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The Impact of Intangible Capital on the Productivity of Small Firms

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ORIGINAL ARTICLE

The Impact of Intangible Capital on the Productivity of Small Firms

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Abstract

Despite the mounting evidence in support of the role of intangible capital on firm performance, some research gaps remain. This paper focuses on the link between intangible capital and firm performance with a particular focus on the effect firm size has on the relationship by studying the population of Slovene enterprises between 2007 and 2020. We find that while intangible assets are positively associated with productivity, the link is by no means linear. Furthermore, micro firms appear to benefit most from investing in intangible assets, while the effect is less robust for small and medium-size enterprises (SMEs) and large firms. Amongst different types of intangible assets, the strongest effect on productivity was found for investment in property rights and goodwill, while long-term deferred development costs had a weaker effect on firm productivity.

Keywords: Intangible capital, Productivity, Firm size

JEL classification: O47, L11

Introduction

Intangible capital has long been recognized as the key to strong economic performance. Over a century ago, Veblen (1908) defined intangible assets as »immaterial items of wealth, immaterial facts owned, valued, and capitalized on an appraisement of the gain to be derived from their possession.« However, measuring the intangible has been a challenge, which contributed to the delayed empirical evidence on the role of intangibles for productivity. Literature on the role of intangible assets in economic development and their contribution to economic growth, sectoral dynamics and firm performance began emerging in the 1960s and 1970s, is stressing that a notable proportion of productivity growth cannot be completely explained by standard productivity growth elements (capital and labour). Instead the literature suggests that other elements such as education, skills and R&D could explain it (Griliches, 1980, 1981; Kendrick, 1972) could play an important role. The intangible capital literature continued to develop steadily also in the 1980s and 1990s, studying for example the role of advertising, internationalization, market entry, firm valuation, goodwill, market strategy, firm competencies, firm performance and profitability.[1] But the literature gained momentum with the research of Lev (2001) and Nakamura (1999) and primarily the seminal definition of intangible capital by Corrado et al. (2006, 2009) who divided intangible capital into three broader categories, which are: (1) computerized information, (2) innovative property, and (3) economic competencies. The literature has since been developing fast, both methodologically, investigating sources of data, measurement approaches and definitions[2] as well as providing evidence of the size of the investment into intangibles

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[1] Barrett, 1986; Barwise et al., 1990; Harvey & Lusch, 1997; Hirschey, 1982; Hula, 1989; Kumar, 1987; Lefcbvre et al., 1996; Patterson & Hayenga, 1995.
[2] Awano et al., 2010; European Commission, 2014; Globalinto, 2021; Perani & Guerrazzi, 2012; Piekkola, 2011b.

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as well as their contribution to growth at national and sectoral[3] as well as firm level.[4]

While evidence on the impact of intangible capital on economic performance and productivity is already abundant, there is very scarce evidence on the role of intangible assets and intangible investments in micro, small and medium firms. Data shows that the distribution of intangible investments and assets is heavily right skewed, primarily to the benefit of large firms, while the vast majority of firms invests little or even nothing (Kaus et al., 2020). Evidence also suggests that in small and medium firms, the investment in intangible assets is very often »*minor because they tend to consider intangible investment as an inefficient cost and concentrate on investments in tangible assets*« (Seo & Kim, 2020), although also in smaller firms the intangible assets do contribute to productivity. Nevertheless, the research on the role of intangibles in micro, small and medium firms (hereinafter MSMEs) is still scarce, especially in the literature for the emerging economies.

This paper further investigates the nature of intangible assets and investments in micro, small and medium companies in Slovenia with the focus on determining the differences in the intensity of intangible investments by firm size class as well as its contribution to firm productivity, while not focusing on the aggregate intangible assets only but also providing a more detailed insight into the contribution of intangible capital components. Methodologically, the analysis relies on the population data of Slovenian companies in the period between 2007 and 2020, using their detailed financial statements data.

The paper makes several contributions to the literature. First, it adds to the understanding of the importance of intangible investments for productivity growth also in micro firms, which is from managerial and policy perspective especially important in view of the knowledge economy and knowledge-intense services, where micro and small firms are more prevalent. Second, it is to the best of our knowledge the first such regional study, focusing on the Central and Eastern Europe (CEE) or South East Europe (SEE) economy. Given the importance of the small business sector in the region, the results again make important implications also for the process of catching up with the most developed in the EU and firms maintaining their competitive positions in the global value chains. Third, it is the first study that investigates both the total intangibles as well as the components of intangible capital. The analysis also uniquely relies on a population-wide dataset which contributes to the validity and possibility to generalize the results.

In continuing, first the theoretical background is provided and research hypotheses developed. This is followed by the explanation of the empirical methodology. The results are discussed in the third section. The paper ends with a discussion and conclusions.

1 Theoretical background

1.1 Defining intangible capital

While the contribution of intangible capital to aggregate, sectoral and firm performance has been long acknowledged (Budworth, 1989; Chudnovsky, 1979; Cox, 1977; Eisner, 1978; Kendrick, 1972; Veblen, 1908), the empirical analysis gained momentum primarily with the rise of the knowledge economy (Farrell, 2003; Guthrie et al., 2001) and the seminal works of Nakamura (1999) who argued that spending on intangibles should be capitalized, since they generate future value and as such are in fact investments, and Lev (2001) who provides the first economic framework to analyse managerial and investment issues regarding intangible assets and their impact on corporate performance and market values. The literature at the time, despite struggling to provide a unified definition, predominantly focused on the contributions of R&D, brand value and economic competences (Ballot et al., 2001; Bobillo et al., 2006; Johnson et al., 2002; Leliaert et al., 2003; Lev, 2004; Lev & Sougiannis, 1996). Despite the literature usually being focused on a specific component of intangible capital, these elements established themselves as the »core« of intangibles also in the now wide-spread definition of intangibles (Corrado et al., 2006). According to Corrado et al. (2006), intangible capital comprises: 1) computerized information (computer software, computerized databases), 2) innovative capital (primarily research and development (R&D), but also other innovative expenditure), 3) economic competencies (brand equity, firm-specific human capital and organizational structure).

[3] Corrado et al., 2016; Fukao et al., 2009; Piekkola, 2011a; Roth & Thum, 2013; Tsakanikas et al., 2020.
[4] Bontempi & Mairesse, 2015; Chappell & Jaffe, 2018; Crass et al., 2015; Drenkovska & Redek, 2015; Kaus et al., 2020; Prašnikar et al., 2017; Rico & Cabrer-Borrás, 2020.

1.2 Impact of intangibles on firm performance

Measurement of intangible capital was the first obstacle in determining the link between firm productivity and intangible capital. Several options were available to comprise measures of intangible investment, from (1) industry-level data with input–output approach (Corrado, Haltiwanger, et al., 2005; Corrado, Hulten, et al., 2005; Roth, 2010, 2020) to (2) firm-level survey data (Awano et al., 2010; European Commission, 2014; Globalinto, 2021; Perani & Guerrazzi, 2012; Prašnikar, 2010) and (3) measures of intangible capital based on population administrative dataset (Ilmakunnas & Piekkola, 2014; Piekkola, 2011b). Various estimates of intangible investments have shown that the actual investment varies significantly between countries, ranging from 5 to even 13% of GDP (see for example (Roth & Thum, 2013; Tsakanikas et al., 2020; van Ark et al., 2009), however, the contribution of intangible capital to economic performance, usually measured with productivity, is strong and positive. Initial estimates showed that intangible capital contributed around a quarter of the total productivity growth in the six investigated EU economies and the US and the UK in the period between 1995 and 2006. For example, in Germany, France, Italy, Spain, Denmark and Austria, productivity grew on average by 1.32% per year and the contribution of the intangible capital deepening was 0.3 percentage points. In the US, productivity grew on average by 2.96% per year and intangible capital contributed 0.83 percentage points (van Ark et al., 2009). Also the estimates of Roth and Thum (2013) show a positive as well as robust relationship between intangibles and labour productivity growth. In addition, authors stress that incorporating intangibles into the empirical analysis helps to explain a large proportion of the unexplained variance – the latter decreases even by 51%. Corrado et al. (2018) investigate the period between 2000 and 2013 and find that during the crisis, the intangible investments were relatively resilient, while tangible investment fell. Intangible investment also bounced back relatively fast. This is consistent with the estimates of Roth (2020) who investigated in detail the behaviour of intangible investment in the period between 2000 and 2014. The results first show that the tangible investment was significantly more affected by the 2009 crisis, especially in some countries, e.g. Greece, Spain, Italy, Portugal and Slovenia. On the other hand, intangible investments declined moderately and soon regained growth. In other countries (e.g. Ireland, Austria, Germany, France and Sweden), there was only a moderate decline in 2009, but then growth resumed. The estimates also confirm that intangibles had a strong and positive contribution to productivity growth.

A number of papers at the firm level also confirm the existence of the link between intangible capital and firm productivity. For example, Kaus et al. (2020) find that firms that invest more in intangibles are more productive. They particularly stress the contribution of R&D, while software and patent investment are less important. They also identify big differences between industries and firms and stress that the impact of intangibles is more positive with firms with high focus on intangibles. Di Ubaldo and Siedschlag (2021) show using firm-level data from Ireland between 2006 and 2012 that the estimated average elasticity of productivity with respect to investment in knowledge-based capital per employee is 0.3. Nakatani (2019) studies the case of New Zealand and shows that for example the impact of R&D became more pronounced after the crisis in 2009 and also finds that an R&D tax incentive contributes to higher profitability performance.

Empirical analysis on the role of intangible capital in emerging markets is still relatively scarce, although for the European economies (new EU members) the data and analyses are indeed done within the broader analysis of the EU economies. Nonetheless, the results show that the impact of intangible investment is positive as well. Several studies were done for Latin America, Brazil, Russia, India, China and South Africa (BRICS), and China. Nadeem et al. (2017) focus on the role of intangible capital for BRICS countries and find that intangible capital is positively related to return on assets and equity as well as components of intangible capital (human, structural and physical capital). Fleisher et al. (2015) similarly show that intangible investments positively impact the performance of both domestically and foreign-owned firms in China, but also show that sectors where domestic firms invested more in intangibles have comparatively gained competitive advantage. Ivanov and Mayorova (2015) investigate the retail sector in Russia and show that besides investing in intangibles, it is also important to manage the intangible assets appropriately in order to derive competitive advantages from them. De Castro and Uhlenbruck (2018) stress also the role of privatization (predominantly the role of foreign owners) in determining the intensity of intangible investment. Vrh (2018, 2019) investigates the link between domestic value added and exports performance in Central and Eastern European Countries (CEECs) and finds a positive impact of intangible capital on

the share of domestic value added. Prašnikar and his team investigated the investments in intangible capital in Slovenia, BiH and Albania and in all three cases identify a link between firm performance and intangible investments (Prašnikar, 2010, Prašnikar et al., 2013; Prašnikar & Knežević Cvelbar, 2012), but also highlight the importance of export orientation for learning and strengthening firm's »*genetic material*« (Prašnikar et al., 2017).

1.3 Firm size and impact of intangibles

Evidence of the impact of intangible capital on firms depending on their size is currently still scarce in the extant literature. For example, Piekkola and Rahko (2019) use administrative data to measure the impact of innovation inputs, which are defined by intangible capital components. They stress that the relationship between innovative input and profitability is not straightforward – while high-market-share companies can derive more profit, those with low market shares derive less profit from new innovations. Kaus et al. (2020) finds that the distribution of intangible investment is very right-skewed, with many firms investing nothing or very little in intangible investments. They add that firms that invest more in intangible capital are also more productive. Seo and Kim (2020) show that intangible capital (human capital, advertising, R&D) is very important also for SMEs that want to be very productive. They make a very important note on the perceived lesser importance of intangibles, claiming that managers in SMEs often »consider intangible investment as an inefficient cost and concentrate on investments in tangible assets«. However, their results show that all three types of intangible capital (human capital, advertising, R&D) have a positive effect on firm profitability, with the most pronounced being the impact of advertising.

Based on the above discussion and the relevant literature at large, we take advantage of the data on the population of Slovene enterprises to (i) explore the distribution of intangible assets across firms, (ii) see how investment intensity in intangible assets is related to firm size, and (iii) explore the effect of intangible assets of performance of micro and SME firms. Given the findings of the literature, we hypothesize that:

H1. *The intensity of investments in intangible capital differs by firm size.*

Namely, given existing evidence, we expect intangible capital to be highly concentrated even when compared to fixed assets. Moreover, we expect a considerable proportion of firms to have no intangible capital at all. Given the size-threshold for investments in intangible capital, we expect micro, small and medium-sized firms to be less likely to invest in intangible capital. Those micro and SME firms that do invest in intangible assets will experience a positive performance effect.

H2. *Intangible capital has a positive impact on firm performance, however, the intensity of the contribution will be affected by firm size.*

H3. *Intangible capital components differ in importance of their contribution towards firm performance by firm size.*

The literature in this field examining the comparative importance of intangible investments by firm size is scarce, however, we follow the ideas of Seo and Kim (2020) who argue that managers in SMEs often »consider intangible investment as an inefficient cost and concentrate on investments in tangible assets«. Following the broader discussion on the role of intangibles, we nevertheless believe that some components of intangibles may be more important than other (as shown similarly by Corrado et al., 2006).

2 Research design

2.1 Data and methodology

The analysis relies on the population data of Slovenian companies in the period between 2007 and 2020 (AJPES, Agencija Republike Slovenije za javnopravne evidence in storitve, 2021a). The database comprises balance sheet and income statement data for the whole population of the Slovenian limited liability and joint stock companies, which includes depending on the year around 50–60 thousand companies. The balance sheet and financial statements data comprise also data on intangible capital as captured by the International accounting standards.

To analyse the population of enterprises, several different approaches were used. First, descriptive statistics were prepared. To study the contribution of intangible investment and assets to the productivity of firms, several categories of intangible assets were considered: total intangible assets, property rights and long-term deferred development costs. The total intangible assets, according to the International accounting standards, incorporates the following: (a) Intellectual property rights, (b)

Goodwill, (c) Active long-term deferred development costs and (d) Other intangible assets.[5] The active long-term deferred development costs are often used to incorporate R&D into the assets or capitalize the assets. In the estimations, the total intangible assets, IP and deferred development costs will be used to estimate the contribution to productivity, as these, as will be shown, represent the major parts of intangible assets.

To estimate the importance of intangible capital for firm productivity, regression analysis was used. The regressions followed the standard approach. In order to explore the impact that intangible assets have on firm performance, we focus on exploring the correlation between firm productivity and intangible assets. We estimate a relatively parsimonious production function:

$$\ln(sales)_{it} = \alpha + \beta_1 \ln(capital)_{it} + \beta_2 \ln(material\_costs)_{it} + \beta_3 \ln(employ)_{it} + \beta_4 Int\_cap\_sh_{it} + \beta_5 exp_{it} + \gamma I + \delta T + \varepsilon_{it} \quad (1)$$

where $sales_{it}$, $capital_{it}$, $material\_costs_{it}$ and $employ_{it}$ are sales revenue, fixed assets and expenditure on materials and services (all in EUR), respectively, while $employ_{it}$ is the average number of full-time employees. exp_{it} is the exporting status indicator (which takes on value "1" for firms with positive export sales and "0" for firms with no export sales). Depending on specification, Int_cap_sh[6] captures either the existence of different types of intangible assets at the firm level with an indicator variable for firms with positive (i) assets in long-term property rights, (ii) assets in goodwill, and (iii) assets in long-term deferred development costs or the share of individual components (i)-(iii) in total assets. We also control for time (T) and industry (I) fixed effects in all specifications. ϵ_{it} is the error term. Given the likely high correlation between components of intangible assets, we estimate (1) separately for each of the three regressions. While our benchmark estimates rely on the OLS estimator, we also control for (unmeasurable) time-invariant firm-specific factors by estimating a fixed-effects version of model (1).

2.2 Data

In total, the database contains roughly 850 thousand observations over the period of 14 years. The average observed company had 7.75 employees, while the median was much lower with only 1 employee. Average sales were at 1.3 million euros per company, with 50% of the companies selling 70 thousand or less. On average over the entire period, the observed value added per employee was 34.5 thousand euros, while median company only had value added of around 23 thousand euros per employees. Table A1 provides further detail about the basic descriptive variables.

3 Results

3.1 Characteristics of intangible investment in Slovenian firms

3.1.1 Size structure of the observed population

The analysis focuses on limited liability or joint stock companies (and excludes self-proprietors). These represent around 50% of the total population of Slovenian companies.[7] The observed population of companies comprised predominantly micro companies, which represented between 87 and 90% of the observed population (Fig. 1). Small and medium companies with 10–199 employees represented around 10% of the population, while the 300 large companies represented only around 0.5% of the population. On average, the observed micro companies had in 2020 1.6 employees with average company sales of almost 300 thousand euros. Small and medium companies had on average 32.7 employees with average yearly sales of 5.95 million and the large companies on average had 602 employees and sales of 249 million euros (details provided in Table A1).

3.1.2 Intangible assets by firm size

On average, in 2020 around 70% of all companies reported no intangible assets. The shares and their

[5] The companies according to the International accounting standards (IFRS, 2021) report these four categories of intangible assets. For an asset to be recognized as an intangible asset by accounting standards, it must be measurable and must bring future benefit. It is acknowledged also that "intangible asset is an identifiable non-monetary asset without physical substance" (IFRS, 2021). All four variables are categories in the financial statements of companies and represent sub-categories of "intangible assets". Since these are the officially reported values to the tax-auditors, the data represent a source of most reliable data on officially reported intangibles. Intangible categories represent the following accounting categories: (a) Intellectual property rights (AOPT05), (b) Goodwill (AOPT06), (c) Active long-term deferred development costs (AOPT06) and (d) Other intangible assets (AOPT08). Total intangible assets are provided in the balance sheet category AOPT04.

[6] The shares are calculated as the share of total or intangible asset component as share/compared to total assets (accounting category AOPT01).

[7] While the number of self-proprietors is large (50 of 120 thousand in 2020), their relative economic importance is small. On average, they have 0.7–0.8 employees, but 2/3 have no employees. In 2019, the largest companies, which represent around 0.2% of all companies (including self-proprietors) contributed in total to around 1/3 of total employment and 1/3 of total revenue in the economy. Medium companies contributed the last third.

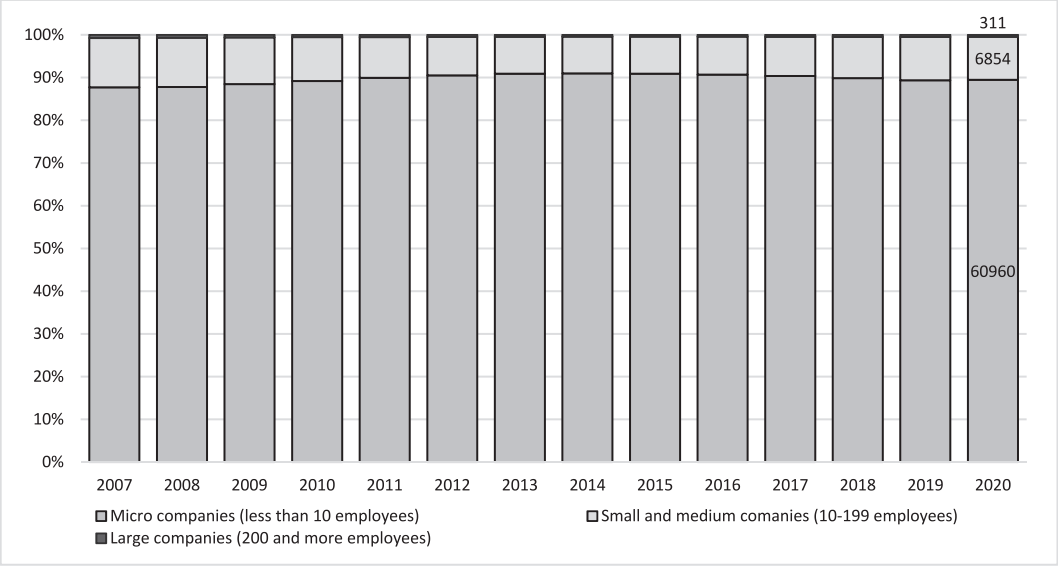

Fig. 1. Number of observed companies by size. Source: AJPES data and own calculations.

absolute number have been increasing since 2006. If in 2007 the share of firms with no intangible capital was 55.6%, the share rose to 70.5% by 2020. This can be explained by the increase in the share of MSMEs in the total number of firms (Fig. 1) and the fact that MSMEs are less likely to invest in intangible assets, in particular micro companies (Fig. 2). Even 74.5% of micro firms had no intangible assets in 2020. As companies grow, they also invest into intangibles – as the share of the SMEs with no intangibles is

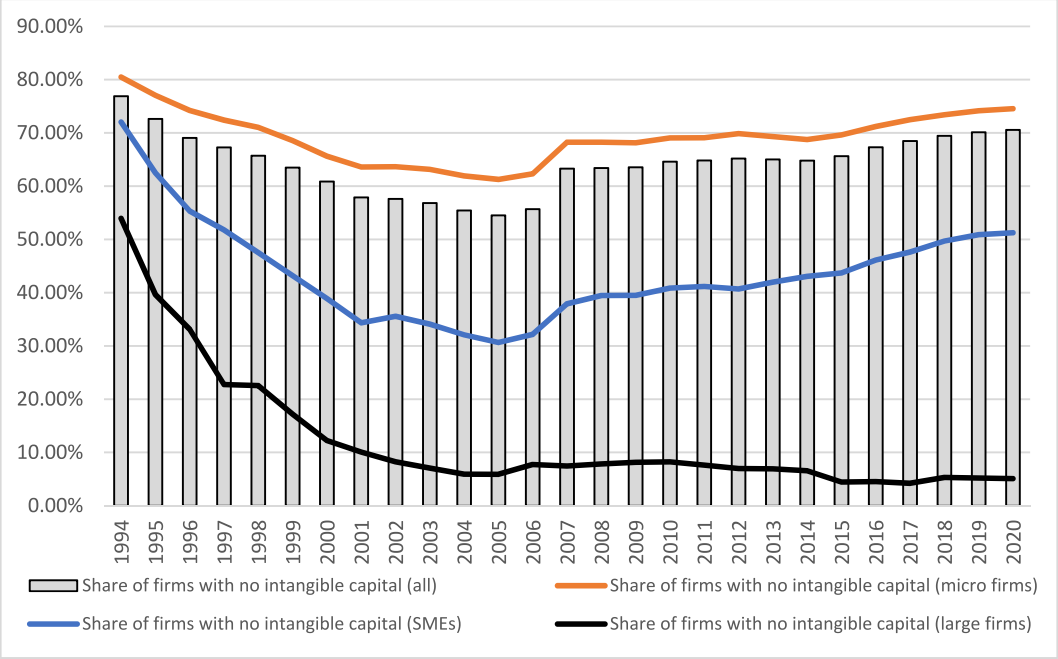

Fig. 2. Share of firms with no intangible capital by firm size. Source: AJPES data and own calculations.

»only« 54%. Intangible investment in Slovenia is comparatively most important in large firms. Since 2001, the share of large firms with no reported intangible assets has declined from 10 to 5%. Knowing that there are around 300 large firms, this implies around 15 large companies with no reported intellectual property rights, goodwill, active long-term deferred development costs or other intangible assets. For example, in 2020, there were 5 such companies in manufacturing and 3 in retail (NACE G) and 3 in NACE N, in total 16 such companies.

The share of intangible capital in total assets in Slovenia was increasing rapidly between 1994 and 2005. In 1994, the share of intangible capital represented about 3.4% of all firm assets. By 2005 it reached 4.8%. This was a period of fast growth in Slovenia, economic transformation and accession to the EU (2004). Between 2006 and 2007 economic growth as well as investments accelerated, but due to the focus on tangible investment, primarily investments into »core« activities (Griliches, 1980; Griliches & Mairesse, 1995; Kendrick, 1972), the share of intangible assets in total firm assets declined. The period during and after the 2009 crisis was marked with a general decline in investment rate. The share of investments in GDP declined from even 29.4% in 2008 to around 19% on average (Statistični urad Republike Slovenije, 2022). While the tangible investments declined significantly, which was particularly evident in Slovenia, the share of intangible investments remained relatively stable (Roth, 2020). The investment cycle in Slovenia, especially in terms of tangible investments, was determined primarily by the investment dynamics in large firms (Prašnikar, 2010, 2012). The granularity seems to be a major factor driving also intangible investments, in addition, the relationship is not as straightforward as in the case of tangible investments, where the investment was significantly more pronounced in large companies. Intangible assets in large firms represented around 5% of assets on average after 2008, and the share was increasing ever since. In small and medium companies and in micro companies, the share of intangible assets were declining. If in 2005 the share was at around 5%, it declined to only 3.2% by 2020 (Fig. 3). Especially in micro companies, the decline is sharp in the period 2005–2007, which marks the process of strong investment cycle in tangible capital (Bole et al., 2018). In addition, the decline can be perceived by the bias of micro, small and medium companies towards tangible investments, as the intangible is perceived as less efficient (Seo & Kim, 2020).

A closer look into the structure of intangible assets (Fig. 4) reveals that micro firms invested on average the least in all three categories of intangible assets: goodwill, property rights and deferred development costs. For example, in terms of development costs, micro companies on average had an about 3 times

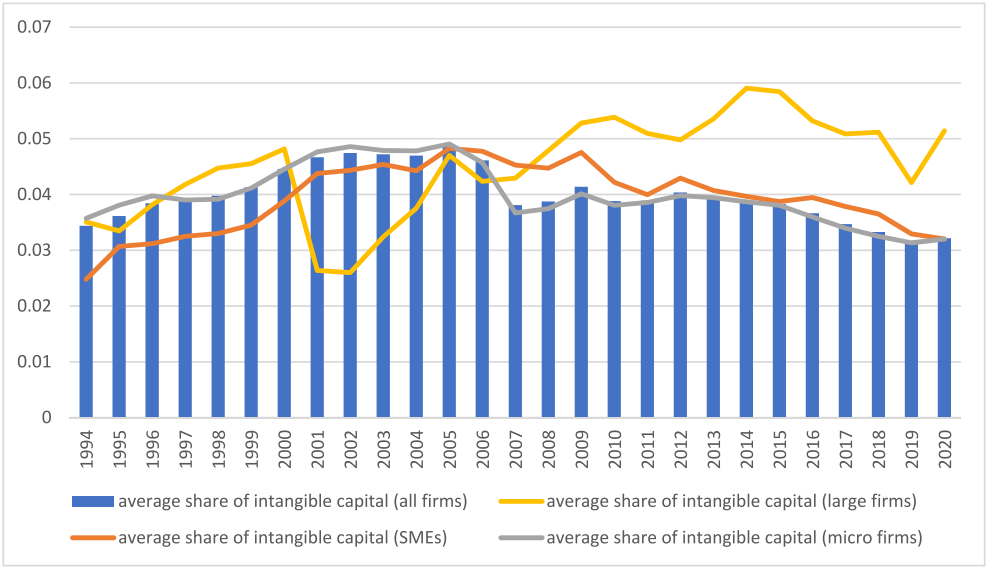

Fig. 3. The share of intangible capital as percent of fixed assets, 1994–2020. Source: AJPES data and own calculations.

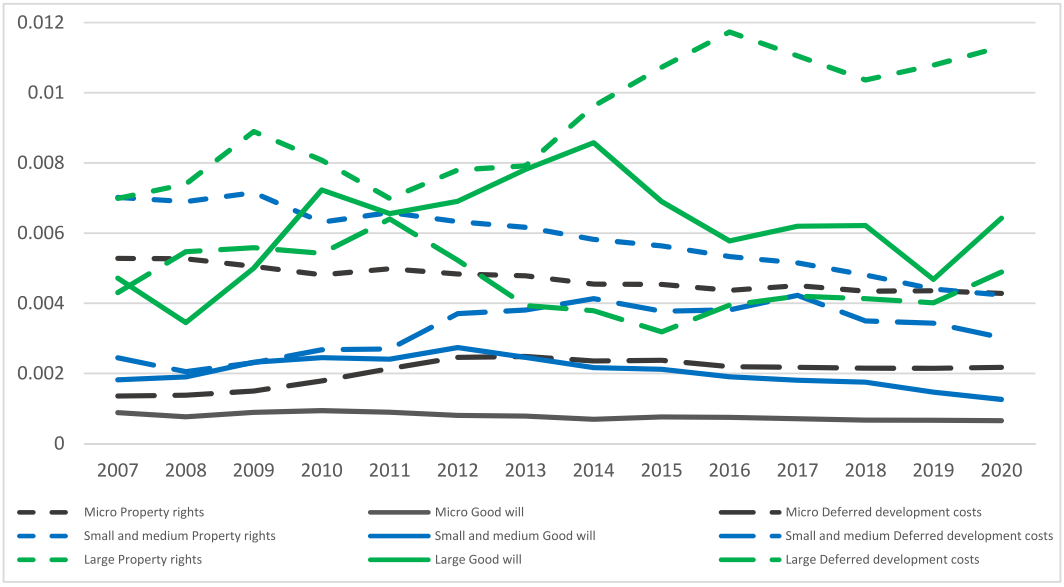

Fig. 4. The share of intangible capital as percent of fixed assets by type of intangibles, 2007–2020. Source: AJPES data and own calculations.

lower share of development costs as share of assets in comparison to small and medium companies in the entire observed period between 2007 and 2020: 0.21% of all assets in micro companies in comparison to 0.32% in small and medium and about 0.46% in large companies. Property rights in the observed period on average represented about 0.47% in micro companies, 0.57% in small and medium and 0.92% in large companies. The difference is most striking in the case of goodwill, which in micro companies represented just 0.076% of assets, 0.2% in small and medium companies and 0.61% in large companies. Fig. 3 also reveals the trends. The share of intangible assets in the case of all three investigated categories was relatively stable since 2011 for micro companies. In the case of small and medium companies, the share of goodwill has been declining slightly, the share of property rights was also declining steadily, while the development costs increased significantly between 2007 and 2011, but then remained at the new higher level. In the case of large companies, the most notable trend is the fast increase in the share of property rights. The differences in the intangible capital by type as share of all assets are highly statistically significant in all cases ($p < 0.000$), only the significance of the differences in the development costs between small and medium and large companies are significant at 0.0032.

3.2 Intangible assets and firm productivity

Generally, intangible capital has been shown to positively impact productivity of firms as well as drive productivity growth at industry and national level (Corrado et al., 2019, 2018; Piekkola, 2011a; Tsakanikas et al., 2020). The literature on intangible assets and their contribution to productivity suggests also that intangible assets, although often neglected in MSMEs, also significantly contribute to firm performance (Rico & Cabrer-Borrás, 2020). The distribution of value added by firms depending on intangible capital and type of intangible capital (Fig. 5) shows that in general in 2020 value added per employee was the lowest in companies with no intangible capital (median value for companies with intangible capital statistically significantly higher). Similar is true also if firms have either property

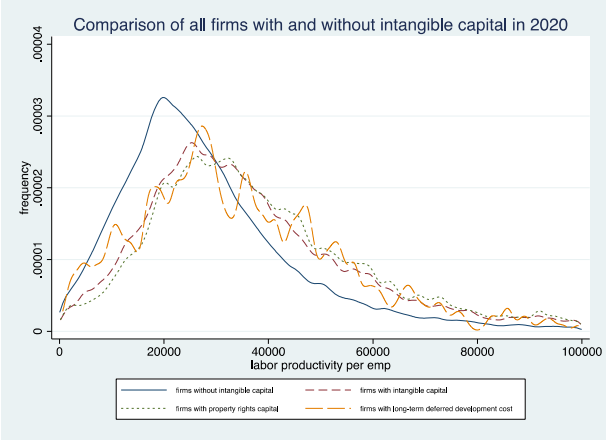

Fig. 5. Value added per employee in firms with and without intangible capital. Source: AJPES data and own calculations.

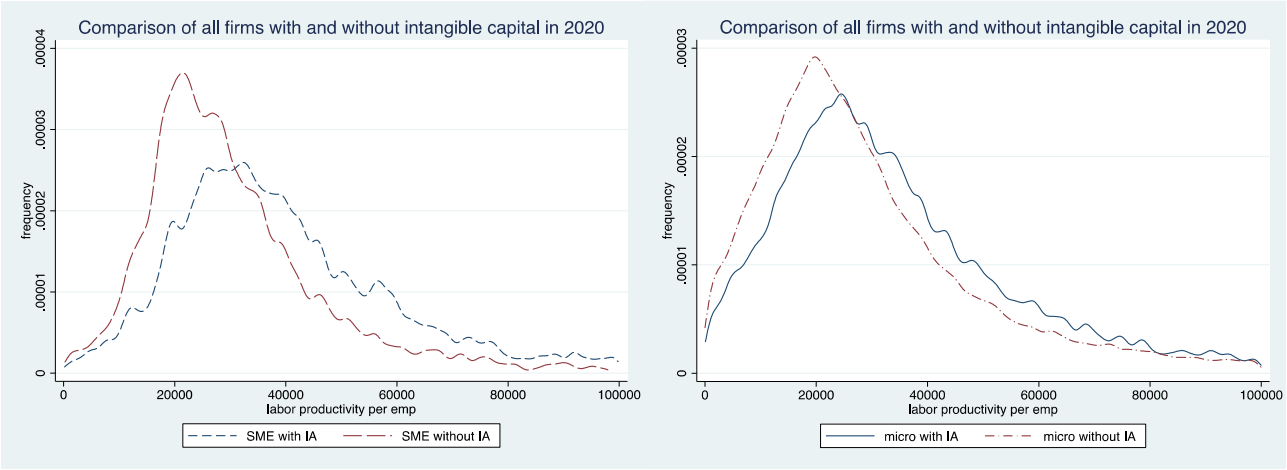

Fig. 6. Value added per employee in firms with and without intangible capital by firm size for micro and small and medium companies. Note. *Distributions for large companies are not shown, as there are only 16 large companies with no intangibles in 2020. Source: AJPES data and own calculations.*

right, or long-term development costs. These are investigated in more detail below.

Intangible assets were a characteristic of firms with higher value added also if firm size was controlled for (Fig. 6). The distribution of value added per employee in small and medium companies with intangible assets had larger median than in firms with no intangible assets (left panel, Fig. 4, $p = 0.000$). Similar is true also for micro firms (right panel, $p = 0.000$). The distribution for large firms is not depicted, due to the small number of firms (16) with no intangible assets.

Besides value added per employee (i.e. productivity), intangible capital also has a positive correlation with employment and relative size of capital (in comparison to industry average) (Figs. 4 and 5). Fig. 7 depicts the distribution of the relative size of firm capital (relative to the respective annual industry average) for (i) firms with no intangible capital, (ii) firms with intangible capital, (iii) firms with an above average share of intangible capital (in the respective industry) and (iv) firms with at least twice the average share of intangible capital. As expected, the distribution relative capital of firms with intangible capital stochastically dominates that of firms with no intangible capital. On the other hand, firms with an above average share of intangible capital appear to be relatively smaller (compared to the average firm with intangible capital), while relative capital of firms with twice the

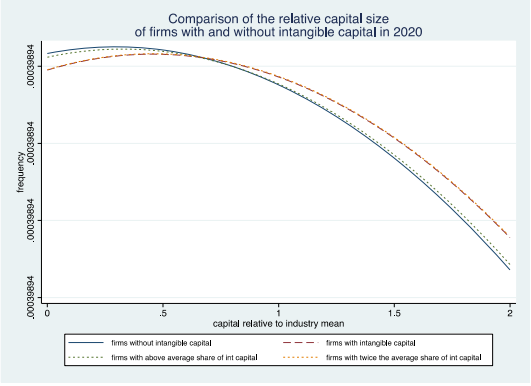

Fig. 7. Relative size of capital of firms with and without intangible capital in comparison to industry average in 2020. Source: AJPES data and own calculations.

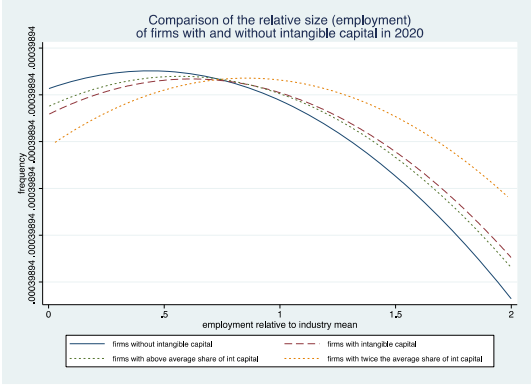

Fig. 8. Relative size of firms with and without intangible capital in terms of employment in comparison to industry average in 2020. Source: AJPES data and own calculations.

average share of intangible capital only marginally exceeds that of all firms with intangible capital. This confirms our finding that a critical size of firm capital is key for effective use of intangible capital and that the effect of the share of intangible capital on firm performance is likely not linear.

Fig. 8 looks at the relative size of firms with respect to employment by focussing on the same for cohorts as above. As was the case with the relative size of capital, firms with intangible capital tend to employ more than those without intangible capital. There is a substantial difference in terms of the size of firms with at least twice the average share of intangible capital compared to the average firm with intangible capital, while firms with above average shares of intangible capital perform slightly worse than firms with intangible capital. Again, it is obvious that the effect of intangible capital on employment is not linear.

The association between intangible capital and firm performance indicators (size and productivity) is clearly strong, but is also likely to be non-linear. While firms with intangible capital tend to also be larger and more productive than those without it, the share of intangible capital does not (linearly) predict either size or productivity. A closer look at the correlation between firm performance and availability of intangible capital is needed with a special focus on the effect firm size has on the relationship. In order to gain further insight into the differential effect of firm size on the link between intangible capital and firm performance, we focus on regression analysis next.

3.3 Regression analysis

To determine the impact of intangible investment on firm performance, a standard productivity approach was used, as described by equation (1). To measure intangible capital and its impact, the components of intangible capital were used: (a) Intellectual property rights, (b) Goodwill, (c) long-term deferred development costs and (d) their totals (property rights and long term deferred development costs, property right, goodwill and long term deferred development costs).[8]

The estimates presented in Table 1 show that, in addition to the standard production-function determinants of firm output (capital, material costs and employment), intangible assets also positively affect firm sales. While the effect of intangible assets on sales is generally positive, it is only significantly different from zero in case of total intangible assets share (column 5), the share of property rights (column 1) and the share of property rights and long-term deferred development costs (column 4). Ownership of property rights on intellectual property in particular appears to be highly correlated with firm productivity,[9] while long-term deferred development costs and goodwill, while positive, are not significantly correlated with firm productivity. This may be an indication of the fact that goodwill mainly reflects the difference between the market value of the firm and its book value, which may not have an immediate effect on firm productivity, while long-term deferred development costs may serve as an accounting catch-all category for development projects of longer duration, which, again, may cause a lack of correlation with current productivity.

In addition, we find a strong negative correlation between the squared term of intangible asset shares and firm productivity in all specifications. This indicates that the impact of intangible capital on firm productivity displays decreasing marginal productivity after a threshold level of intangible capital has been exceeded.

If we split the sample by firm size into micro firms (less than 10 employees) and SMEs (between 10 and 200 employees), we get a clearer picture of the differential impact of firm size on the respective elasticity of intangible assets. As before, due to the very small population of large firms with no intangible assets, we do not show the estimates for the subsample of large firms. Micro firms are revealed to have the strongest association between the share of intangible assets and firm productivity. Both property rights and goodwill are revealed to have a strong positive effect on productivity, with the effect being decidedly non-linear. Given the relative share of micro firms in the population of Slovene enterprises, it is clear that the full sample correlations are primarily driven by micro firms. SMEs (columns 6–10) generally exhibit weaker correlations, which are in most cases insignificant. The only exception is the long-term deferred development costs which show a weakly significant negative correlation with firm productivity.

[8] The category »Other intangible assets« was excluded from the regression analysis, due to concerns with the quality of data – only around 5000 companies in total reported the »other« category, with high volatility. In addition, the »other« category is much less clearly defined and includes for example also emission coupons, value corrections (Agencija Republike Slovenije za javnopravne evidence in storitve, 2021b) and as such does not represent the intangible capital this analysis is interested in.

[9] After controlling for the impact of production-function determinants in the regression of firm sales, the remaining determinants effectively explain firm productivity.

Table 1. Regression results on the contribution of intangible capital to firm performance (fixed-effects estimates).

VARIABLES	All companies					Small and medium companies					Micro companies				
	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Ln(material costs)$_{it}$	0.698***	0.697***	0.698***	0.697***	0.697***	0.648***	0.648***	0.648***	0.648***	0.648***	0.708***	0.708***	0.707***	0.708***	0.707***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Ln(capital)$_{it}$	0.017***	0.017***	0.017***	0.017***	0.017***	0.017***	0.017***	0.017***	0.017***	0.017***	0.016***	0.016***	0.017***	0.016***	0.016***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Ln(employment)$_{it}$	0.295***	0.295***	0.295***	0.295***	0.295***	0.348***	0.348***	0.348***	0.349***	0.349***	0.280***	0.280***	0.280***	0.280***	0.280***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Share of property rights $_{it}$	0.042**						0.014					0.049**			
	(0.019)						(0.030)					(0.024)			
(Share of property rights)$^2_{it}$	−0.062**						−0.027					−0.060**			
	(0.024)						(0.041)					(0.029)			
Long-term deferred dev. cost share		0.001						−0.086*					0.002		
		(0.039)						(0.045)					(0.054)		
(Long-term deferred dev. cost share)^2		−0.103**						0.001					−0.077		
		(0.048)						(0.062)					(0.064)		
Share of goodwill			0.044						−0.098					0.283***	
			(0.061)						(0.062)					(0.098)	
(Share of goodwill)^2			−0.142*						0.107					−0.431***	
			(0.075)						(0.084)					(0.113)	
Share of property rights and long-term deferred dev.cost				0.035**		−0.033					0.045**				
				(0.018)		(0.026)					(0.022)				
(Share of property rights and long-term deferred dev.cost)^2				−0.078***		−0.001					−0.073***				
				(0.022)		(0.035)					(0.027)				

(*continued on next page*)

Table 1. (continued)

VARIABLES	All companies					Small and medium companies					Micro companies				
	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$	$Ln(sales)_{it}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Share of property rights, goodwill and long-term deferred dev.cost					0.031*					−0.048**					0.053**
					(0.017)					(0.024)					(0.022)
(Share of property rights, goodwill and long-term deferred dev.cost)^2					−0.077***					0.021					−0.088***
					(0.021)					(0.032)					(0.026)
Export-status	0.033***	0.033***	0.033***	0.033***	0.033***	0.003	0.003	0.003	0.003	0.003	0.040***	0.040***	0.040***	0.040***	0.040***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Small and medium size dummy (micro is base)	−0.002	−0.002	−0.002	−0.002	−0.002										
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)										
Large companies dummy (micro is base)	0.022**	0.022**	0.022**	0.022**	0.022**										
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)										
Constant	3.495***	3.495***	3.495***	3.496***	3.496***	4.147***	4.145***	4.146***	4.145***	4.147***	3.446***	3.445***	3.446***	3.445***	3.446***
	(0.258)	(0.258)	(0.258)	(0.258)	(0.258)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(0.272)	(0.272)	(0.272)	(0.272)	(0.272)
Observations	352,319	352,319	352,319	352,319	352,319	80,996	80,996	80,996	80,996	80,996	267,044	267,044	267,044	267,044	267,044
R-squared	0.790	0.790	0.790	0.790	0.790	0.816	0.816	0.816	0.816	0.816	0.752	0.752	0.752	0.752	0.752
Number of enterprises	54,447	54,447	54,447	54,447	54,447	12,858	12,858	12,858	12,858	12,858	48,852	48,852	48,852	48,852	48,852
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note. Standard errors in parentheses, ***p < 0.01, **p < 0.05, *p < 0.1.

The econometric results highlight the importance of intangible assets for micro firms. Comparing these results to the characteristics of intangible investments in micro data highlights an interesting pattern. The share of companies that do invest in intangible assets is the smallest among micro companies, since only around 30% of micro companies invest in intangible assets. However, those that do invest have a statistically significant impact on firm performance, which is in fact even stronger than in large firms. Sectoral impacts have been controlled for.

In summary, the impact of intangible capital on firm productivity appears to be very heterogeneous both across firm size, share of intangible capital as well as the amount of capital a firm has[10]. While smaller firms appear to experience a bigger boost to productivity by investing in intangible capital, the effect tends to dissipate somewhat as the share of intangible capital exceeds the threshold value. On the other hand, firms with more capital tend to experience a stronger association between share of intangible capital and productivity.

4 Discussion and conclusion

Intangible capital in its many incarnations has long been seen as the key factor in a firm's ability to generate value added, improve its market power and provide long-term profitability. While there is ample empirical evidence in support of the positive long-term impact of intangible capital on firm productivity and efficiency, the evidence is mainly focused on medium-sized and large firms and firms in mature Western markets.

This paper aims to fill the empirical gap in the literature by focusing on the hitherto underexplored data for a former transition country and focus on the effect of firm size on the link between intangible capital and firm performance. Our findings indicate that micro firms with at most nine employees experience the strongest positive association between intangible capital and firm performance, while the effect is less robust for SMEs or large firms. The effect itself is highly nonlinear as its marginal impact tends to weaken after a certain threshold intensity of intangible assets has been passed. Furthermore, not all forms of intangible assets have proven equally effective. Property rights, in particular, and goodwill to a lesser extent have been shown to have a positive correlation with firm performance, while long-term deferred development costs have been revealed to be less effective.

Our findings lead to some potential policy implications. Firstly, in studied industries, small and capital intensive firms were found to benefit most from investing in intangible assets. Stimulating investment in intangible assets would enable firms on the margin to bridge the financing gap and, by making the investment in intangible assets, provide themselves with long-term growth potential. Secondly, policies stimulating investment in (intellectual) property rights in particular would seem to be most beneficial. Investment in long-term deferred development costs are found to be the least effective as short-term productivity determinant. Potentially, given a long enough horizon, long-term deferred development costs may impact productivity long term. Lastly, policies stimulating investment in intangible assets should take account of the fact that they display decreasing marginal effectiveness once a threshold level of investment has been exceeded.

The research results may also be limited due to the nature of data and not directly comparable to those that follow the Corrado et al. (2006) definition. Intangible assets, as measured by the International accounting standards, incorporate the 4 categories used in this analysis. According to the accounting standards, much of the actual intangible investments would be considered as cost. Consequently, in the future it may be interesting to repeat the estimation using a different, possibly survey dataset. Second, intangible capital interestingly has a pronounced impact in micro companies. A more focused, detailed analysis of micro companies, possibly using a mixed-methods approach, could help understand the results better.

Conflict of interest

The authors declare there is no conflict of interest.

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[10] Regressions results where the sample was split between the top and bottom quartiles of capital distribution indicate that firms with more capital (top quartile) are likely to experience a positive effect of intangible capital on productivity, while firms in the bottom quartile show no significant correlation. These results were omitted from the paper for the sake of brevity and are available from the authors upon request.

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Appendix

Table A1. Descriptive statistics for sales, and number of employees for the studied companies by company size.

	Micro					Small and medium					Large				
	Sales		Employment		Number of firms	Sales		Employment		Number of firms	Sales		Employment		Number of firms
	Mean	SD	Mean	SD	Count	Mean	SD	Mean	SD	Count	Mean	SD	Mean	SD	Count
2007	282423	1544435	1.72	2.18	42798	5373559	20300000	35.46	34.90	5612	82629458	180000000	611.61	967.34	371
2008	287823	1662963	1.70	2.18	45645	5800472	23800000	35.18	34.90	5998	88550199	207000000	610.82	985.20	354
2009	238587	1291864	1.66	2.15	47686	4993208	18600000	34.86	35.11	5895	85360030	188000000	617.49	999.38	316
2010	249073	1529414	1.59	2.10	49716	5376143	21800000	34.69	34.69	5717	85373909	158000000	611.26	949.19	301
2011	249129	1605428	1.53	2.08	51986	6117703	30000000	34.59	34.40	5512	94409649	219000000	597.38	853.65	300
2012	242748	1661560	1.40	2.06	54070	6500910	39600000	34.73	34.93	5370	96615010	236000000	604.21	834.59	286
2013	234678	1770631	1.39	2.03	55734	6469627	35300000	34.44	34.75	5305	98927396	243000000	607.31	859.78	273
2014	238485	1636268	1.42	2.02	57852	6378389	32600000	33.80	34.07	5465	102000000	248000000	608.87	864.99	273
2015	243094	1463876	1.46	2.04	59296	6360349	35500000	33.57	34.15	5649	104700000	241000000	619.91	862.73	269
2016	264514	2978791	1.52	2.07	59492	6232144	33000000	33.21	33.68	5825	102100000	240000000	611.19	836.75	286
2017	281826	2749487	1.56	2.10	60061	6291159	31200000	33.11	33.34	6106	116200000	301000000	610.66	814.01	303
2018	302747	3353227	1.60	2.13	59976	6406240	30200000	33.00	32.90	6454	118700000	317000000	609.75	800.39	319
2019	318832	4535272	1.63	2.15	60023	6349720	31700000	32.79	32.64	6832	116300000	288000000	611.55	804.90	323
2020	296746	3559891	1.62	2.13	60960	5949038	30400000	32.63	32.67	6854	111400000	249000000	602.97	795.68	311