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Intangible Capital in France and Germany: Is there a Measurement Issue?

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Senior Lectureship in International Economics

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Intangible Capital in France and Germany:

Is there a Measurement Issue?¹

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Abstract

In this article, we highlight important differences in capital investment and capital stock in intangible assets between France and Germany, which we attribute to potential measurement issues between the two countries. Using data from the latest EUKLEMS/INTANProd release for the period between 1995 and 2020, we identify investment in software and databases, along with investment in organizational capital, as key drivers of these differences. Investment in software appears to be four times higher in France than in Germany, while organizational capital is about two and a half times larger in France. Given the comparable economic growth patterns of these two countries over recent decades, we believe these measurement discrepancies could have significant implications for understanding both past growth trends and future growth perspectives.

Keywords: Intangible capital; Labour Productivity; Germany; France; EU

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1. Introduction

Intangible capital is becoming increasingly important as a productive factor in modern economies due to their transition toward being increasingly knowledge-based and because its inherent nature generates spillover effects not typical of traditional inputs (Audretsch & Belitski, 2020; Nonnis et al., 2023). The rise of Artificial Intelligence (AI) and the complementary intangible investments it requires is accelerating the shift toward intangible capital, such as R&D and software, which are rapidly replacing tangible components as major input in production. The recent report from Mario Draghi (Draghi, 2024a, 2024b) supports this trend, encouraging European firms and policymakers to foster investment in advanced technologies to catch up with major players such as the US and China.

Moreover, researchers attempting to predict the impact of this new generation of investments emphasize the delayed effect of disruptive and general-purpose technologies. These technologies typically show positive effects on productivity only after a certain period. This phenomenon is often referred to as J-curve effect, where the adjusted productivity curve initially declines, reflecting a decrease in total factor productivity (TFP), followed by a subsequent increase. Given this, it is essential to accurately assess the level of intangible capital investments made by businesses and countries to evaluate their potential impact on labor productivity.

However, this task is challenging, as intangible capital is by nature difficult to measure and quantify compared to other types of capital investments (Bavdaž et al., 2023). Furthermore, to a certain extent, national and business accounting practices remain anchored to traditional models centered on tangible assets like buildings and machinery. Significant progress has been made in recent years toward harmonizing the classification of intangible capital and incorporating it into business and national accounts. Despite these advancements, many intangible expenditures are still not properly capitalized and treated as investments, even though their effects span multiple years, much like any other type of investment.

In this research, we compare intangible investments in France and Germany, two leading economies in Europe, and outline the key characteristics of each country's approach to these investments. This comparison allows us to identify potential measurement issues between the two countries, with our findings suggesting that Germany's investments in software and organizational capital are likely too low, while France's investments in these assets, in comparison, appear as slightly too high.

Our research includes a call for harmonization of the measurement of software and organizational capital at the national and European levels, necessary to allow the EU countries to face the unprecedented challenges the AI revolution presents.

This paper is structured as follows. The next section presents some key stylized facts about intangible capital stock and investment in France and Germany. Section 3 provides a more detailed discussion of potential issues in the measurement of software and organizational capital in the two countries, while Section 4 concludes.

2. Intangible Capital Stock and Investment in France and Germany

France and Germany have exhibited contrasting trends in investment in intangible capital over the period 1995-2020.² As shown in Table 1, which lists average intangible investment as a percentage of gross value added (adjusted for intangibles) during this period, France has been one of the top investors among the 19 European countries and the US included in the sample. In accordance with the existing literature (Roth, 2024), France ranked second, with 17% of value-added, trailing only Sweden and investing as much as the US and Finland. In contrast, Germany invested only 11% of value-added, placing it among the countries with the lowest intangible investment in the sample. This difference stems from both intangibles not included in national accounts (such as design, brand, training, and organizational capital) and those included in national accounts (such as R&D, software and databases, and other intellectual property products).

Table 1. National and non-national account average intangible capital investment in selected countries, expressed as percentage of gross value added corrected for intangibles.

	Nat. Acc.	Non-Nat. Acc.	Total Int.
1. Sweden	0.09	0.10	0.19
2. France	0.07	0.11	0.17
3. Finland	0.06	0.11	0.17
4. United States	0.06	0.10	0.17
5. United Kingdom	0.04	0.11	0.15
6. Netherlands	0.04	0.10	0.14
7. Denmark	0.05	0.08	0.14

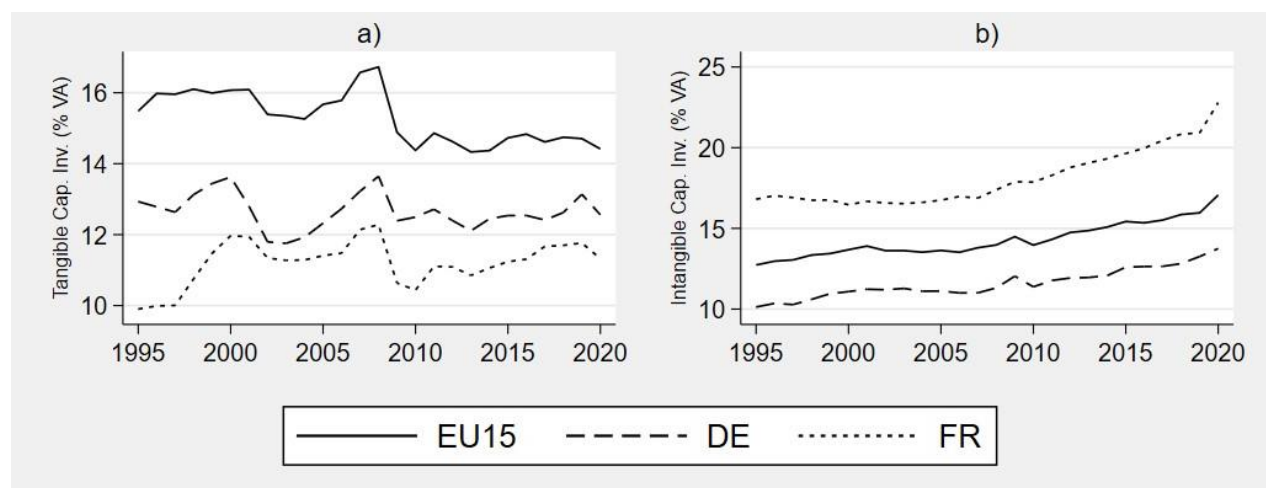
² The data used in this study is sourced from the latest release of the EUKLEMS/INTANProd database (Bontadini et al., 2023). It follows the classification of intangible assets proposed by Corrado et al. (2005), which divides them into seven types: computer software and databases (referred to as "software" for simplicity in this paper), research and development, other intellectual property products, design, brand, training, and organizational capital.

8. Slovenia	0.03	0.09	0.12
9. Czech Republic	0.04	0.08	0.12
10. Latvia	0.02	0.09	0.11
11. Portugal	0.03	0.08	0.11
12. Germany	0.04	0.07	0.11
13. Italy	0.04	0.07	0.11
14. Slovakia	0.02	0.08	0.10
15. Estonia	0.02	0.08	0.10
16. Hungary	0.03	0.07	0.10
17. Luxembourg	0.01	0.08	0.10
18. Austria	0.05	0.04	0.09
19. Spain	0.03	0.06	0.08
20. Lithuania	0.02	0.07	0.08

Data Source: EUKLEMS/INTANProd (Bontadini et al., 2023).

The different investment patterns are further illustrated in Figure 1, which tracks tangible and intangible capital investment over time. While tangible capital investments were comparable between the two countries, with Germany slightly ahead, France invested significantly more in intangibles, consistently above the EU15 average, while Germany remained below.

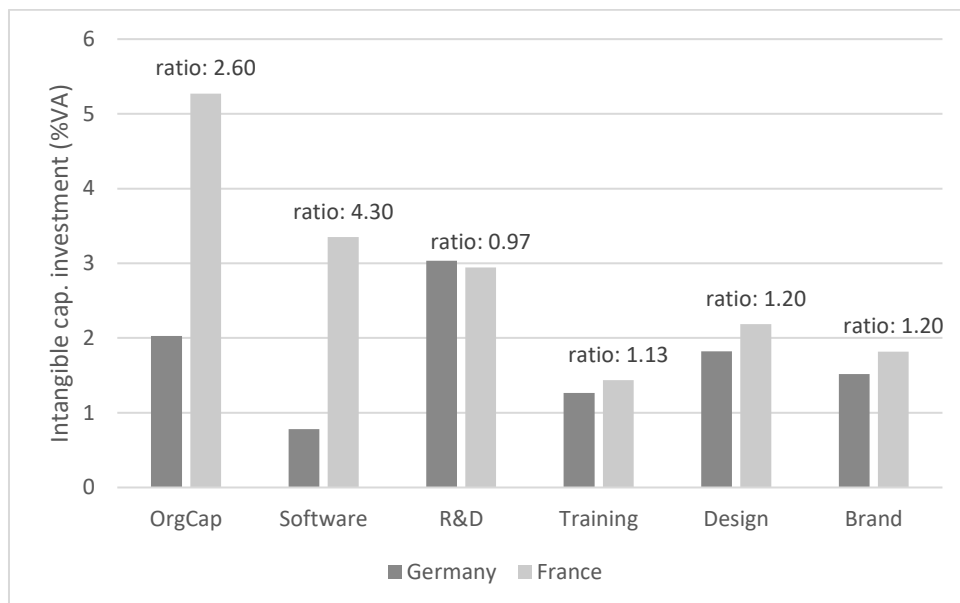
Figure 1. Tangible and intangible capital investment as percentage of gross value added over time (1995-2020).



Data Source: EUKLEMS/INTANProd (Bontadini et al., 2023).

What drives these differences? Figure 2 breaks down the various types of intangible capital, revealing that the largest disparities come from organizational capital, where France invested over 5% compared to Germany's 2%, and software, where France invested more than 3%, while Germany invested less than 1%.

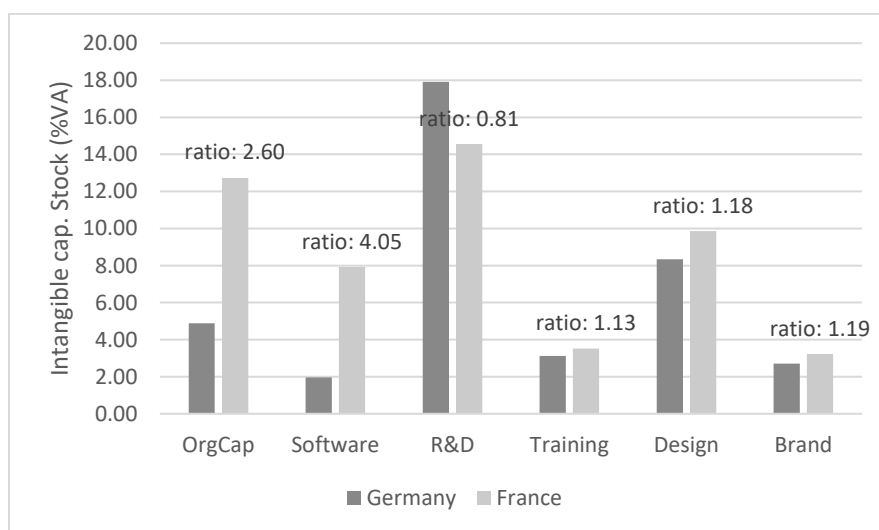
Figure 2. Average intangible capital investment, expressed as percentage of gross value added for the period 1995-2020. Breakdown of single intangible capital types.



Data Source: EUKLEMS/INTANProd (Bontadini et al., 2023).

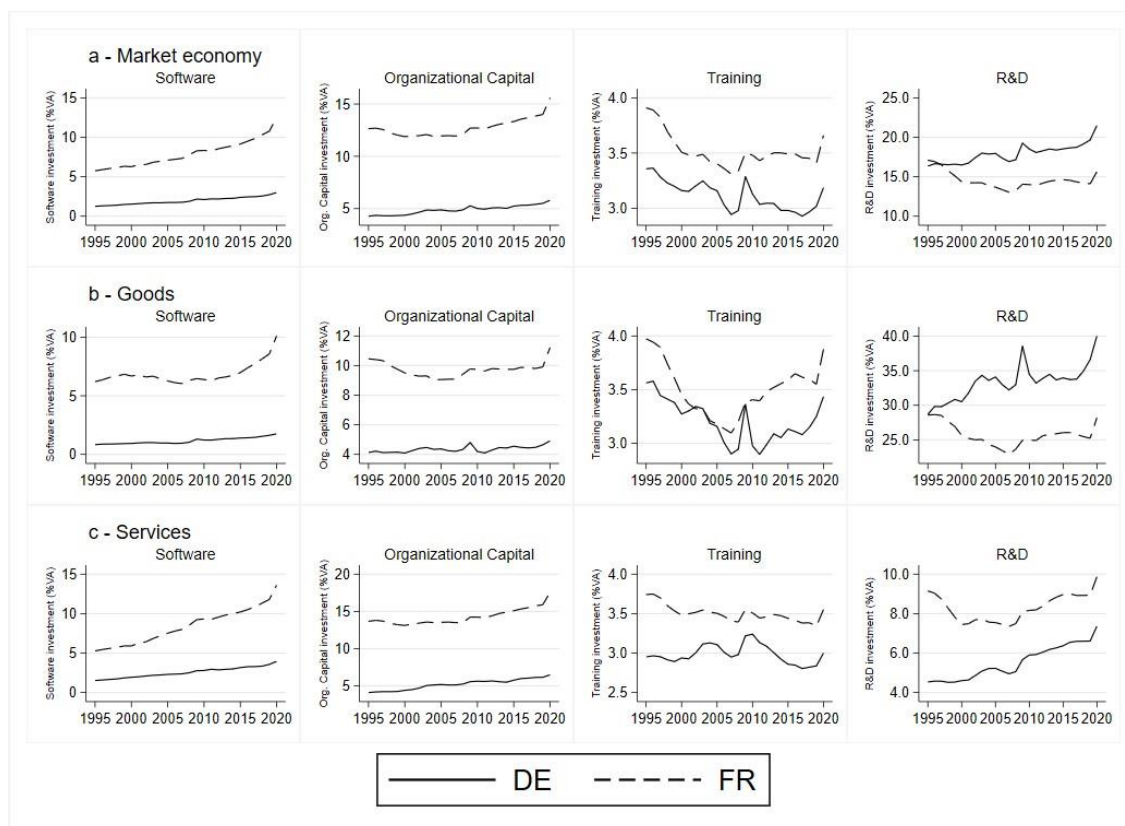
These differences are even more pronounced when looking at capital stock. Figure 3 shows the average capital stock as a percentage of gross value added (corrected for intangibles) for the period 1995-2020. In France, organizational capital reached nearly 13% of value added, while in Germany, it was less than 5%. Similarly, software accounted for almost 8% of value added in France, compared to less than 2% in Germany.

Figure 3. Average intangible capital stock, expressed as percentage of gross value for the period 1995-2020. Breakdown of single intangible capital types.



Data Source: EUKLEMS/INTANProd (Bontadini et al., 2023).

Figure 4. Intangible capital investment, expressed as percentage of gross value added over time (1995-2020). Breakdown of single intangible capital types. Market economy, Goods and Services sectors.



Data Source: EUKLEMS/INTANProd (Bontadini et al., 2023).

Figure 4 breaks down intangible capital investment as a percentage of value added over time for four types of intangible capital: software, organizational Capital, training and R&D, across the market economy (first row), the Goods sector (second row), and the Services sector (third row). The major differences in software and organizational capital in Germany and France are confirmed, with these gaps remaining consistent over time and even widening in the last decade in the case of software, particularly in the services sector.

3. Explaining the Discrepancy, is there a Measurement Issue?

France and Germany have experienced similar labor productivity growth rates in recent decades (Guillou et al., 2018; Nonnis et al., 2024), and the significant discrepancy in investment levels between the two countries' efficiency cannot be explained by efficiency alone. A more plausible explanation may lie in measurement issues concerning investment in software and organizational capital in the two countries.

Table 2. Levels and Ratios of Investments in Software and Organizational Capital in selected Sectors, France and Germany, average values 1995-2020

Industry Name	Industry Code	Computer Software			Organizational Capital		
		DE	FR	FR/DE	DE	FR	FR/DE
Manufacturing	C	0.53	4.68	8.8	2.05	4.63	2.3
Manufacture of machinery and equipment	C28	0.34	4.23	12.4	2.22	5.22	2.4
Manufacture of motor vehicles	C29-C30	1.1	4.79	4.4	1.99	3.33	1.7
Information and communication	J	4.36	12.71	2.9	2.88	6.61	2.3
Financial and insurance activities	K	0.92	4.97	5.4	3.31	10.13	3.1
Professional, scientific and technical activities	M	0.73	5.12	7.0	4.11	7.99	1.9
Market economy	MARKT	0.78	3.35	4.3	2.03	5.27	3.4

Notes: Sectors are selected for their relative importance and comparability in the two countries. Numbers refer to average values as percentage of value added over the period 1995-2020.

We begin by examining the measurement of software investments in France and Germany in more detail. Table 2 shows the average software investment rates as a percentage of value added for selected industries in both countries, including total manufacturing (C), manufacture of machinery and equipment (C28), manufacture of vehicles (C29-C30), information and communication (J), financial and insurance activities (K) and professional, scientific and technical activities (M). As mentioned above, the ratio (FR/DE) for the market economy is 4.3 (3.35/0.78), indicating that France invested, on average, 3.35% of its value added in software compared to Germany's 0.78% over the period from 1995 to 2020. While this difference is already puzzling for two equally advanced and deeply integrated economies, it becomes even more compelling when analyzing single sectors and sub-sectors. For instance, within manufacturing, France invested almost 9 times more in software. Looking closer at specific sub-sectors known for Germany's strong industrial performance, such as the manufacture of motor vehicles or the manufacture of machinery and equipment, we find that France invested 4.4 and 12.4 times more in software per unit of value-added, respectively. A similar picture emerges in business services sectors J, K, and M, where France invested up to 5 and 7 times more than Germany. These huge differences are evident across nearly all sectors of the French and German economy (Table 3) and over time (Figure 5).

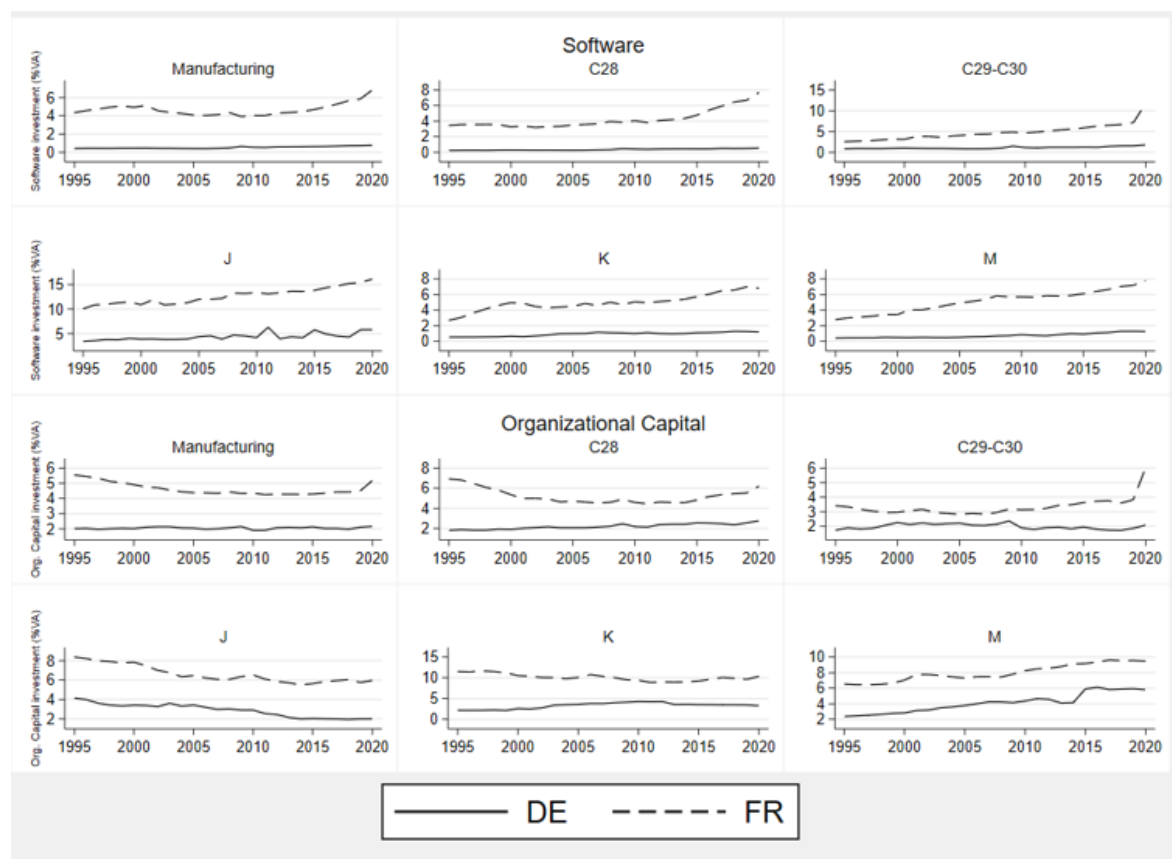
Table 3. Levels and Ratios of Investments in Software and Organizational Capital across Sectors, France and Germany, average values, 1995-2020

Industry Name	Industry Code	Computer Software & Databases			Organizational Capital		
		DE	FR	FR/DE	DE	FR	FR/DE
Agriculture, forestry and fishing	A	0.17	0.06	0.4	0.11	0.79	7.2
Mining and quarrying	B	0.48	3.4	7.1	2.13	3.16	1.5
Manufacturing	C	0.53	4.68	8.8	2.05	4.63	2.3
Manufacture of food products; beverages and tobacco products	C10-C12	0.06	1.18	19.7	2.52	4.45	1.8
Manufacture of textiles, wearing apparel, leather and related products	C13-C15	0.15	3.4	22.7	1.66	4.8	2.9
Manufacture of wood, paper, printing and reproduction	C16-C18	0.08	3.11	38.9	1.98	6.71	3.4
Manufacture of coke and refined petroleum products	C19	0.11	1.4	12.7	2.62	10.59	4
Manufacture of chemicals and chemical products	C20	0.53	2.12	4.0	1.78	3.74	2.1
Chemicals; basic pharmaceutical products	C20-C21	0.88	2.17	2.5	1.62	3.59	2.2
Manufacture of basic pharmaceutical products and pharmaceutical preparations	C21	1.66	2.21	1.3	1.28	3.17	2.5
Manufacture of rubber and plastic products and other non-metallic mineral products	C22-C23	0.18	1.86	10.3	1.98	5.4	2.7
Manufacture of basic metals and fabricated metal products, except machinery and equipment	C24-C25	0.13	1.93	14.8	1.82	5.41	3
Manufacture of computer, electronic and optical products	C26	2.21	59.47	26.9	2.88	6.11	2.1
Computer, electronic, optical products; electrical equipment	C26-C27	0.94	30.82	32.8	2.42	4.89	2
Manufacture of electrical equipment	C27	0.33	4.51	13.7	2.14	3.62	1.7
Manufacture of machinery and equipment n.e.c.	C28	0.34	4.23	12.4	2.22	5.22	2.4
Manufacture of motor vehicles, trailers, semi-trailers and of other transport equipment	C29-C30	1.1	4.79	4.4	1.99	3.33	1.7
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of	C31-C33	0.23	4.15	18.0	1.95	4.1	2.1
Electricity, gas, steam and air conditioning supply	D	0.64	1.27	2.0	1.15	2.41	2.1
Electricity, gas, steam; water supply, sewerage, waste management	D-E	0.48	1.23	2.6	1.15	2.63	2.3
Water supply; sewerage, waste management and remediation activities	E	0.21	1.15	5.5	1.16	3.18	2.7
Construction	F	0.28	0.51	1.8	1.21	4.01	3.3
Wholesale and retail trade; repair of motor vehicles and motorcycles	G	0.76	1.18	1.6	1.43	5.79	4
Wholesale and retail trade and repair of motor vehicles and motorcycles	G45	0.53	-	-	1.18	4.3	3.6
Wholesale trade, except of motor vehicles and motorcycles	G46	0.93	-	-	1.39	6.36	4.6
Retail trade, except of motor vehicles and motorcycles	G47	0.65	-	-	1.63	5.56	3.4
Transportation and storage	H	0.44	1.47	3.3	1.16	3.88	3.3
Land transport and transport via pipelines	H49	0.29	-	-	1.14	3.61	3.2
Water transport	H50	0.3	-	-	0.53	19.34	36.5
Air transport	H51	0.57	-	-	0.79	5.03	6.4
Warehousing and support activities for transportation	H52	0.59	-	-	1.12	3.47	3.1
Postal and courier activities	H53	0.51	-	-	1.63	3.89	2.4
Accommodation and food service activities	I	0.4	0.28	0.7	0.4	1.91	4.8
Information and communication	J	4.36	12.71	2.9	2.88	6.61	2.3
Publishing, motion picture, video, television programme production; sound recording, p	J58-J60	6.37	13.41	2.1	2.36	6.3	2.7
Telecommunications	J61	2.91	4.19	1.4	2.84	6.67	2.3
Computer programming, consultancy, and information service activities	J62-J63	3.67	15.26	4.2	3.26	6.47	2
Financial and insurance activities	K	0.92	4.97	5.4	3.31	10.13	3.1
Real estate activities	L	0.04	0.12	3.0	-	0.92	-
Professional, scientific and technical activities	M	0.73	5.12	7.0	4.11	7.99	1.9
Professional, scientific and technical activities; administrative and support service activ	M-N	0.63	3.61	5.7	3.14	6.31	2
Administrative and support service activities	N	0.49	1.44	2.9	1.68	3.91	2.3
Public administration and defence; compulsory social security	O	0.54	1.26	2.3	1.21	1.24	1
Public administration, defence, education, human health and social work activities	O-Q	0.44	0.85	1.9	1.13	1.17	1
Education	P	0.36	0.9	2.5	1.11	1.55	1.4
Human health and social work activities	Q	0.4	0.44	1.1	1.05	0.86	0.8
Human health activities	Q86	0.51	0.38	0.7	0.94	0.79	0.8
Residential care activities and social work activities without accommodation	Q87-Q88	0.11	0.55	5.0	1.34	0.97	0.7
Arts, entertainment and recreation	R	0.33	1.28	3.9	0.81	4.79	5.9
Arts, entertainment, recreation; other services and service activities, etc.	R-S	0.4	2.58	6.5	1.14	4.64	4.1
Other service activities	S	0.44	3.77	8.6	1.32	4.52	3.4
Market economy (all industries excluding L, O, P, Q)	MARKT	0.78	3.35	4.3	2.03	5.27	3.4

Notes: Numbers refer to average values as percentage of value added over the period 1995-2020. Source: Authors' own calculations based on the EUKLEMS/INTANProd 2022 database (Bontadini et al., 2023).

Such pronounced differences in software investment between France and Germany, despite their close economic integration within the EU and Eurozone, cannot be attributed solely to their actual industrial or firm performance. Instead, they are more likely the result of disharmonized measurement of software and embedded (in-house) software investments in the two countries.³

Figure 5. Investments in Software and Organizational Capital in selected Sectors over time, France and Germany, 1995-2020.



Source: Authors' own calculations based on the EUKLEMS/INTANProd 2022 database (Bontadini et al., 2023).

Second, we summarize the measurement of organizational capital. The current version of the EUKLEMS/INTANProd data release (Bontadini et al., 2023) measures investments in organizational capital – following Corrado et al. (2005, p. 29) – by attributing 20% of manager salaries as investments in organizational capital.⁴ The EUKLEMS/INTANProd data release

³ At large German corporations such as Bosch, Siemens and car manufacturers, software should account for a sizeable portion of total R&D expenditure, amounting to at least 1/4. For example, Bosch 2022 annual report indicates that 44,000 of its 85,500 R&D employees are software developers. At Siemens, software revenue in industrial process technology accounts for almost a quarter of total sales, suggesting that the software share within R&D is likely higher than this ratio.

⁴ We assume that the 20% figure was applied as the methodological background document (Bontadini et al., 2023) did not specify detailed calculation for the own-account estimate for organizational capital, although it clearly

(Bontadini et al., 2023) uses the Structural of Earning Survey, which provides information on the annual earnings and number of employees by occupation⁵. The crucial question here pertains to the quantity of managers in France and Germany. Might it be that France has a significantly higher portion of managers than Germany? Might this discrepancy be attributed to a lack of harmonization in the ISCO classification systems in France and Germany? Might this explain the larger investment rates, as depicted in Table 4, in organizational capital for France compared to Germany?

Our research seems to suggest this interpretation. Whereas in Germany, official statistics indicate a management share of 5% among the active population in 2017 (Schuster & Strahl, 2019), in France, we observe a four-fold higher proportion of 21.7% in 2022, from 8% in 1982 (Brillet, 2024). Such strong differences in the share of managers in France and Germany likely do not reflect differences in business and organizational models but rather point to a lack of harmonization in the ISCO classifications between the two countries. This likely explains a large portion of the significant variance in investments in organizational capital between France and Germany.

Regarding the specific measurement of investments in own-account organizational capital, and considering our research results in line with the recommendations of Stehrer et al. (2019), who constructed the first harmonized intangible EUKLEMS dataset⁶, own-account organizational capital investment data should be handled with great care, considering potential measurement issues in the ISCO classifications. Future research endeavors would need to refine both the conceptual and empirical part of the survey for organizational capital.

Thirdly, the large discrepancy in intangible investments between France and Germany might be partly due to an underreporting of intangibles in Germany (Roth et al., 2023) and a potential slight over-reporting in France (Guillou et al., 2018). Germany's investment in software appears to be unusually low, with France investing four times more on average over the period considered (3.4% in France vs 0.8% in Germany) and significantly less than all other EU countries in our sample. Moreover, the low investment levels in Germany, as highlighted by official sources and well-established databases based on them, such as the EUKLEMS/INTANProd database, which we utilize in this study, are at odds with the actual

mentioned its embeddedness in the CHS 2005 framework (Corrado et al., 2005, p. 29; Roth & Thum, 2013, p. 491).

⁵ The information is provided at the three-digit level of the 2008 International Standard Classification of Occupations (ISCO).

⁶ We refer to Roth (2025) for an overview.

industrial and firm performance in Germany. Our results indicate that Germany's investment in software should be higher than currently depicted in the German national accounts.

We want to highlight at this instance that addressing these measurement issues related to investments in software would increase software and, consequently, intangible capital investments in Germany. Given that software investments are incorporated in the official German GDP calculation, this would lead to an increase of Germany's official GDP.

Moreover, possible errors may also affect the measurement of organizational capital. The large differences between the two countries reflect differences in the number of managers between France and Germany. However, we advance that Germany's management share is likely too low, whereas France's share seems to be disproportionately high. In line with prior work by Stehrer et al. (2019), we opt for a cautious usage of the own-account data of organizational capital due to potential biases in the ISCO classification., and recommend further harmonization of ISCO classifications between Germany and France as well as across the EU.

Given that we identify measurement discrepancies in software and organizational capital investments between France and Germany, the first policy implication is further harmonization of data measurement at both national bilateral and EU levels. This might require a collaborative effort involving national statistical agencies, national ministries of economics, Eurostat, and other relevant stakeholders. This also holds for the harmonization of investments in organizational capital, especially regarding ISCO classifications.

Furthermore, due to the importance of intangibles for firms' performance and economic growth, urgent attention is required to address how firms account for their investments, particularly under current accounting rules such as IAS 38. The present IFRS rules for capitalizing intangibles emphasize separability, control, and certainty of future benefits and diverge from the intrinsic nature of intangible investments, such as complementarity, commonality and spillover effects, and uncertainty. There is a need to revisit these rules to align firm's accounting practices in order to allow European firms to disclose in a straightforward and easy-to-implement way their level of investment in intangible assets.

4. Conclusion

We find that the strong difference in intangible investments in software and organizational capital in France and Germany is partially attributable to measurement problems. Our analysis suggests that software and organizational capital investments in Germany are likely underreported in national accounts.

Several policy conclusions have been presented. First, our results ask for a more detailed exploration of the national accounts calculation of software in France and Germany and call for greater harmonization at the European level. Second, our findings ask for a reevaluation of the measurement of investment in organizational capital, encompassing both conceptualization and survey dimensions. Thirdly, we call for a prompt and straightforward reform of firm accounting practices to disclose the information regarding the key components of intangibles, making this information accessible to the different stakeholders. Future research endeavors should prioritize addressing these existing measurement issues in order to ensure accuracy in the harmonization of investment data for France and Germany.

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