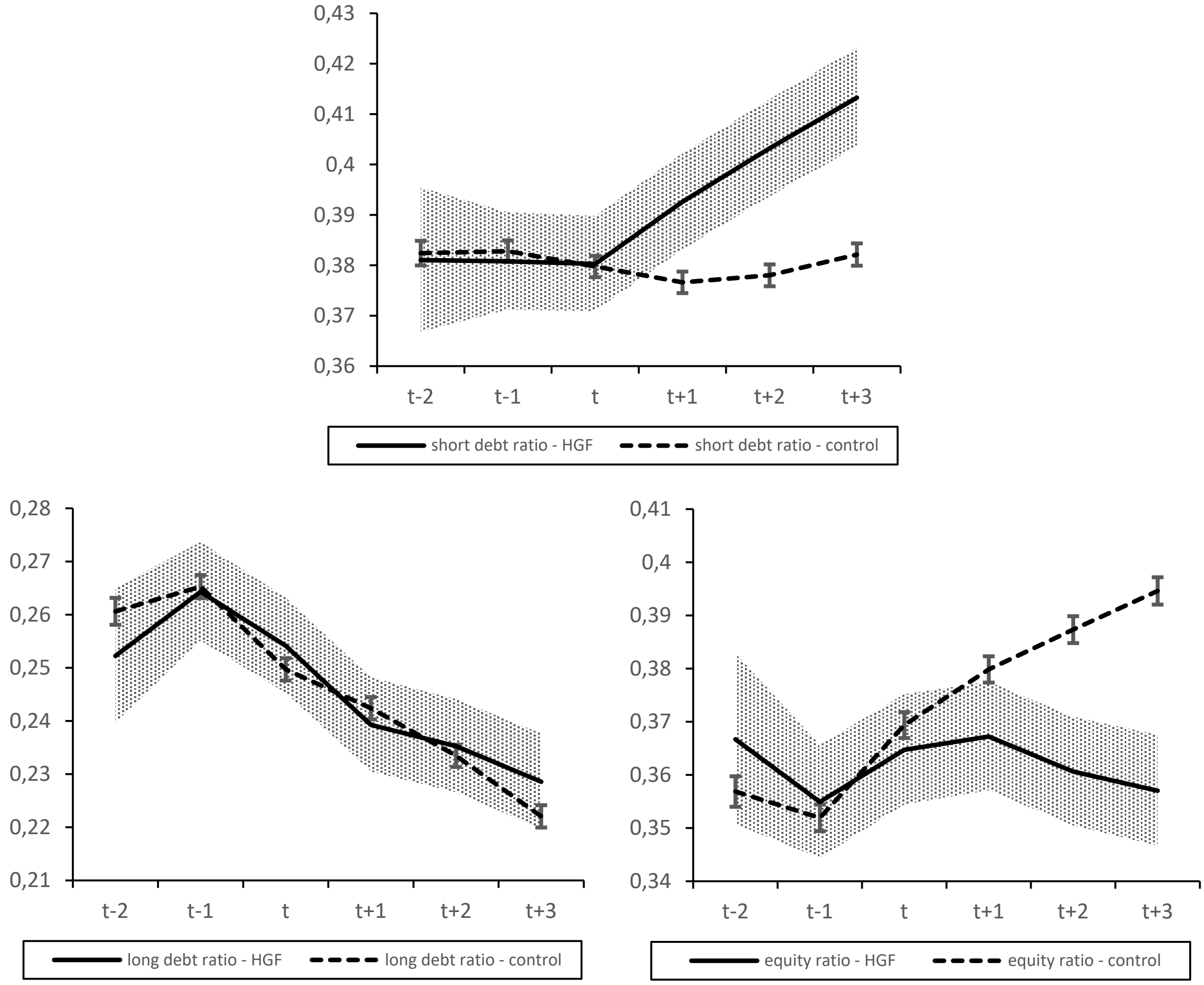
In manufacturing (column (5)), the results are mostly similar to the results in column (4). Despite the coefficient of the short-term debt ratio being non-significant in period *t+3*, the difference in the 3-year high-growth period is 3.5 percentage points. Therefore, HGFs in manufacturing use short-term debt almost to the same extent as all HGFs on average. In column (6) that considers KIS, the coefficients of the short-term debt ratio are instead non-significant. Even the change in the whole 3-year period is non-significant. Although the difference in the change in the long-term debt ratio is more negative than in manufacturing, namely -0.5 of a percentage point, it is non-significant. In KIS, the development of the capital structure is mostly similar between the HGFs and the matched control firms. On average, HGFs in KIS use relatively less debt finance and more equity finance than other HGFs. The finding that the development of the capital structure in HGFs differs between manufacturing and KIS is interesting. One explanation here may be that HGFs in KIS rely more on internal finance due to their lack of proper collateral since firms in services typically have weaker collateral than firms in manufacturing, which points to the importance of retained profits for growth investments.

Table 4. Difference-in-differences estimations with radius matching

Δshort-term debt ratio	(4) All firms	(5) Manufacturing	(6) KIS
t+1	0.015*** (0.003)	0.014*** (0.005)	0.012 (0.011)
t+2	0.009*** (0.003)	0.015*** (0.005)	0.009 (0.011)
t+3	0.006** (0.003)	0.006 (0.005)	-0.006 (0.011)
t, t+3	0.031*** (0.005)	0.035*** (0.007)	0.015 (0.017)
Δlong-term debt ratio			
t+1	-0.008** (0.003)	-0.005 (0.005)	-0.014 (0.009)
t+2	0.005 (0.003)	0.000 (0.005)	0.003 (0.009)
t+3	0.005 (0.003)	0.003 (0.005)	0.007 (0.009)
t, t+3	0.002 (0.005)	-0.002 (0.007)	-0.005 (0.012)
Observations	28,760	13,380	3,417
Observations, matched HGFs	1,393	580	246
Observations, matched control firms	26,892	12,558	2,416
Observations, HGFs off support	36	14	31
Observations, unmatched control firms	439	228	724

Bootstrapped standard errors with 100 repetitions in the parentheses. Δ indicates change in the ratio from the previous year. Asterisks indicate the significance level, *<0.1, **<0.05, ***<0.01. In column (4), the radius is 0.005 and in columns (5) and (6) 0.01. KIS refers to knowledge-intensive services. *t, t+3* examines the whole 3-year high-growth period.

We then graphically examine the development of debt and equity ratios. Figure 2 displays the development of the capital structure for the HGFs and matched control firms. It clearly shows that the short-term debt ratios of both the HGFs and the matched control firms follow the same pattern up until period *t*, after which HGFs increase their ratio from 0.38 to over 0.41 while the curve of the matched control firms remains almost flat. This supports the results presented in Table 4 that high growth is positively related to short-term financial leverage. The long-term debt ratios of both groups decrease each year during the 3-year growth period from over 0.25 to below 0.23, which is in line with the literature because leverage is negatively related to the age of a firm (Van Caneghem & Van Campenhout, 2012). The results reveal that high growth is unrelated to the long-term debt ratio. Figure 2 shows that HGFs increase their short-term leverage almost to the same extent as they decrease their long-term leverage, while the control firms pay off their long-term debts and increase their equity ratio. It is thus apparent that short-term debt is used more than internal finance during periods of high growth. The number of observations in period *t-2* is 23,670. Namely, not all observations are observed in this period, yet we can still conclude that the patterns of the two groups are similar until period *t* before the high-growth period that supports the significant relationship with high growth. The confidence intervals of control firms are clearly narrower than those of HGFs that mostly follows from the larger number of observations in the control group.



Note: 95% confidence intervals are marked with grey area and vertical bars for HGFs and matched control firms, respectively.

Figure 2. Debt and equity ratios of the HGFs and the matched control firms

Based on the results in Table 4 and graphic descriptions in Figure 2, we may summarize that HGFs primarily finance their growth opportunities with short-term debt. In other words, high growth over several years has a positive relationship with short-term financial leverage. Figure 2 shows that the changes in the ratios between the HGFs and the matched control firms occur mostly parallel to each other in periods *t-1* and *t-2*, but the HGFs begin to increase their short-term debt ratio since they generate high growth. The fact that HGFs reduce both their long-term debt ratio and equity ratio means that short-term debt is the most used source of finance when firms generate high growth over several years. In the 3-year high-growth period, the median HGF increases the value of its total assets by over €2.5 million, a rise of about 70%. Since almost half of this is financed by short-term debt, this emphasizes the potential risk in HGFs' capital structure because problems are likely to arise during a tightening credit market if long-term assets are financed by short-term debt.

5.3 Robustness check

In Table 5, robustness checks are run with kernel matching and three-nearest-neighbors matching to test the sensitivity of the results to different matching methods. In these robustness checks, the same propensity scores as in Table 4 are used. In the kernel matching, the radii are the same as in the radius matching: 0.005 for all firms, and 0.01 for manufacturing and KIS. The three-nearest-neighbors matching is conducted without a radius.

If we compare the DID estimations after kernel matching to the results shown in Table 4, we can see that the results remain generally similar. Further, the results for the long-term debt ratio are mostly non-significant, as in Table 4. The results with kernel matching thus support the conclusion that the HGFs rely relatively more on short-term debt than the control firms. Namely, high growth lasting several years is linked to increasing short-term leverage since short-term debt is the most used source of finance for high-growth entrants.

Also with the three-nearest-neighbors matching, the results support our conclusions by clearly indicating the importance of short-term debt for HGFs. It may hence be concluded that the results are robust to different matching methods.

Table 5. Difference-in-differences estimations with kernel matching and three-nearest-neighbors matching

	Kernel matching			Three-nearest-neighbors matching		
	(7)	(8)	(9)	(10)	(11)	(12)
Δshort-term debt ratio	All firms	Manufacturing	KIS	All firms	Manufacturing	KIS
t+1	0.016***	0.013***	0.011	0.015***	0.016***	0.014
	(0.003)	(0.005)	(0.010)	(0.004)	(0.006)	(0.010)
t+2	0.009**	0.015***	0.009	0.011***	0.013**	0.017
	(0.004)	(0.005)	(0.012)	(0.004)	(0.006)	(0.012)
t+3	0.006**	0.006	-0.007	0.004	0.003	-0.007
	(0.003)	(0.005)	(0.011)	(0.004)	(0.006)	(0.013)
t, t+3	0.031***	0.034***	0.013	0.030***	0.031***	0.024
	(0.004)	(0.007)	(0.016)	(0.006)	(0.008)	(0.017)
Δlong-term debt ratio						
t+1	-0.007**	-0.004	-0.012	-0.008*	-0.009	-0.018*
	(0.004)	(0.005)	(0.009)	(0.004)	(0.006)	(0.010)
t+2	0.005	0.000	0.002	0.003	0.002	-0.002
	(0.003)	(0.005)	(0.009)	(0.004)	(0.007)	(0.010)
t+3	0.005	0.003	0.007	0.004	0.007	0.012
	(0.003)	(0.006)	(0.009)	(0.004)	(0.007)	(0.010)
t, t+3	0.002	-0.002	-0.002	0.000	0.000	-0.008
	(0.005)	(0.008)	(0.015)	(0.006)	(0.008)	(0.015)
Observations	28,760	13,380	3,417	28,760	13,380	3,417
Observations, matched HGFs	1,393	580	246	1,429	594	277
Observations, matched control firms	26,892	12,558	2,416	3,596	1,493	612
Observations, HGFs off support	36	14	31			
Observations, unmatched control firms	439	228	724	23,735	11,293	2,528

Bootstrapped standard errors with 100 repetitions in the parentheses. Δ indicates change in the ratio from the previous year. Asterisks indicate the significance level, *<0.1, **<0.05, ***<0.01. In column (7), the radius is 0.005 and in columns (8) and (9) 0.01. KIS refers to knowledge-intensive services. *t, t+3* examines the whole 3-year high-growth period.

6 CONCLUSIONS

To be able to grow and create new jobs, HGFs must make investments to increase the level of production or improve the quality of their products or services, and these investments have to be financed by debt or equity. Still, especially growth-oriented firms often face tight credit constraints that force them to retain profits to be able to make the necessary investments in the future (see Brown et al., 2009). While the existing literature generally examines how capital structure predicts high growth, the development of the capital structure during an actual period of high growth has hardly been considered. This paper addresses this gap by studying how the capital structure develops when a firm becomes an HGF and generates high growth over a 3-year period.

The results show that HGFs largely finance their growth with short-term debt. High growth is thus linked to increasing short-term financial leverage, whereas long-term financial leverage decreases almost to the same extent as with the matched control firms. Since HGFs also decrease their equity ratio, the results highlight the importance of short-term debt for high-growth entrants. Yet, HGFs might suffer from tight credit constraints as they decrease their long-term leverage. Despite previous studies emphasizing retained profits while predicting high growth, this paper shows that HGFs in fact use more short-term credit than retained profits when generating high growth over several years. The results are similar when estimating only manufacturing firms. These findings point to the potential risk in HGFs' capital structure as problems are likely to arise during a tightening credit market if long-term assets are financed by short-term debt.

However, the results are non-significant in knowledge-intensive services. One explanation here may be the intangible nature of knowledge-intensive services where firms are lacking in pledgeable assets. Such firms' relatively greater use of internal finance likely underscores the problem of asymmetric information between borrowers and lenders.

Finnish firms along with other European firms have suffered from slow productivity growth in the last decade. HGFs are necessary innovators that play a critical role in both productivity growth and job creation. This means it is important to have better understanding of their characteristics and financial decisions. While this paper studied SMEs, future research could focus more deeply on innovative start-ups, which are restructuring many traditional industries and creating new markets. Another interesting topic for future studies would be the differences in investments between industries.

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Appendix

Table A1. Definitions of the variables

Variable	Definitions
$HGF_{i,(t, t+3)}$	The top 10% of job creators in a 3-year period. The ranking is based on the Birch Index. Measured within years.
$Birch_{(t, s)}$	$=L_{t+3}/L_t \times (L_{t+3}-L_t)$ when determining HGFs $=L_t/L_{t-1} \times (L_t-L_{t-1})$ when using it as a control variable for past growth
long debt $ratio_{i,t}$	=(long-term debt)/(total assets)
Δlong debt $ratio_{i,t}$	=(longdebt $ratio_t$)-(longdebt $ratio_{t-1}$)
short debt $ratio_{i,t}$	=(short-term debt)/(total assets)
Δshort debt $ratio_{i,t}$	=(shortdebt $ratio_t$)-(shortdebt $ratio_{t-1}$)
equity $ratio_{i,t}$	=equity/total assets
$\ln(E_{i,t}/E_{i,t-1})$	$=\ln(equity_{i,t}/equity_{i,t-1})$
$IC_{i,t}$	Intangible capital
$IC_{i,t}/L_{i,t}$	IC per employee
total $assets_{i,t}$	The value of total assets
$slack_{i,t}$	=tangible capital/total debt
$profitmargin_{i,t}$	=net income/sales
$sales_{i,t}$	A firm’s sales
value $added_{i,t}/L_{i,t}$	=(sales-intermediates)/L
firm $age_{i,t}$	Calculated from the year the firm entered the VAT register or the year the establishment was founded, where the earlier date is used.
$L_{i,t}$	The number of employees