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Intangible Assets in Finnish Business

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Abstract

This working paper investigates intangible investments in Finnish firms from 2014 to 2019, utilizing comprehensive, register-based data from Statistics Finland. We analyze seven categories of internal intangible investments and observe that these investments are highly concentrated, with the top 10% of investors accounting for approximately two-thirds of the total. However, this concentration is comparable to that of employment, value added, and tangible investments. Firms that invest in intangibles generally exhibit higher productivity levels. Specifically, organizational capital and new financial products demonstrate a positive and statistically significant correlation with labor productivity. These findings highlight the significance of intangible investments for firm performance and offer insights into their distribution patterns within the Finnish business sector.

Tiivistelmä

Suomessa toimivien yritysten aineettomat investoinnit

Tässä työpaperissa tarkastellaan Suomessa toimivien yritysten aineettomia investointeja vuosina 2014–2019 hyödyntäen Tilastokeskuksen kattavia rekisteripohjaisia aineistoja. Analysoimme seitsemää yrityksen sisäisten aineettomien investointien kategoriaa ja havaitsemme, että nämä investoinnit ovat varsin keskittyneitä: investoijien suurimman 10 prosentin osuus kattaa noin kaksi kolmasosaa yritysten kaikista aineettomista investoinneista. Tämä keskittyminen on kuitenkin verrattavissa työllisyyden, arvonlisäyksen ja aineellisten investointien vastaavaan keskittymiseen. Aineettomia investointeja tekevät yritykset ovat yleensä myös tuottavampia. Erityisesti organisaatiopääoma ja uudet rahoitustuotteet korreloivat positiivisesti ja tilastollisesti merkittävästi työn tuottavuuden kanssa. Tämän työpaperin havainnot korostavat aineettomien investointien merkitystä yritysten menestymiselle ja tarjoavat tietoa niiden jakautumisesta yrityssektorilla.

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Keywords: Intangible investments, Finnish firms, Labor productivity, Concentration

Asiasanat: Aineettomat investoinnit, Suomalaiset yritykset, Työn tuottavuus, Keskittyminen

JEL: D22, L25, O32, O34

1. Introduction

Corrado et al. (2022, p. 4) state that "… understanding modern firms and indeed modern economies requires broadening the concept of capital beyond tangible assets to include intangibles, and that research and development spending is not the only way to capture intangible capital investments are outlays expected to yield a return in a future period."

This observation has motivated the "Intangibles as drivers of change and renewal: Firm dynamics underlying the next stage of the knowledge economy" -project (InChange) by Business Finland and ETLA Economic Research. The InChange project is largely based on the pioneering work of Corrado et al. (2005) in measuring intangible investments and accumulated capital stocks but its primary focus is at the level of a firm.

This working paper documents and analyzes the core data of the InChange project (other contributions of the project include Hildén & Rouvinen, 2024; Hyytinen et al., 2025; Koski, 2025; Koski, Pajarinen, et al., 2024a, 2024b; Kässi, 2025; Lähdemäki & Kuusi, 2025; Pikka, 2024; Rouvinen, 2025; Rouvinen, Breznitz, et al., 2025a, 2025b).

Ideally, intangible capital stocks accumulated via a series of investments would be measured at market values – reflecting the stocks' future earning potentials. In practice, measuring intangibles is mostly cost-based.[1] This is the case also in the context of this working paper.

The cost-based approach first makes a general assumption (that oftentimes does not vary by industry or firm) about what proportion of an expenditure constitutes an investment, and then an assumption about the rate at which the capital stock depreciates or loses value (again, often without firm or industry variation). After deflating a nominal investment series, the real capital stock can be calculated as a net present value using the perpetual inventory method.[2]

A common sub-type of cost-based measurement is based on the wages of occupational groups. This may include considering labor-related fringe benefits and overhead costs as well as using a coefficient that describes how the work performed by an occupational group is divided between immediate use and investment. Instead of wages, hours worked could also be used as a measure, in which case the quality of the labor input would not be valued.

In principle, intangible investments and capital stocks at the firm, industry, and national economy levels should sum up seamlessly from finer to coarser levels. Roth et al. (2023,

[1] In some cases, intangible rights such as patents or trademarks are also measured. They may be considered intermediate outputs in our context.

[2] A further complication here is "catching up" to the correct level, although with the afore-mentioned assumptions, this is easy in the case of long time series – at the firm level, however, questions arise regarding the correct level for a new or young firm, and whether capital stocks should adjust with employee turnover.

p. 265, two references in the original omitted) present quite harsh criticism in this regard in stating that their "… micro-evidence contrasts with patterns in intangible capital investments for Germany derived from the existing international datasets at the macro- and sectoral level, such as e.g. the evidence from the INNODRIVE and the harmonised EU-KLEMS 2019 datasets." Their working paper version (Roth et al., 2021, p. 5, a reference in the original omitted) makes a further observation that is omitted from the final version: "This calls into question whether intangible capital is being measured validly in these databases, and whether the intangibles that have not been incorporated into the national accounts would need to be constructed from micro-data, as proposed by the GLOBALINTO project. Our findings justify future research along these lines."

The Corrado et al. (2005) research tradition followed in the InChange project primarily operates at the level of a nation-states or broad industries. However, the focus of the InChange project is on the level of a firm. Our companion contribution (Rouvinen, Kässi, et al., 2025) reviews firm-level literature on intangibles in some detail, so we make only a few observations here.

Previous research consistently shows that firms investing more in intangibles are more productive (Añón Higón et al., 2017; Belitz et al., 2018; Bloch et al., 2023; Cincera et al., 2020; Crass & Peters, 2014; Di Ubaldo & Siedschlag, 2021; Ilmakunnas & Piekkola, 2014; Mouel & Schiersch, 2024; Piekkola, 2020, 2024; Roth et al., 2023; Thum-Thysen et al., 2021). A key challenge in all these studies is identifying causality. Nevertheless, both theoretical reasoning and empirical studies, which better capture causality by utilizing panel data, suggest that intangible investments indeed cause firm-level productivity.

Another quite consistent observation from the literature is complementarity across subcategories of intangible investments. In other words, at the firm level, the best results are typically achieved by combining, e.g., R&D, skilled labor, and sales and marketing efforts (Añón Higón et al., 2017; Crass & Peters, 2014; Piekkola, 2020). Similarly, the full benefits of software and data are realized only when combined with organizational change and tangible infrastructure (Thum-Thysen et al., 2021).

A third observation from earlier literature is that intangible investments do not benefit all firms – at least not to the same extent. Their usefulness at the firm level is related to the characteristics of both the firm itself and its operating environment.

A difficult aspect of intangibles from a policy perspective is that, while one firm's investments do support others' investments on the "input side" (via spillovers and externalities), they reduce the profitability of investments on the "output side". This occurs not only because successful investments by competitors erode the returns on one's own investments when competing in the same markets but also because one's own new discoveries replace one's old discoveries. Due to scalability and other characteristics of intangibles (Haskel & Westlake, 2017), they are associated with a "winner-takes-all/most" market dynamic, which leads to market concentration and thus ultimately to the fading of incentive and pricing benefits associated with fierce competition (De Ridder, 2024; Mouel & Schiersch, 2024).

2. Data

In the construction of intangible investment categories, we aim to follow the guidelines of the EUKLEMS & INTANProd database documented by Bontadini et al. (2023). Thus, as in the analytical module of the EUKLEMS & INTANProd database, we consider 8 categories of intangible investment:

1. Computer software and databases (Soft_DB),
2. Research and development (RD),
3. Entertainment & Artistic Originals (OIPP),
4. New Financial Product (NFP),
5. Design,
6. Organizational Capital (OrgCap),
7. Brand,
8. Employer provided training (Train)

The first three categories above are also reported in the National Accounts System as intangible capital services.

In addition, we aim to divide each category of intangible investment into own-account (*internal*) and purchased (*external*) components.

In defining internal intangible investments, we rely on an occupation-based approach, apart from (a) entertainment and artistic originals and (b) employer-provided training categories. In the occupation-based approach, we aim to define relevant occupations that reflect the type of intangible investment made in each category. The advantage of this approach is that it is based on nationwide employer–employee register data, including essentially all firms and their workers in Finland.[3]

To define the list of occupations for each intangible investment category, we rely on definitions from earlier studies and our own assessments:

- For computer software and databases, we utilize the list of Koski, Anttila, et al. (2024, Table 1, p. 43).
- For R&D, we use Statistics Finland's occupation list for the socio-economic group 32, that is, senior officials and employees in research and planning.[4]
- Regarding the categories of new financial products and design, we did not find any relevant lists from previous research, which is why occupations in these categories are based on our assessment.

[3] Another possibility would be to use R&D surveys and other survey-based data, but the sample sizes are typically only a few thousand firms or even fewer, and there may also be a remarkable rotation of firms (at least in the smaller end) involved in surveys in different years, which impairs the usefulness of these data sources for firm-level analysis and comparisons over time.

[4] The occupation list is available at *https://stat.fi/fi/luokitukset/corrmaps/ammatti_1_20100101%23sosioekon_asema_901_20110901*, and metadata on the classification of socio-economic groups at *https://stat.fi/en/luokitukset/sosioekon_asema/sosioekon_asema_1_19890101?code=32*.

– Occupations in the organizational capital category are derived from Piekkola (2020, Appendix A, p. 667-668).
– Finally, occupations regarding brand category are based on Bontadini et al. (2023, Box 2, p. 28).

In the estimation of internal components based on occupation, we use the sum-of-costs approach. We measure intangible investment as the fraction of wages paid to workers in each category. Following Bontadini et al. (2023), we allocate into intangible investments 15% of wages of workers in managerial positions, and 50% of wages of workers in professional positions, respectively. In addition, for occupations belonging to technicians, associate professionals, and other lower skill levels, we allocate into intangible investments in a total of 25% of wages, which has been used, e.g., in Piekkola (2020). In certain cases, occupations can be classified into several categories, in which case we make case-by-case judgments in allocating across categories. In Appendix 1, we document in detail which occupations belong to each intangible investment category and how costs are distributed among the categories.

Measuring internal intangible investments in the category of entertainment and artistic originals differs from the above method. In this category, the source of data is Statistics Finland's nationwide financial statement database, which covers practically all business enterprises in the country. To measure the investments, we calculate the year-to-year firm-level changes of the balance sheet variable 'Intangible Assets'. This balance sheet variable includes patents, licenses, trademarks, brands, business names, pharmacy rights, rental rights, various copyrights, and user rights. When performing the calculations, we observe some large outliers in the data, for which we could not find proper explanations. Thus, to facilitate coherent time-series data, we dropped the highest 1% of the observations of the variable distribution each year.

Regarding the category employer provided training, previous research regarding Finland has utilized survey-based data, *CVTS* (Continuing Vocational Training Survey)[5] by Statistics Finland (e.g., Maliranta & Rouvinen, 2007). The survey is conducted every five years, and the latest published data is from 2015 and 2020. The 2020 survey was sent to 3,000 business firms that employed at least ten workers. Unfortunately, this data is not available as ready-made firm-level data sets and require special-access permissions. At the time of our study, we were unable to obtain access to this data. We also attempted to find other data on employer-provided training but could not find any. Thus, our analyses do not cover employer-provided training.

External intangible investments are calculated using the nationwide financial statement database of Statistics Finland. We found practicable items for the 3 categories of intangibles:

– First, we proxy external investments of computer software and databases by the income statement item 'computer, design, and programming expenses.

[5] More information on CVTS is available at *https://stat.fi/en/statistics/documentation/cvts*.

- Second, in the case of external R&D investments, we use the income statement item 'research and development expenses" as a proxy.
- Third, for brands, we use the income statement item 'advertising, sales, and marketing expenses as a proxy. On the basis Bontadini et al. (2023, p. 24), we use a value of 0.6 as a capitalization factor in each of these categories; that is, we allocate 60% of expenses to external intangible investments.

Our data cover nearly all businesses in Finland. However, we impose some constraints:

- First, we limit the sample to include only firms in the market economy, as defined in the EUKLEMS & INTANProd database.
- Second, we used a firm-size threshold of 20 full-time employees. This is because, in very small firms, occupation titles may be more generic and may not adequately describe the kind of work being done. The organization of work is also more likely to differ in very small firms than in larger ones. Moreover, in smaller firms, missing data is imputed more frequently by statistical officers than in larger firms because of less strict reporting rules.

As mentioned above, the firm-level data for our study come from Statistics Finland, which granted us permission to use both firm- and individual-level ready-made datasets.

The firm-level data used in this study consist of two modules of Statistics Finland's research database: FIRM_ENTER and FIRM_FSS. FIRM_ENTER includes basic background information such as a firm's age, industry, geographical location, legal form, employment, and ownership type. The FIRM_FSS database contains financial statement data. From this database, we use information on value added; tangible investments; tangible and intangible assets; computer, design and programming expenses; research and development expenses; and advertising, sales, and marketing expenses.

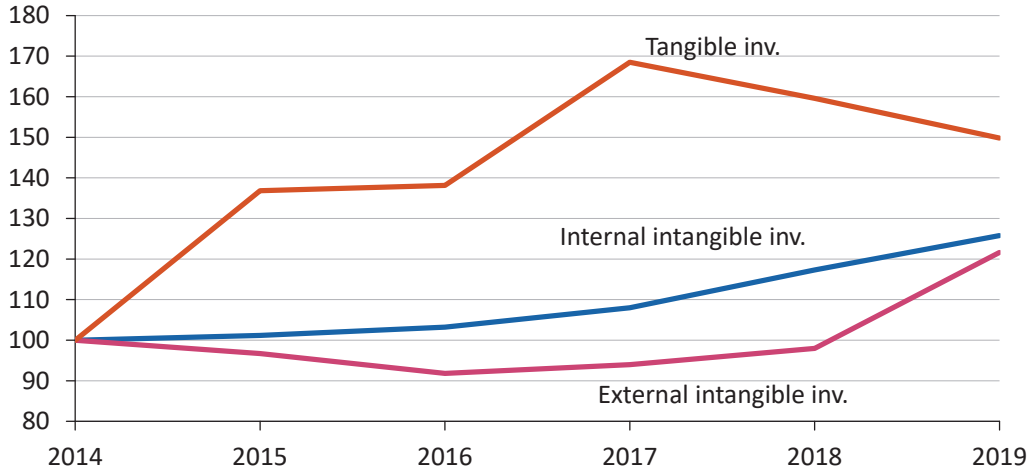
Individual-level data are obtained from Statistics Finland's research database modules FOLK_TKT and FOLK_TULO. From FOLK_TKT, we used information on workers' occupations and their employers. FOLK_TULO includes data on workers' wages that are used in our calculations. Both individual- and firm-level datasets have the same unique identifier variables, which facilitate both linking and aggregation to the level of a firm.

3. Univariate analysis

Figure 1 depicts the development of the sums of intangible and tangible investments in 2014–2019. As noted above, these numbers concern firms in the market economy with at least 20 full-time-equivalent employees.

As can be seen in Figure 1, in 2014–2019 tangible investments grew more rapidly than intangible ones. The growth in tangible investments was particularly high in earlier years; a decline is observed in later years.

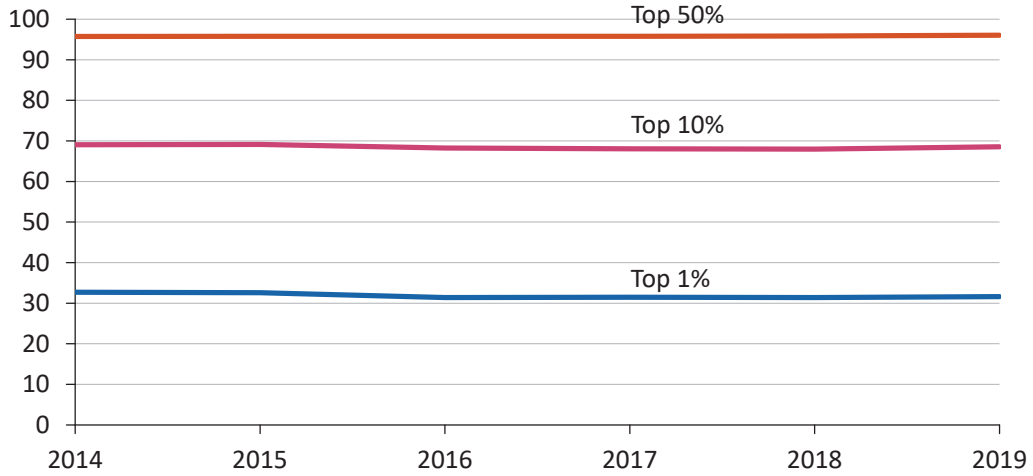
Figure 1. Development of intangible and tangible investments in 2014-2019.



Notes: Statistics Finland's data, the authors' calculations. The sample covers firms in the market economy that employ at least 20 full-time-equivalent workers.

Internal intangible investments have increased more than external ones (Figure 1). As noted earlier, our measurement of external intangible investments is based on only 3 of the 8 categories and is thus not fully comparable to the measurement of internal intangible investments. Therefore, in what follows, we report only the findings regarding internal intangible investments.

Figure 2. The shares of the largest investors of the total intangible investment.



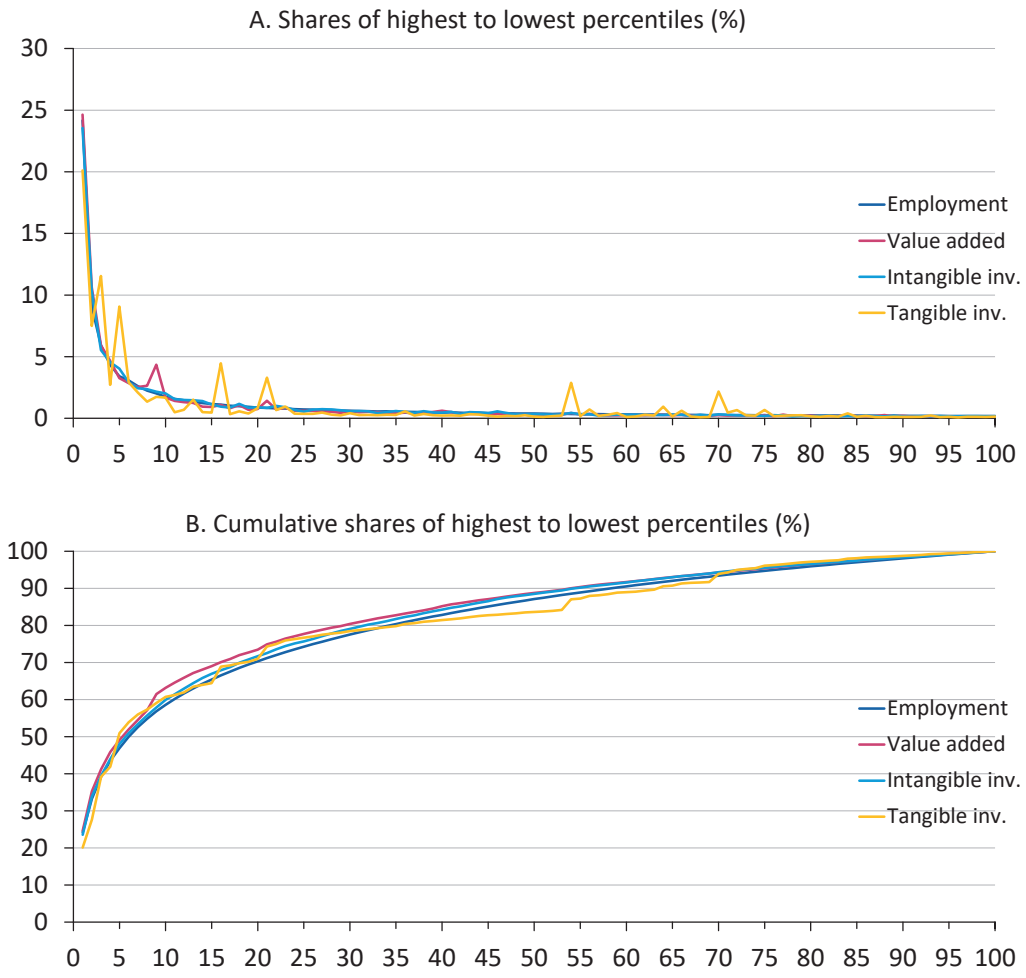
Notes: Statistics Finland's data, the authors' calculations. The sample covers firms in the market economy that employ at least 20 full-time-equivalent workers.

Kaus et al. (2024) find that in Germany, the distribution of intangible investments is heavily skewed to the right. In other words, few large investors' share of the total intangible investment is remarkable. This is also evident in Finnish data. Figure 2 illustrates the shares of the largest 1%, 10%, and 50% investors' proportions of the total intangible investment in 2014-2019.

The largest 1% of investors account for approximately 1/3 of the total intangible investments (Figure 2) and the largest 10% of investors account for approximately 2/3. The largest 50% of investors account for 95% of total intangible investments. These shares have been stable over the observation years.

In Figure 3, the horizontal *x*-axis depicts the employment distribution of firms from the highest to lowest percentile in 2019. The largest 1% of the firms is leftmost edge of the figure, the second largest 1% is the second "slice" to the right etc. In Pane A, the vertical *y*-axis depicts the shares of each "slice" of (a) total employment, (b) value added, (c) intangible investments, and (d) tangible investments. In Pane B, the *y*-axis depicts the *cumulative* shares of those four variables by each "slice".

Figure 3. The percentages of employment, value added, intangible investment, and tangible investment by the percentiles of firms' employment in 2019.



Notes: Statistics Finland's data, the authors' calculations. The sample covers firms in the market economy that employ at least 20 full-time-equivalent workers.

Part A of Figure 3 shows that intangible investments are correlated with firm size. For example, the share of the highest percentile of firms with respect to employment accounts for 24% of the total intangible investments in our sample. However, this share is

fully comparable to the shares of the other three variables of interest: the respective shares regarding employment, value added, and tangible investments are 24%, 25%, and 20%. In addition, we note that the percentages fall substantially when firm size decreases. For instance, the percentage of the 10th highest percentile of employment distribution of these four variables is only approximately 2%.

Part B of Figure 3 shows that the cumulative shares of intangible investments and the other three variables increase rapidly in the highest percentiles of employment distribution and then gradually decelerate when firm size decreases. The patterns of the cumulative shares of the four variables do not deviate significantly from each other. For instance, the cumulative percentages of the 10th largest percentiles regarding firm size of employment, value-added, intangible, and tangible investments are 59%, 63%, 60%, and 61%, respectively. The cumulative percentages of the 75th largest percentiles are 95%, 95%, 96%, and 96%, respectively.

Thus, while the distribution of intangible investments is highly concentrated with respect to firm size, the distribution in this respect does not differ significantly from the distributions of employment, value added, and tangible investments.

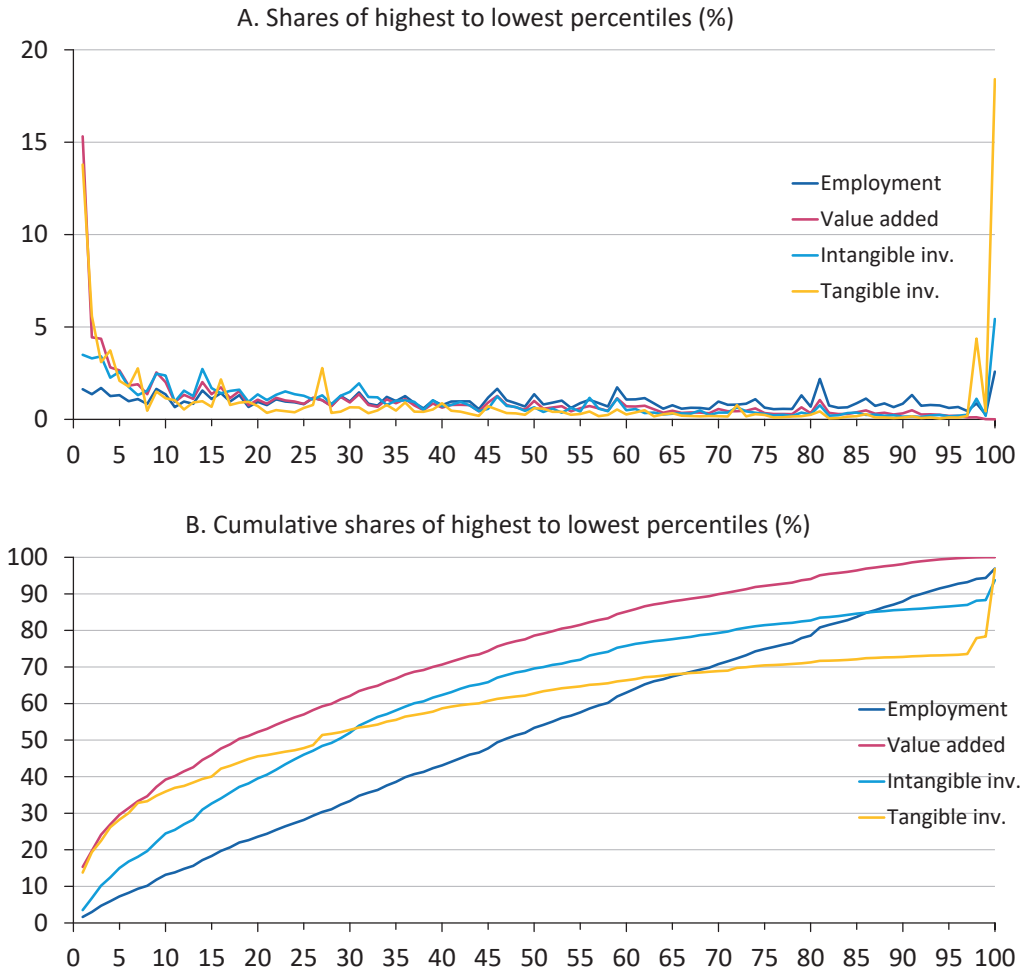
In Figure 4, we examine the same four variables, but instead of the percentiles of employment, we have the percentiles of labor productivity measured by value added per full-time equivalent employment on the x-axis.

In Figure 4, we have more fluctuating patterns than those regarding employment:

- First, the share of each percentile of intangible investments is much more balanced. For example, the highest percentile for labor productivity accounts for 3.5% of the total intangible investments, and the 10th percentile accounts for 2.4%.
- Second, we notice that there are peaks at both ends of the distribution: the least productive percentile of firms accounts for 5.4% of intangible investments, which is the highest share among all percentiles.
- Third, the distribution of intangible investments is comparable to that of employment, whereas the distributions of value-added and tangible investments have different patterns. The distribution of value-added has a large peak at the highest percentile of labor productivity but not at the lower end of the distribution. Instead, the distribution of tangible investments has large peaks at both ends of the spectrum.

One could speculate that the peaks at the lower end of the distributions are at least partly related to growth phases of firms in these percentiles. That is, they may be intensively hiring workers and making intangible and tangible investments but do not yet have output and value added to the same extent.

Figure 4. The shares of employment, value added, intangible investment, and tangible investment by the percentiles of firms' labor productivity in 2019.



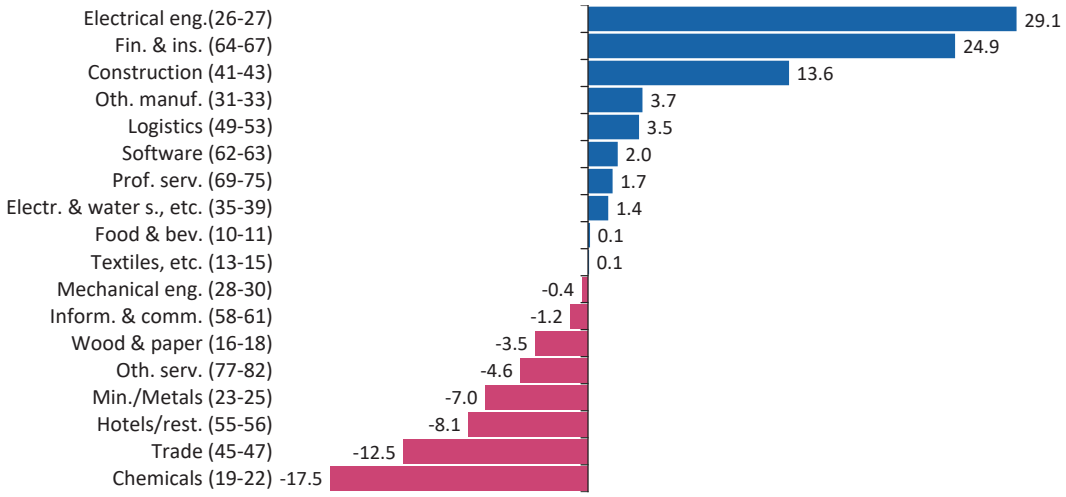
Notes: Statistics Finland's data, the authors' calculations. The sample covers firms in the market economy that employ at least 20 full-time-equivalent workers.

Figure 5 compares the share of intangible investments to the share of value-added of the highest 10th percentile of the employment distribution by industry. Figure 5 shows that in electronics and electrical engineering, the difference between the shares of intangible investments and value-added is the largest, with a difference of 29%. The difference is also positive and substantial in finance and insurance (64–67, 25%-points). In the other end, the differences are negative and the largest in the chemical industry (19–22, -18%-points) and in trade (45–47, -13%-points). The differences are the most even in food and beverages (10–11, 0.1%-points) and in the manufacturing of textiles, clothes, shoes, etc. (13–15, 0.1%-points). In mechanical engineering, the difference is also relatively small (28–30, -0.4%-points).

Figure 5 suggests that in electronics and electrical engineering and in finance and insurance the creation of intangible assets, in comparison with the creation value added, is concentrated in large firms. However, in the chemical industry and trade sector, the role of large firms is less evident. In addition, in food and beverages, clothing and textiles,

and mechanical engineering, the concentration percentage of intangible investments is balanced with the concentration percentage of value added.

Figure 5. The difference of the shares of intangible investment and value added of top 10 percentile firms of employment distribution in 2019, by industry (Nace Rev. 1).



Notes: Statistics Finland's data, the authors' calculations. The sample covers firms in the market economy that employ at least 20 full-time-equivalent workers. For details regarding Figure 1, see Appendix 1.

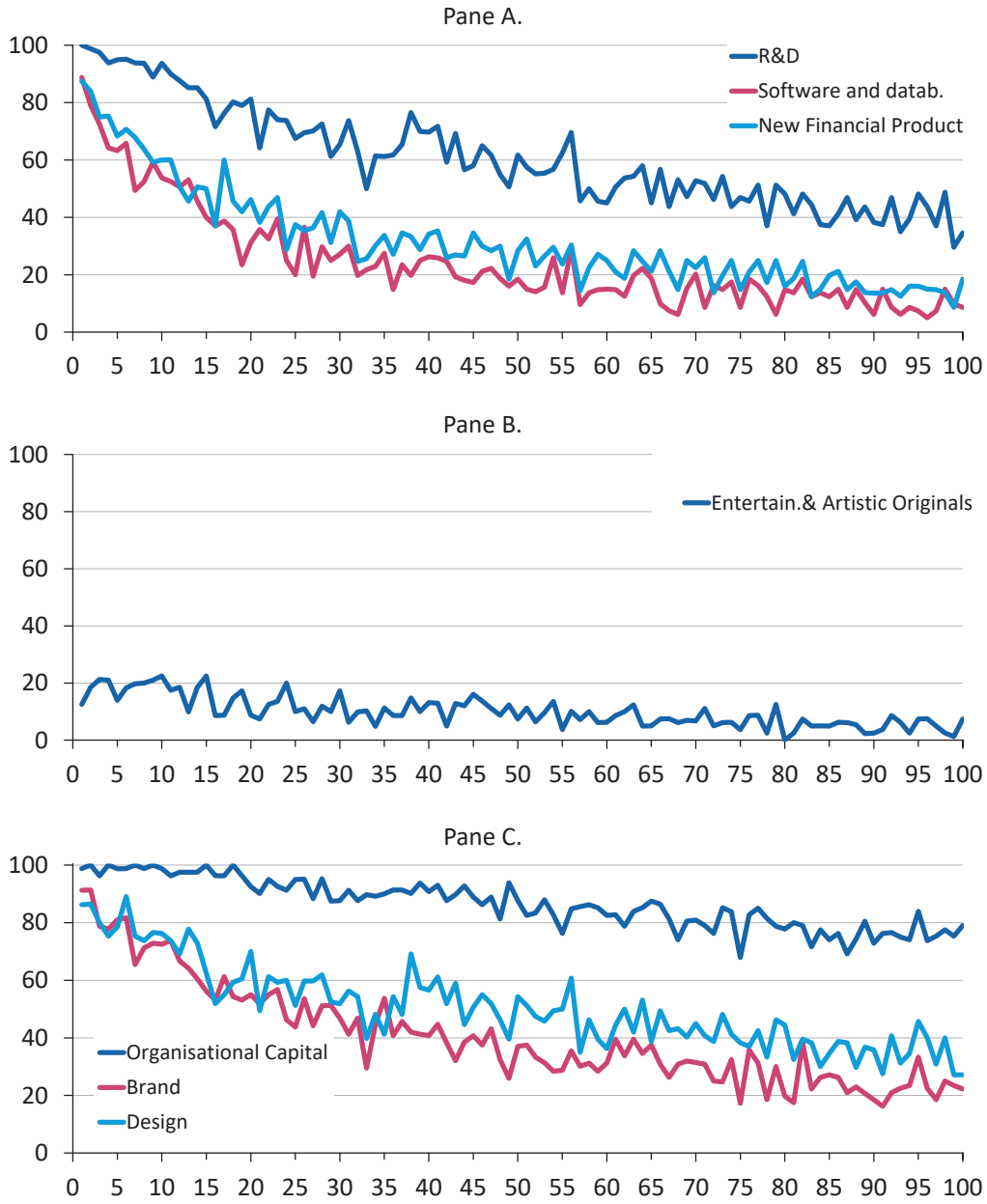
In what follows, we study the concentration of intangible investment by subcategory. In each subcategory. After excluding tiny investments (under €10,000 or under 1% of a firm's total intangible investment), 92% of our sample firms invested in at least one subcategory of intangibles. The most significant subcategories are organizational capital and R&D. In total, 87% of firms invested in organizational capital and 61% in R&D. These subcategories are followed by design (51%), brand (41%), new financial product (32%), computer software and databases (25%), and entertainment and artistic originals (10%).

Figure 6 illustrates the shares of firms investing in the subcategories. Larger firms tend to invest in all subcategories more frequently than smaller ones. All firms in the highest percentile of employment distribution invest in R&D; in the 50th percentile, the share is 62% and in the 99th percentile 30%. The subcategory of entertainment and artistic originals has a flatter distribution than other sub-categories.

When looking at the proportions of each subcategory (Figure 6), we note that organizational capital and R&D have the largest shares in practically each percentile of the firm size distribution. Furthermore, organizational capital has a more even distribution than other occupation-based intangible investment subcategories: even in the lowest percentile of employment distribution, 80% of firms have invested in this subcategory. The largest deviation, calculated by subtracting the percentage of the highest percentile from that of the lowest percentile, is found in computer software and databases. In this subcategory, 89% of firms in the highest percentile have invested in computer software and databases, whereas only 9% of firms in the lowest percentile have such investments, yielding a difference of 80%-points. The lowest deviation, in turn, is in entertainment

and artistic originals, where the difference is only 5%-points between the highest and the lowest percentile.

Figure 6. The presence of types of intangible investment for each percentile of firms' employment distribution, % of firms investing in 2019.



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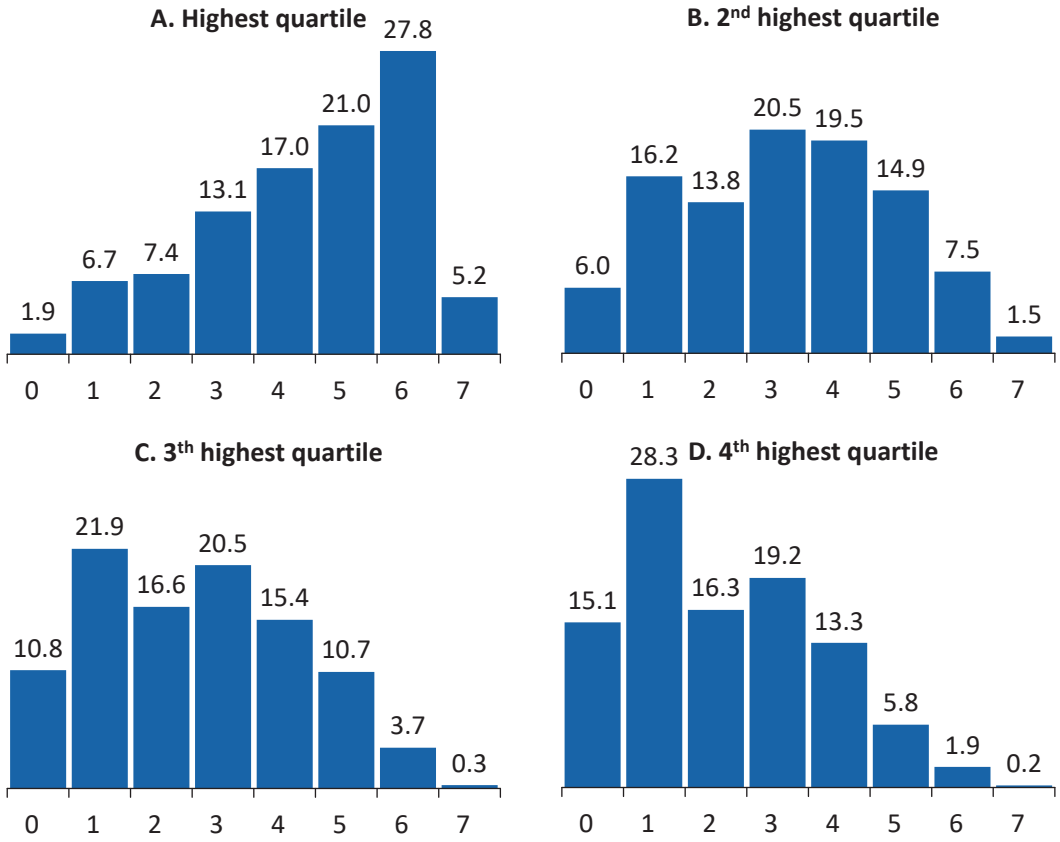
In Figure 7, we divide our firm sample into four quartiles based on their employment and calculate percentages of co-existence of subcategories: firm size increases the likelihood of investing in several types of intangibles. In the top quartile, 54% of firms have invested in at least 5 subcategories of intangibles, whereas in other quartiles, the percentages are 24%, 15%, and 8%. In addition, in the lowest quartile of firms, 45% have one

or two types of intangible investments, while in the highest quartile, the corresponding share is only 14%.

Figure 7. The percentages of co-existence of intangible investment types (0–7) by quartiles of employment distribution in 2019.



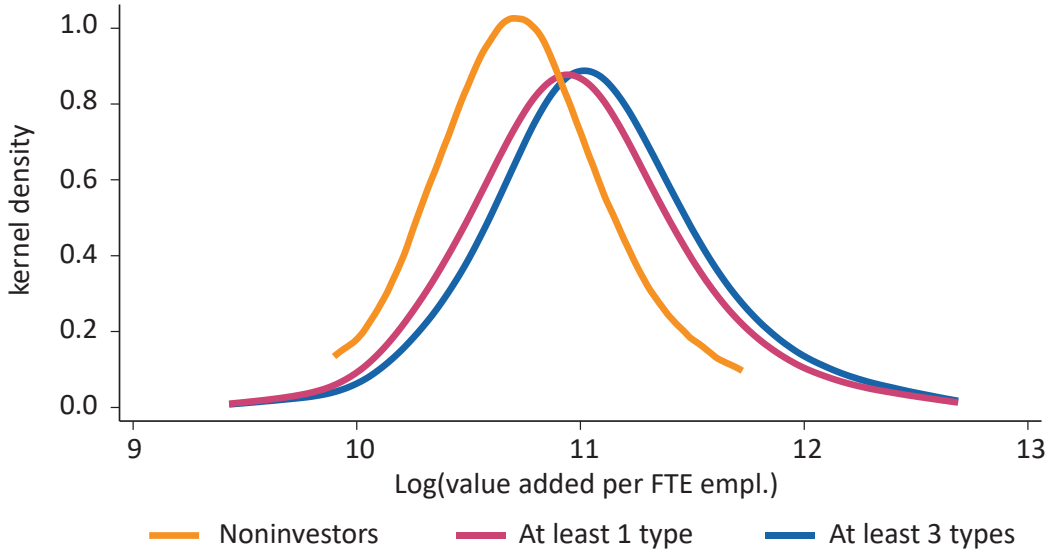
Notes: Statistics Finland's data, the authors' calculations. The sample covers firms in the market economy that employ at least 20 full-time-equivalent workers.

Lastly, as a "teaser" before turning to the multivariate analysis of the economic outcomes of intangible investments, we explore the distributions of labor productivity in the three firm groups:

- The first group consists of firms that did not have intangible investments in 2019.
- The second group has at least one type of intangible investment, and
- the third group has at least three types of intangible investments.

In Figure 8, we have drawn the kernel distributions of the above three groups. The figure indicates that firms with intangible investments have higher productivity levels than non-investors, on average. In addition, there is some indication that higher intangible intensity is associated with higher productivity. In the next section, we analyze the correlations between intangible investments and productivity in more detail.

Figure 8. Kernel densities of labor productivity by the intensity of mix of intangible investment types in 2019.



Notes: Statistics Finland's data, the authors' calculations. The sample covers firms in the market economy that employ at least 20 full-time-equivalent workers.

4. Multivariate analysis

In this section, we analyze the relationship between intangible investments and economic outcomes using econometric methods.

Intangible investments include 7 subcategories of intangibles defined in the previous sections and their aggregate. We consider only internal investments. Labor productivity is the outcome variable in this analysis.

To derive an empirical model to analyze the association between intangible inputs and labor productivity, we start with an extended Cobb-Douglas production function for firm i at time t:

$$Y_{it} = A_{it} K_{it}^{\beta_K} I_{it}^{\beta_I} L_{it}^{\beta_L} C_{it}^{\gamma} e^{\varepsilon_{it}},$$

where subscripts i and t denote firm i and time t, respectively. Y is the value added of a firm, capturing the firm's output; A is the disembodied technology; K is the tangible capital measured by balance sheet item machinery and equipment; I includes the intangible inputs measured by items described in previous sections; L is labor measured by the firm's full-time equivalent employment; C is a vector of control variables including firm's age in years, industry (dummies based on the NACE Rev. 1 classification at the 3-digit level), geographical location (5 dummies based on provinces with capital region as a reference area), and observation year; and e is a stochastic error term.

After dividing both sides by L_{it}, taking the logarithm of each side, and rearranging the terms, we obtain an empirically convenient equation for labor productivity (i.e., a firm's output divided by its labor input):

$$\ln\left(\frac{Y_{it}}{L_{it}}\right) = \ln A_{it} + \beta_K \ln\left(\frac{K_{it}}{L_{it}}\right) + \beta_I \ln\left(\frac{I_{it}}{L_{it}}\right) + \theta \ln L_{it} + \gamma \ln C_{it} + \varepsilon_{it},$$

where $\theta = (\beta_K + \beta_I + \beta_L - 1)$ accounts for deviations from constant returns to scale. This equation provides the basis for our empirical modeling. We estimate the equation using pooled ordinary least squares (OLS) and fixed-effects (FE) linear regression models with cluster-robust standard errors.[6] In the estimation sample, we have 11,128 firms and 44,091 firm-year observations from 2014 to 2019.

Table 1 summarizes the estimation results. Columns (1) and (3) report the results of the OLS and fixed-effects panel estimations of the equation described above. In Columns (2) and (4), we further divide intangible inputs into seven subcategories described in the previous sections.

The results suggest that the intensity of intangible input use correlates positively and statistically significantly with labor productivity. In addition, the intensity of tangible input has a positive and statistically significant coefficient. A comparison of the coefficients of these two variables shows that the coefficient of intangibles is larger in the OLS estimations but smaller in the FE estimations. The Wald test for equality of these two coefficients reveals that the difference is statistically significant in the OLS regression ($p<0.01$) but not in the FE regression ($p<0.14$). Thus, we cannot make a robust interpretation of the relative importance of these inputs on labor productivity. In addition, given that the estimated coefficient for the variable *Labor* is $\theta = (\beta_K + \beta_I + \beta_L - 1)$, the estimated coefficient for L (i.e., β_L) is in the 0.614–0.842 range. In other words, our estimation results suggest that investments in intangible and tangible capital, as well as labor, are productive because they all correlate positively and statistically significantly with a firm's labor productivity. Furthermore, firm age has a positive coefficient in all estimations. The sign of this correlation is the kind that one could expect because, compared to mature firms, startups are often investing in factors of production disproportionately to output, yielding lower productivity levels during the investment period.

The results reported in Columns (2) and (4) regarding the separation of intangible inputs into 7 subcategories indicate that the categories of organizational capital and new financial products correlate positively and statistically significantly with labor productivity. The Wald test shows that the coefficient of organizational capital is statistically larger than the coefficient of new financial products in the OLS estimation ($p < 0.01$) and in the FE estimation ($p < 0.06$). Furthermore, the categories of computer software and

[6] Fixed-effects panel model has the advantage over pooled OLS that it considers unobserved heterogeneity (i.e., some unobserved factor that affects the dependent variable) but it may yield to imprecise estimates if regressors have only limited time-series ("within") variation.

databases, design, and entertainment and artistic originals also have positive and statistically significant coefficients in the OLS estimation but not in the FE estimation.

Table 1. Regression results for labor productivity.

	(1) OLS Coef./S.E.	(2) OLS Coef./S.E.	(3) FE Coef./S.E.	(4) FE Coef./S.E.
Intangible intensity	0.100***		0.019***	
	(0.007)		(0.007)	
Tangible intensity	0.070***	0.070***	0.039***	0.039***
	(0.006)	(0.006)	(0.012)	(0.012)
Labor	0.012	-0.010	-0.157***	-0.163***
	(0.014)	(0.015)	(0.027)	(0.026)
Age	0.042***	0.042***	0.090	0.088
	(0.014)	(0.014)	(0.077)	(0.077)
Software & datab.		0.006***		-0.001
		(0.002)		(0.001)
R&D		0.003		0.001
		(0.005)		(0.003)
Financial prod.		0.004***		0.002**
		(0.002)		(0.001)
Artistic orig.		0.003*		0.000
		(0.001)		(0.001)
Design		0.011**		0.002
		(0.005)		(0.003)
Org. capital		0.020***		0.010**
		(0.003)		(0.004)
Brand		0.004		-0.000
		(0.002)		(0.001)
Constant	10.291***	11.031***	10.455***	10.546***
	(0.199)	(0.193)	(0.251)	(0.237)
Year-indicators	Yes	Yes	Yes	Yes
Industry-indicators	Yes	Yes	Yes	Yes
Region-indicators	Yes	Yes	Yes	Yes
Observations	44091	44091	44091	44091
Firms	11128	11128	11128	11128
R^2(adj.)	0.716	0.715		
R^2(within)			0.023	0.023
R^2(overall)			0.007	0.007

Notes: Statistics Finland's data, the authors' calculations. The sample covers firms in the market economy that employ at least 20 full-time-equivalent workers. The industry indicators are measured using Nace Rev. 1 codes at the 3-digit level. The sample period includes 2014–2019. All continuous variables are transformed into logs using $x = ln(x+1)$. Columns (1) and (2) report the results of ordinary least squares linear regressions, and columns (3) and (4) report the results of linear fixed-effects regressions. The cluster-robust standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

We also perform estimations that include the interactions of intangible variables. The interaction terms are included in the estimation equations one at a time in rotation. The results, which consist of the coefficients and their statistical significance, are reported in

Appendix 3. The interaction terms vary significantly between the estimation models. The only term that is statistically significant in both OLS and FE estimations is the interaction between R&D and design. However, the magnitude of the correlation is quite close to zero in both estimation models.

5. Conclusions

This study analyzes the distribution and economic outcomes of intangible investments in Finnish firms from 2014 to 2019 using combined firm- and individual-level data sets from Statistics Finland.

Based on the guidelines of the EUKLEMS & INTANProd database documented in Bontadini et al. (2023), we define measures for 7 categories of intangible investments:

1. computer software and databases,
2. research and development,
3. entertainment and artistic originals,
4. new financial products,
5. design,
6. organizational capital, and
7. brand.

The analysis reveals that the distribution of intangible investments is heavily right-skewed, with the largest 1% of investors accounting for about one-third, the largest 10% of investors for about 2/3, and the largest 50% of investors for about 95% of total intangible investments. This concentration is particularly evident in the electronics and electrical engineering, and finance and insurance sectors. While the distribution of intangible investments is quite highly concentrated regarding firm size, the distribution in this respect, however, does **not** significantly differ from the distributions of employment, value-added, and tangible investments.

We also find that the co-existence of intangible investment types is related to firm size, that is, larger firms typically utilize more categories of intangible assets simultaneously than smaller firms. For example, in the highest quartile of employment distribution, over half of the firms have invested in at least 5 sub-categories of intangibles, whereas in the lowest quartile of employment distribution, the respective proportion is less than 10%.

Regarding economic outcomes, the results show that firms with intangible investments exhibit higher productivity levels than non-investors, and higher intangible intensity seems to be associated with higher productivity. Among the intangible investment categories, organizational capital and new financial products show a statistically significant positive correlation with labor productivity.

Overall, the findings highlight the importance of intangible investments in firm performance and provide insights into the concentration patterns of intangible investments in the Finnish business sector.

Appendix 1. Occupations in intangible investment categories

Table 2. Description of occupations in different intangible investment categories.

ISCO-08 Code	Description	Investment share of wages	Distribution of occupation's investment share (%)							
			Software & datab.	R&D	Financial prod.	Artistic originals	Design	Organiz. capital	Brand	Empl. pr. tr.
1120	Managing directors and chief executives	15						100		
1211	Finance managers	15	20					80		
1212	Human resource managers	15	20					80		
1213	Policy and planning managers	15	20					80		
1219	Business services and administration managers not elsewhere classified	15	20					80		
1221	Sales and marketing managers	15						50	50	
1222	Advertising and public relations managers	15						50	50	
1223	Research and development managers	15						100		
1311	Agricultural and forestry production managers	15						100		
1312	Aquaculture and fisheries production managers	15						100		
1321	Manufacturing managers	15						100		
1322	Mining managers	15						100		
1323	Construction managers	15						100		
1324	Supply, distribution and related managers	15						100		
1330	Information and communications technology service managers	15	50					50		
1341	Childcare services managers	15						100		
1342	Health services managers	15						100		
1343	Aged care services managers	15						100		
1344	Social welfare managers	15						100		
1345	Education managers	15						100		
1346	Financial and insurance services branch managers	15			50			50		
1349	Professional services managers not elsewhere classified	15						100		
2111	Physicists and astronomers	50		100						
2112	Meteorologists	50		100						
2113	Chemists	50		100						
2114	Geologists and geophysicists	50		100						
2120	Mathematicians, actuaries and statisticians	50	50	50						
2131	Biologists, botanists, zoologists and related professionals	50		100						
2132	Farming, forestry and fisheries advisers	50		100						
2133	Environmental protection professionals	50		100						

ISCO-08 Code	Description	Investment share of wages	Distribution of occupation's investment share (%)							
			Software & datab.	R&D	Financial prod.	Artistic originals	Design	Organiz. capital	Brand	Empl. pr. tr.
2141	Industrial and production engineers	50		50			50			
2142	Civil engineers	50		50			50			
2143	Environmental engineers	50		50			50			
2144	Mechanical engineers	50		50			50			
2145	Chemical engineers	50		50			50			
2146	Mining engineers, metallurgists and related professionals	50		50			50			
2149	Engineering professionals not elsewhere classified	50		50			50			
2151	Electrical engineers	50		50			50			
2152	Electronics engineers	50		50			50			
2153	Telecommunications engineers	50		50			50			
2161	Building architects	50		50			50			
2162	Landscape architects	50		50			50			
2163	Product and garment designers	50		50			50			
2164	Town and traffic planners	50		50			50			
2165	Cartographers and surveyors	50		50			50			
2166	Graphic and multimedia designers	50		50			50			
2310	University and higher education teachers	50						100		
2320	Vocational education teachers	50						100		
2330	Secondary education teachers	50						100		
2341	Primary school teachers	50						100		
2342	Early childhood educators	50						100		
2351	Education methods specialists	50		50				50		
2352	Special needs teachers	50						100		
2353	Other language teachers	50						100		
2354	Other music teachers	50						100		
2355	Other arts teachers	50						100		
2356	Information technology trainers	50						100		
2359	Teaching professionals not elsewhere classified	50						100		
2411	Accountants	50			75			25		
2412	Financial and investment advisers	50			75			25		
2413	Financial analysts	50	25		75					
2421	Management and organization analysts	50		50				50		
2422	Policy administration professionals	50		50				50		
2423	Personnel and careers professionals	50		50				50		
2424	Training and staff development professionals	50		50				50		
2431	Advertising and marketing professionals	50						50	50	
2432	Public relations professionals	50						50	50	

ISCO-08 Code	Description	Investment share of wages	Distribution of occupation's investment share (%)							
			Software & datab.	R&D	Financial prod.	Artistic originals	Design	Organiz. capital	Brand	Empl. pr. tr.
2433	Technical and medical sales professionals (excluding ICT)	50						50	50	
2434	Information and communications technology sales professionals	50						50	50	
2521	Database designers and administrators	50	100							
2522	Systems administrators	50	100							
2523	Computer network professionals	50	100							
2529	Database and network professionals not elsewhere classified	50	100							
2631	Economists	50	50	50						
2632	Sociologists, anthropologists and related professionals	50		100						
2633	Philosophers, historians and political scientists	50		100						
3118	Draughts persons	25					100			
3311	Securities and finance dealers and brokers	25			50			50		
3312	Credit and loans officers	25			50			50		
3313	Accounting associate professionals	25			50			50		
3314	Statistical, mathematical and related associate professionals	25	34		33			33		
3315	Valuers and loss assessors	25			50			50		
3321	Insurance representatives	25						100		
3322	Commercial sales representatives	25						100		
3323	Buyers	25						100		
3324	Trade brokers	25						100		
3331	Clearing and forwarding agents	25						100		
3332	Conference and event planners	25						100		
3333	Employment agents and contractors	25						100		
3334	Real estate agents and property managers	25						100		
3339	Business services agents not elsewhere classified	25						100		
3341	Office supervisors	25						100		
3342	Legal secretaries	25						100		
3343	Administrative and executive secretaries	25						100		
3344	Medical secretaries	25						100		
3411	Legal and Related Associate Professionals	25						100		
3412	Social work associate professionals	25						100		
3413	Religious associate professionals	25						100		
3421	Athletes and sports players	25						100		
3422	Sports coaches, instructors and officials	25						100		

ISCO-08 Code	Description	Investment share of wages	Distribution of occupation's investment share (%)							
			Software & datab.	R&D	Financial prod.	Artistic originals	Design	Organiz. capital	Brand	Empl. pr. tr.
3423	Fitness and recreation instructors and program leaders	25						100		
3431	Photographers	25						100		
3432	Interior designers and decorators	25						100		
3433	Gallery, museum and library technicians	25						100		
3434	Chefs	25						100		
3435	Other artistic and cultural associate professionals	25						100		
3511	Information and communications technology operations technicians	25	100							
3512	Information and communications technology user support technicians	25	100							
3513	Computer network and systems technicians	25	100							
3514	Web technicians	25	100							
4132	Data entry clerks	25	100							
4227	Survey and market research interviewers	25	100							

Source/notes: Authors' assessments utilizing the studies of Bontadini et al. (2023), Koski et al. (2024), and Piekkola (2020), and Statistics Finland's Occupation List of Classification of Socio-economic Groups (*https://stat.fi/fi/luokitukset/corrmaps/ammatti_1_20100101%23sosioekon_asema_901_20110901*).

Appendix 2. Intangible investment shares of large firms by industry

Table 3. The shares (%) of employment (fte), value added, intangible investment and tangible investment of top 10 percentile firms of employment distribution in 2019, by industry.

Nace Rev. 1 Industry	*Employment*	*Value added*	*Intangible inv.*	*Tangible inv.*
Food & bev. (10-11)	56.74	60.72	60.86	51.13
Textiles, etc. (13-15)	43.54	46.08	46.16	72.52
Wood & paper (16-18)	59.70	70.67	67.13	74.86
Chemicals (19-22)	50.81	75.47	58.01	63.44
Min./Metals (23-25)	50.91	62.42	55.46	68.43
Electrical eng. (26-27)	62.65	41.14	70.22	67.82
Mechanical eng. (28-30)	57.85	62.66	62.26	63.95
Other manuf. (31-33)	53.54	56.61	60.31	36.10
Electr. & water s., etc. (35-39)	48.46	51.27	52.65	60.02
Construction (41-43)	53.63	58.68	72.32	32.00
Trade (45-47)	65.09	57.93	45.43	61.81
Logistics (49-53)	65.25	64.44	67.90	67.63
Hotels/rest. (55-56)	55.86	59.09	51.00	60.32
Inform. & comm. (58-61)	54.89	60.33	59.16	84.60
Software (62-63)	49.70	47.22	49.24	15.81
Finance & ins. (64-67)	65.99	41.17	66.09	55.14
Prof. serv. (69-75)	49.49	52.77	54.44	40.24
Oth. services (77-82)	57.35	53.31	48.75	44.17

Source/notes: The data sources are Statistics Finland and the authors' calculations. The sample covers firms in a market economy that employ more than 20 full-time equivalent workers.

Appendix 3. Regression results of interaction terms of intangible assets.

Table 1. Regression results of interaction terms of intangible assets.

Interaction term	(A) OLS Coef.		(B) FE Coef.	
Software & datab. # R&D	0.0002		-0.00002	
Software & datab. # Financial prod.	0.0005		-0.00027	
Software & datab. # Artistic orig.	0.0000		-0.00026	
Software & datab. # Design	-0.0002		0.00002	
Software & datab. # Org. capital	0.0039	***	0.00000	
Software & datab. # Brand	0.0007	*	0.00013	
R&D # Financial prod.	-0.0003		-0.00009	
R&D # Artistic orig.	-0.0001		-0.00005	
R&D # Design	0.0057	***	0.00132	*
R&D # Org. capital	-0.0003		0.00061	
R&D # Brand	-0.0003		-0.00022	
Financial prod. # Artistic orig.	0.0006		-0.00034	*
Financial prod. # Design	-0.0001		-0.00013	
Financial prod. # Org. capital	0.0074	***	0.00045	
Financial prod. # Brand	0.0001		-0.00039	
Artistic orig. # Design	-0.0010	**	-0.00004	
Artistic orig. # Org. capital	0.0013		-0.00025	
Artistic orig. # Brand	-0.0004		-0.00013	
Design # Org. capital	-0.0009		0.00033	
Design # Brand	-0.0004		0.00014	
Org. capital # Brand	0.0113	***	0.00095	

Source/notes: The data sources are Statistics Finland and the authors' calculations. The sample covers firms in a market economy that employ more than 20 full-time equivalent workers. Each interaction term was included in turn in the main regression equations reported in Table 1, columns (2) and (4). Column (A) reports the results of ordinary least-squares linear regressions, and column (B) reports the results of linear fixed-effects regressions. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

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