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**Working Paper**

## Measurement Discrepancies in Intangible Capital: Evidence from Five Advanced Economies

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**Alberto Nonnis**

**Felix Roth**

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**Hamburg Discussion Paper in International Economics [No. 22]**

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**University of Hamburg****Privatdozentur in Economics**

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# Measurement Discrepancies in Intangible Capital: Evidence from Five Advanced Economies

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## Abstract

The growing importance of intangible capital poses major challenges for its measurement in national accounts. This paper asks whether estimates of intangible investment are comparable across countries, examining France, Germany, Italy, the UK and the US. We assess reported estimates against independent, internationally harmonized sources: occupational data on ICT specialists and managers, wage data from the Structure of Earnings Survey, R&D composition data from ANBERD, and firm-level investment data from the EIB Investment Survey (EIBIS). We find that the largest cross-country gaps, particularly in software and organizational capital, are difficult to reconcile with the underlying distribution of inputs. France and Germany employ similar shares of ICT specialists yet report a threefold difference in software investment relative to value added, while the higher organizational capital recorded in France is not matched by its managerial wage structure. A micro-informed recalibration suggests that these measurement differences can materially affect cross-country productivity comparisons.

**Keywords** Intangible capital • Measurement • Labor Productivity • EU

**JEL-Classifications** C82 • D24 • O47

# 1 Introduction

It is a well-documented stylized fact that advanced European economies and the US have experienced a prolonged productivity slowdown since the 2000s. The fact that this deceleration coincides with an era of massive investment in digital and disruptive technologies continues to puzzle scholars. This phenomenon is often referred to as the “productivity puzzle” or “productivity paradox 2.0”, an allusion to the original paradox of the 70s and 80s which prompted Robert Solow’s famous 1987 sentence that computers are seen everywhere except in productivity statistics. Much like in previous decades, the mismeasurement of new technologies offers a possible explanation for this conundrum. As noted by Brynjolfsson et al. (2021), this paradox may partly stem from the nature of capital in transformative technologies, where measured output remains initially low during the phase of high capital formation before the full benefits materialize. Today, many of these technologies rely on intangible assets, making their measurement increasingly important for the assessment of economic performance. In fact, a misrepresentation of intangible assets in national accounts is potentially able to explain not only part of the productivity puzzle (Nakamura, 2001; Brynjolfsson, Hitt & Yang, 2002), but could also directly translate into productivity differences across countries.<sup>1</sup>

National accounting systems capitalize several knowledge-based assets, including R&D, software and databases, under intellectual property products (IPP). Yet many intangible activities are internally generated and not directly observable in corporate financial statements, so their measurement relies on estimation procedures and indirect data sources. Data sources and implementation choices may also differ across countries, potentially affecting the comparability of the resulting estimates.

A related issue concerns intangible assets that are not currently treated as investment in national accounts but may generate benefits over multiple periods. The framework proposed by Corrado et al. (2005) classifies intangibles into three macro-categories (such as computerized information, innovative property and economic competences) and advocates treating several additional items as capital formation, such as organizational capital, branding, training, and design. The framework has been widely adopted in the literature, including its implementation in the EUKLEMS/INTANProd database (hereafter EUKLEMS, Bontadini et al., 2023), which we also use in this study. These broader measures provide a useful basis for productivity

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<sup>1</sup> This interpretation is contested: Syverson (2017) and Byrne, Fernald and Reinsdorf (2016) argue that the mismeasurement leaves the productivity slowdown largely unexplained.

analysis, but their measurement remains less established than that of assets formally included in national accounts.

A recent strand of the literature has drawn attention to large differences in measured software and organizational capital between France and Germany. Nonnis, Roth and Bounfour (2025) documented these differences and argued that they are unlikely to reflect genuine economic disparities. Nonnis, Roth and Bounfour (2026) examined the implications of these differences for growth accounting. Both studies, however, took the estimates of intangible investment as given and focused on the France-Germany comparison.

The present paper goes beyond this by asking whether the observed cross-country differences in intangible investment are genuine economic phenomena or largely reflect differences in statistical measurement. Focusing on five major economies (France, Germany, Italy, the UK and the US), we first assess the reported estimates of intangible investment against independent, internationally harmonized sources: occupational data on ICT specialists and managers, wage data from the Structure of Earnings Survey, and R&D composition data from ANBERD. This external validation suggests that several of the most striking cross-country gaps, notably the much higher software and organizational capital investment recorded for France relative to Germany, are difficult to reconcile with the underlying distribution of inputs, and are more consistent with differences in how statistical institutes implement common methodologies. We then draw on firm-level survey data from the European Investment Bank Investment Survey to assess the magnitude of these discrepancies. Under a set of illustrative assumptions, micro-informed adjustments would lower measured French labor productivity by up to around 4%, while raising the estimates for Germany and Italy. These magnitudes should be read as indicative rather than definitive, but they suggest that international comparisons of technological and productivity performance based on current intangible estimates warrant considerable caution.

This paper is structured as follows. Section 2 reviews the literature on intangible investment, cross-country comparisons, and measurement. Sections 3 and 4 present the descriptive evidence at the macro and micro level, respectively. Section 5 discusses potential sources of measurement heterogeneity between countries. Section 6 assesses the consistency of the macro evidence using external sources. Section 7 presents the recalibration of the investment and LPG series. Section 8 concludes.

## 2 Background and Related Literature

The measurement of intangible capital has its roots in the framework of CHS (2005), which broadened the concept of investment to include expenditure on assets such as software, R&D, and organizational capital. Subsequent work has incorporated these assets into national accounts and productivity analysis, providing estimates for a growing number of countries (e.g., Corrado et al., 2013, 2022; Bontadini et al., 2023). This literature has also highlighted the potential role of intangible investment in understanding the productivity slowdown (Ahmad et al., 2017). In particular, the delayed productivity effects of complementary investments around general-purpose technologies suggest that conventional measures may miss part of the output and capital associated with intangible-intensive production (Brynjolfsson, Rock and Syverson, 2021).

These developments have made intangible investment estimates an increasingly common input into cross-country comparisons of productivity and economic performance. Studies such as van Ark et al. (2009), Corrado et al. (2013, 2022), Roth and Thum (2013), Niebel, O'Mahony and Saam (2017) use internationally comparable datasets to examine differences in intangible investment and their relationship with productivity growth. The cross-country dimension is important in this literature because differences in intangible investment are often interpreted as reflecting differences in economic structure, innovation, or productivity performance. Yet the international comparability of the underlying estimates is generally taken as given. Harmonization at the database level does not necessarily imply that the underlying national estimates are constructed in the same way.

There is a related literature showing that the measurement of individual intangible assets can be sensitive to definitions, data sources, and estimation procedures. This issue has been particularly evident for software, where estimates of own-account production depend on occupational classifications, labor inputs, time-use assumptions, and the treatment of activities such as IT consulting and cloud services (Lequiller et al., 2003; Ahmad et al., 2017). Similar concerns arise for organizational capital. OECD work has shown that estimates based on occupational and task-based approaches can vary depending on which activities and occupations are considered to contribute to organizational capital (Squicciarini and Le Mouél, 2012; Le Mouél and Squicciarini, 2015). More generally, firm-level surveys and direct measures of management practices provide alternative ways of observing some intangible activities that are difficult to capture in national accounts (e.g., Bloom and Van Reenen, 2007).

Survey evidence also indicates that firms themselves find these categories hard to report consistently, particularly for organizational capital and own-account software (Martin, 2024).

These contributions point to an important distinction. Measurement problems have been documented for individual intangible assets, and intangible investment estimates have been widely used for international comparisons, but the two strands of literature have rarely been brought together. In particular, there is limited evidence on whether differences in national-account estimates across countries are consistent with differences in observable inputs and activities measured using a common external source.

This paper addresses this gap by assessing national-account measures of intangible investment against independent, internationally harmonized evidence on the inputs that underlie them, for five major economies. We use occupational data on ICT specialists and managers, wage data from the Structure of Earnings Survey, and data on the sectoral composition of business R&D from ANBERD, and we then draw on harmonized firm-level survey data to assess the magnitude of the resulting discrepancies. Rather than proposing a new measure of intangible investment, we use this external evidence to assess the plausibility of existing estimates and to construct a micro-informed recalibration.

### **3 Cross-Country Patterns in Intangible Investment and Productivity**

Our analysis begins with a comparison of intangible capital investment among the five selected countries, using macro-sectoral data from the 2025 release of the EUKLEMS/INTANProd database (Luiss LLEE, 2025; Bontadini et al., 2023).<sup>2</sup> Figure 1 illustrates average intangible and tangible capital formation relative to real gross value added over the 1995-2021 period. It distinguishes between official national accounts assets (panel a), and non-official intangibles based on internal calculations by the database creators (panel b), and tangible capital (panel c).

While tangible capital accumulation remains broadly comparable across countries, the data reveal pronounced cross-country heterogeneity in intangible assets. Italy and Germany invest considerably less than the sample average, particularly when combining official national accounts figures with non-official estimates. By contrast, France and the UK display higher

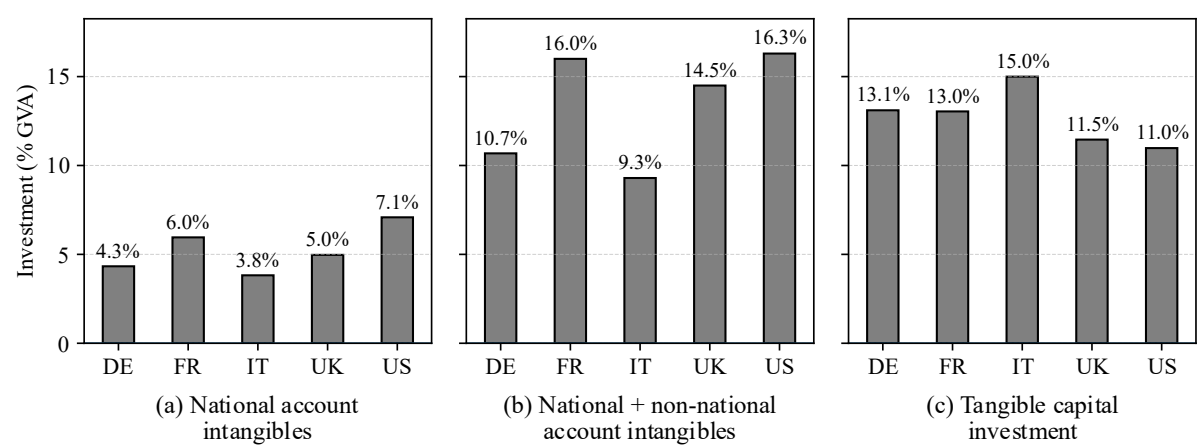
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<sup>2</sup> For National Accounts variables, this article uses the EUKLEMS database mainly for its harmonized cross-country architecture. It is important to note that EUKLEMS faithfully reports the official data published by national statistical institutes. Therefore, any inconsistencies observed in these specific variables reflect inherent differences in official national accounting frameworks, rather than artifacts of the EUKLEMS harmonization process.

investment shares in panel b. The UK pattern appears largely driven by non-national-account intangibles, while France’s investment is relatively high also for national-account intangibles.

A comparison with the United States provides a useful benchmark. The US leads in both panels and exhibits the highest overall levels of intangible investment. Notably, when combining all intangible categories (panel b), most European economies remain considerably behind. However, French investment levels closely trail those observed in the US (16% vs. 16.3%). This outcome is unexpected given the technological leadership of the US in the past decades, which is still reflected today in the global weight of its largest technology firms.

Figure 1. Intangible and Tangible Capital Investment as Percentage of Gross Value added



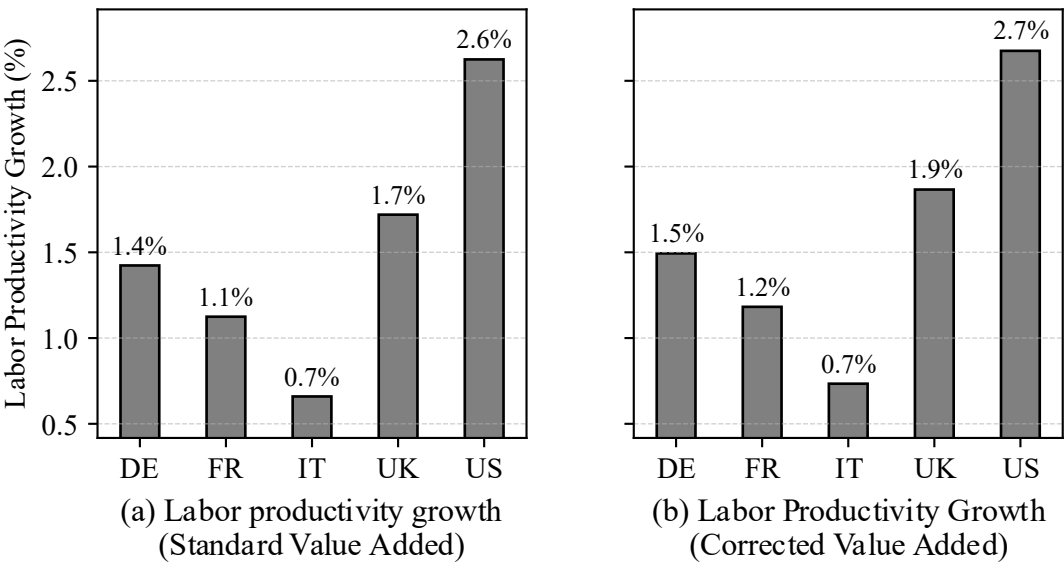
**Notes:** Following CHS (2005), national account intangibles include software and databases, R&D and other intellectual property products, while non-national account intangibles include organizational capital, brand, design, and training. The figures report average values for the market economy over the full sample period (1995-2021) and show the ratio of investment in intangible and tangible assets to real gross value added (standard measure in panels a and c and corrected for non-national-account intangibles in panel b). All variables are expressed in real terms using chained linked volumes (2020). Source: Authors’ calculations based on the EUKLEMS/INTANProd 2025 database (Bontadini et al., 2023).

The investment patterns in Figure 1 largely align with LPG over the same period, as shown in Figure 2, which reports average LPG for the selected economies using both standard value added (panel a) and an adjusted metric incorporating non-official intangibles following the EUKLEMS methodology (panel b). For the US, the UK, and Italy LPG mirrors their respective intangible investment trajectories: the US leads, Italy lags behind, and the UK represent an intermediate case with relatively high intangible investment matched by consistent productivity gains. France and Germany stand out as exceptions. Germany exhibits stronger LPG than its investment levels would imply, while France displays weaker LPG than expected. The contrast between these two neighboring countries is particularly surprising given their structural

economic similarities and deep integration. A vast discrepancy emerges when comparing their total intangible investments (16% vs. 10.7%), a gap that persists, to a lesser extent, when focusing solely on official national accounts intangibles (6% vs. 4.3%). Such divergence is difficult to attribute to capital efficiency alone and is consistent with the measurement anomalies previously discussed in Nonnis, Roth and Bounfour (2025). To understand what drives these variations, Figures 3 and 4 report average investment shares relative to gross value added for official and non-official intangibles, respectively.

Focusing initially on national-account intangibles, Figure 3 indicates that software accumulation largely drives the patterns described above. Germany allocates surprisingly little capital to software relative to the other countries, while France invests markedly more, even surpassing the US. At the same time, US software expenditures appear relatively modest, falling below those recorded for the UK.

Figure 2. Average Labor Productivity Growth (1995-2021)

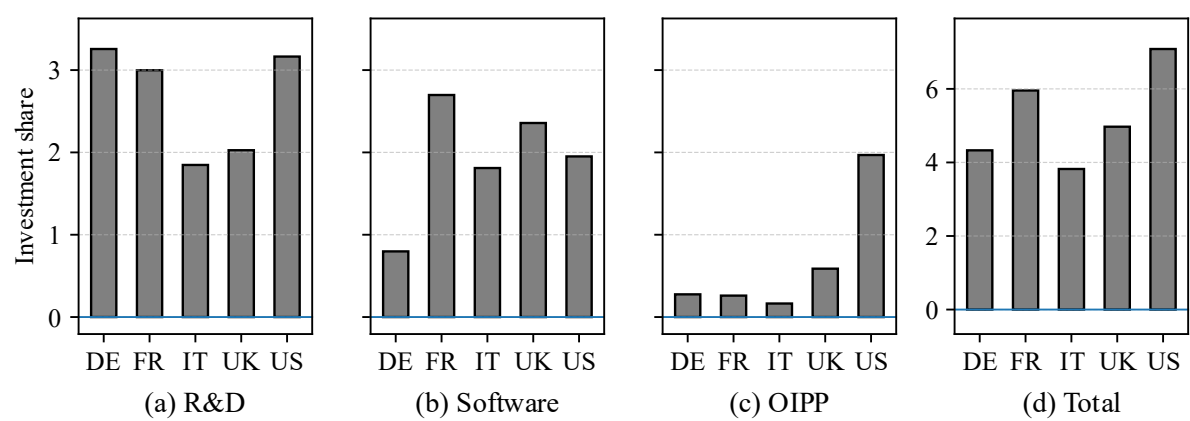


**Notes:** The figures report labor productivity growth (LPG) over the full sample period (1995-2021) for the market economy, computed as gross value added per hour worked by persons engaged. Panel (a) uses the standard measure of value added, while panel (b) uses value added adjusted for non-national-account intangibles. Value added is expressed in real terms using chained linked volumes (2020). Source: Authors’ calculations based on the EUKLEMS/INTANProd 2025 database (Bontadini et al., 2023).

Another notable feature is the large difference in the OIPP component between the US and European economies, with the US investing disproportionately more. At first glance, this gap might suggest potential misallocations between the different categories. However, OIPP does

not constitute a primary official category but is computed as a residual (total intellectual property products, N117, minus R&D, N1171, and software and databases, N1173). Moreover, not all statistical institutes consistently provide industry-level disaggregation for N1171-N1173. The OIPP component also includes artistic originals and mineral exploration, both of which are particularly important in the US due to the size of the entertainment industry and the vast scale of its mining sector. Importantly, even if one assumes a hypothetical reallocation of these assets across categories, the overarching narrative remains unchanged: total US intangible investment would still appear relatively low compared with France, as already shown in Figure 1.

Figure 3. National Account Intangibles as Percentage of Real Gross Value added



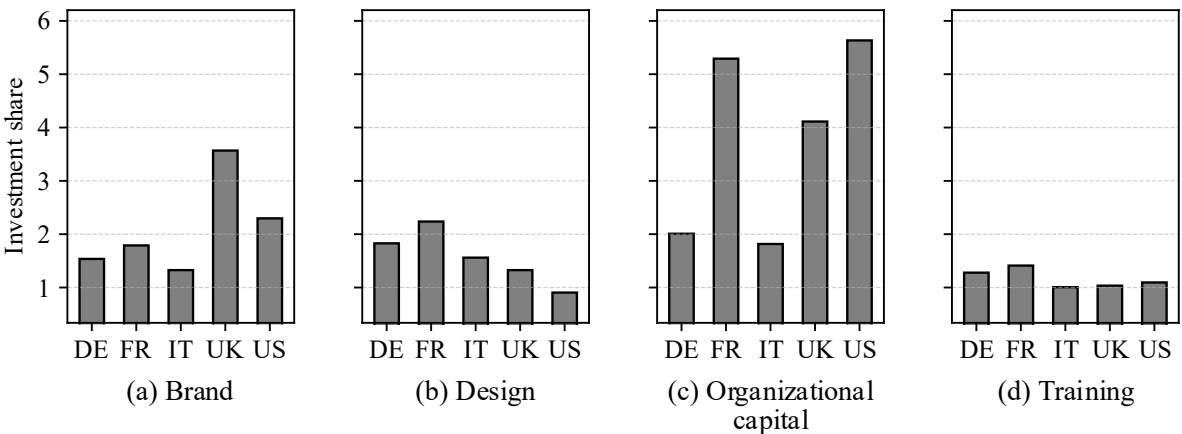
**Notes:** The figures report average values for the market economy over the full sample period (1995-2021) for the three intangible capital aggregates included in national accounts (R&D, software and OIPP), as well as total national account intangibles. All variables are expressed as the ratio of intangible investment to real gross value added (standard measure). All variables are expressed in real terms using chained linked volumes (2020). Source: Authors’ calculations based on the EUKLEMS/INTANProd 2025 database (Bontadini et al., 2023).

R&D investment patterns remain generally aligned with the LPG narrative discussed earlier, at least among the European countries. Germany invests slightly more than France and almost as much as the US, while Italy consistently ranks last. This observation reinforces the argument that software expenditure exhibits the most anomalous pattern, therefore deserving deeper investigation.

Regarding non-national-account intangibles in Figure 4, cross-country differences are predominantly driven by organizational capital. Two distinct clusters emerge: the US, the UK and France invest over 4-5% of value added, whereas Italy and Germany remain below the 2% threshold, with levels comparable to those observed for other non-official intangibles. While the relatively high levels observed in the US and the UK, as well as the lower values in Italy,

align logically with their economic structures and the LPG levels discussed earlier, the contrast between France and Germany once again appears disproportionate. As discussed in subsequent sections, these differences in organizational capital may partly reflect the indirect methodologies used in their estimation.

Figure 4. Non-National Account Intangibles as Percentage of Real Gross Value added



**Notes:** The figures report average values for the market economy over the full sample period (1995-2021) for the four EUKLEMS intangible capital aggregates not included in national accounts (brand, design, organizational capital and training). All variables are expressed as the ratio of intangible investment to real gross value added (corrected for non-national account intangibles). All variables are expressed in real terms using chained linked volumes (2020). Source: Authors’ calculations based on the EUKLEMS/INTANProd 2025 database (Bontadini et al., 2023).

Finally, brand, design and training display relatively moderate cross-country variation. The UK records the highest brand investment, a pattern that the stronger role of service and marketing-intensive sectors in its economy cannot fully explain. Similarly, the comparatively low accumulation in Germany across several categories is only partially explainable by an economic model heavily oriented toward traditional manufacturing activities. Ultimately, structural differences alone are insufficient to account for the magnitude of the international discrepancies observed in aggregate intangible capital formation.

## 4 Firm-level Evidence on Intangible Investment

Further insight into these patterns can be obtained by comparing macroeconomic aggregates with firm-level survey data. In particular, Figure 5 compares EUKLEMS figures with data from the EIB Investment Survey (EIBIS, wave 2025; EIB, 2025), which does not cover the UK. The survey reports intangible and tangible investment as a share of total investment and includes categories that are generally comparable to those used in EUKLEMS, namely tangible capital, R&D, software, organizational capital and training.

In the bottom part of Figure 5, EUKLEMS figures from Figures 3 and 4 are re-expressed to report investment as a share of total investment rather than value added.<sup>3</sup> However, surveyed firms may report investment categories differently from macro data, due to difficulties in distinguishing software development and R&D activities. This issue is especially evident in Germany, where software investment reported in EIBIS is more than four times larger than that recorded in EUKLEMS (16% vs. 3.8%), while R&D is two and a half times higher in EUKLEMS (15.5% vs. 6%). This pattern is consistent with the classification difficulties discussed in Nonnis, Roth and Bounfour (2025), who note that large industrial firms, such as Bosch, Siemens, or major automotive manufacturers, often employ software developers within R&D departments.

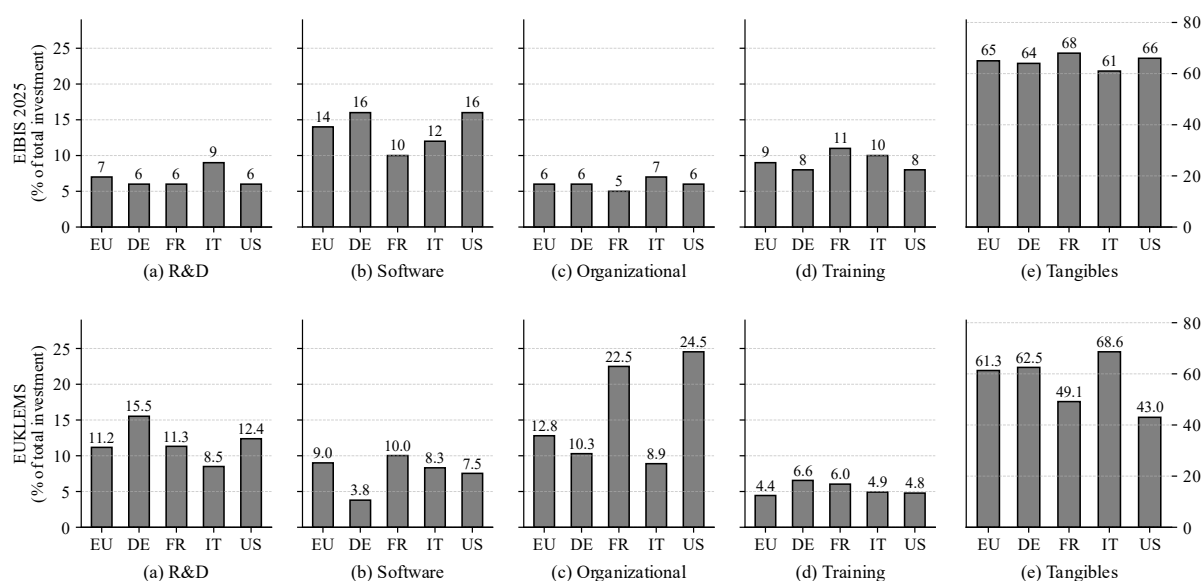
On the other hand, while software accumulation tends to be higher in EIBIS in most countries, France's reported investment is identical in both sources (10%). Meanwhile, R&D remains higher in EUKLEMS, consistent with the argument developed earlier, providing an additional indication that EUKLEMS software figures for France may be overstated. The pattern of elevated R&D estimates in EUKLEMS and lower figures in EIBIS also holds for the US. However, this trend is less pronounced in Italy, where R&D levels are generally similar across the two databases.

To mitigate this issue, it is useful to consider R&D and software jointly. When the two categories are aggregated, EIBIS values become slightly higher than EUKLEMS in Germany (22% vs. 19%), Italy (21% vs. 17%) and the US (22% vs. 20%). In comparison, France remains the only country where EUKLEMS reports considerably higher combined investment (21 vs. 16%).

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<sup>3</sup> Despite this conversion, the two databases should not be interpreted as directly comparable, as they rely on different measurement approaches (industry-level estimates vs. firm-level survey responses).

Figure 5. Intangible and Tangible Investment Shares: EIBIS vs. EUKLEMS



**Notes:** The top panel displays average shares of investment reported by firms in response to the 2025 EIB Investment Survey question: “In the last financial year, how much did your business invest in each of the following with the intention of maintaining or increasing your company’s future earnings?”. Software refers to “software, data, IT networks, and website activities”; Organizational investment to “organisation & business process improvements”; training to “training of employees”; and tangibles to the sum of “machinery and equipment” and “land, business buildings and infrastructure”. The bottom panel displays EUKLEMS investment shares for the market economy for the corresponding categories expressed as a percentage of total investment. Total investment is computed as the sum of R&D, software, OIPP, organizational capital, training, and tangible capital. Source: Authors’ calculations based on the EUKLEMS/INTANProd 2025 database (Bontadini et al., 2023) and on the EIB Group Survey on Investment and Investment Finance (EIB, 2025).

Turning to non-national-account intangibles, training displays relatively little variation among countries in both databases. Organizational capital, however, exhibits markedly different patterns: while EIBIS reports comparable values, EUKLEMS records much higher levels for France and the US, more than twice those observed in Germany and Italy. These differences are mirrored in tangible investment shares, which are rather similar between countries in EIBIS, but appear lower in France and the US in EUKLEMS, reflecting the larger share of intangible investment recorded in the macroeconomic data for these economies.

Table 1. EIBIS vs EUKLEMS Ratios

| BENCHMARK EU   |         |       |            | BENCHMARK US   |         |       |            |
|----------------|---------|-------|------------|----------------|---------|-------|------------|
| Germany        |         |       |            | Germany        |         |       |            |
|                | EUKLEMS | EIBIS | Difference |                | EUKLEMS | EIBIS | Difference |
| R&D            | 1.39    | 0.86  | 0.53       | R&D            | 1.25    | 1.00  | 0.25       |
| Software       | 0.42    | 1.14  | -0.72      | Software       | 0.50    | 1.00  | -0.50      |
| R&D + Software | 0.96    | 1.05  | -0.09      | R&D + Software | 0.97    | 1.00  | -0.03      |
| Organizational | 0.80    | 1.00  | -0.20      | Organizational | 0.42    | 1.00  | -0.58      |
| Training       | 1.48    | 0.89  | 0.59       | Training       | 1.37    | 1.00  | 0.37       |
| Tangibles      | 1.02    | 0.98  | 0.04       | Tangibles      | 1.45    | 0.97  | 0.48       |
| France         |         |       |            | France         |         |       |            |
|                | EUKLEMS | EIBIS | Difference |                | EUKLEMS | EIBIS | Difference |
| R&D            | 1.01    | 0.86  | 0.15       | R&D            | 0.91    | 1.00  | -0.09      |
| Software       | 1.11    | 0.71  | 0.40       | Software       | 1.33    | 0.63  | 0.70       |
| R&D + Software | 1.06    | 0.76  | 0.30       | R&D + Software | 1.07    | 0.73  | 0.34       |
| Organizational | 1.76    | 0.83  | 0.93       | Organizational | 0.92    | 0.83  | 0.09       |
| Training       | 1.36    | 1.22  | 0.14       | Training       | 1.26    | 1.38  | -0.12      |
| Tangibles      | 0.80    | 1.05  | -0.25      | Tangibles      | 1.14    | 1.03  | 0.11       |
| Italy          |         |       |            | Italy          |         |       |            |
|                | EUKLEMS | EIBIS | Difference |                | EUKLEMS | EIBIS | Difference |
| R&D            | 0.76    | 1.29  | -0.53      | R&D            | 0.69    | 1.50  | -0.81      |
| Software       | 0.92    | 0.86  | 0.06       | Software       | 1.10    | 0.75  | 0.35       |
| R&D + Software | 0.83    | 1.00  | -0.17      | R&D + Software | 0.84    | 0.95  | -0.11      |
| Organizational | 0.69    | 1.17  | -0.48      | Organizational | 0.36    | 1.17  | -0.81      |
| Training       | 1.11    | 1.11  | 0.00       | Training       | 1.03    | 1.25  | -0.22      |
| Tangibles      | 1.12    | 0.94  | 0.18       | Tangibles      | 1.60    | 0.92  | 0.68       |
| US             |         |       |            |                |         |       |            |
|                | EUKLEMS | EIBIS | Difference |                |         |       |            |
| R&D            | 1.11    | 0.86  | 0.25       |                |         |       |            |
| Software       | 0.84    | 1.14  | -0.30      |                |         |       |            |
| R&D + Software | 0.99    | 1.05  | -0.06      |                |         |       |            |
| Organizational | 1.92    | 1.00  | 0.92       |                |         |       |            |
| Training       | 1.08    | 0.89  | 0.19       |                |         |       |            |
| Tangibles      | 0.70    | 1.02  | -0.32      |                |         |       |            |

**Notes:** The table reports cross-country investment ratios by asset category using data from EUKLEMS and EIBIS. Ratios are computed relative to the EU average (left panel) and relative to the US (right panel). Values above (below) indicate higher (lower) investment relative to the benchmark. The difference column reports the gap between EUKLEMS and EIBIS ratios. Source: Authors' calculations based on the EUKLEMS/INTANProd 2025 database (Bontadini et al., 2023) and on the EIB Group Survey on Investment and Investment Finance (EIB, 2025).

While EIBIS and EUKLEMS are not directly comparable in levels, relative cross-country ratios within each category are more informative. Table 1 benchmarks the countries in our sample against the EU average (left panel) and against the US (right panel), using both EIBIS and EUKLEMS data. Because the EU aggregate is defined differently<sup>4</sup> in the two datasets, the ratios should be interpreted as indicative of relative patterns rather than exact comparisons.

A first important aspect concerns the distinction between digital knowledge components (namely, R&D and software). As discussed above, these categories are often difficult to disentangle in firm-level data. When considering them jointly, ratios for Germany and the US appear relatively similar across the two datasets. On the other hand, Italy displays lower values in EUKLEMS than in EIBIS, with differences of around 0.11-0.17, while France shows even larger gaps of roughly 0.30-0.34. This suggests that the divergence between macro and survey data is not uniform across countries.<sup>5</sup>

Second, the largest discrepancies arise in organizational capital. In EUKLEMS, France and the US exhibit considerably higher ratios than those reported in EIBIS. Finally, training investment shows comparatively smaller differences between databases, although EUKLEMS values tend to be higher for Germany.

Overall, the evidence indicates that the main divergences across the two sources are concentrated in a limited set of categories and countries. Importantly, the discrepancies between France and Germany do not disappear when moving from macro to micro data. France tends to display higher intangible investment ratios in EUKLEMS than in the survey data, particularly for software and organizational capital, whereas Germany appears more stable across the two sources. Furthermore, Italy shows slightly lower macroeconomic ratios in intangible categories, which may suggest a modest underestimation of intangible investment in macro data. Finally, investment ratios in the EUKLEMS meso/macro data for the US (similar to France) display considerably higher ratios than the micro-level EIBIS data.

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<sup>4</sup> Specifically, the EU aggregate in our EUKLEMS data is based on the 15 European countries with complete data availability (which includes the UK), whereas the EIBIS EU average covers the 27 current EU member states (excluding the UK).

<sup>5</sup> Independent evidence from the UK points in the same direction. Martin (2024) compares survey-based and macro estimates of intangible investment for the UK market sector and finds that they diverge considerably, particularly for the non-capitalized intangibles (Martin, 2024, p. 956). He also documents that firms appear to under-report own-account software (only 15-18% report it, against 49-78% employing ICT specialists, p.956).

## 5 Sources of Measurement Heterogeneity in Intangible Investment

### 5.1 Estimation of Own-Account and Purchased Software

Much of the cross-country differences in recorded software investment come from own-account production, that is software that firms develop for their own use. Since this activity is not directly observed in financial statements, it must be estimated. More informative than the levels, which are not fully comparable across countries, is the share of own-account production in total software investment. This share is high in the UK<sup>6</sup> (70% in 2019), France (52%), and Germany (49%), but much lower in the US<sup>7</sup>, (16% in 2019).<sup>8</sup> The pattern is difficult to explain by differences in actual software production alone. For example, the US, which has by far the largest software economy, reports the lowest share of own-account production.

All five countries model own-account software from occupational data, but they differ in what they observe directly and what they impute (Table 2). At one end, France and the UK anchor the estimate on observed wages (the aggregate wage bill from administrative payroll records, the DSN, in France, ASHE wages by occupation in the UK), to which country-specific corrections for time and non-wage costs are then applied. At the other end, Germany and Italy start from the observed occupational head-count and apply time-share deductions before multiplying by labor costs, with the labor-cost component itself largely imputed and constructed differently in each country. The US sits in between, observing both an occupational head-count and industry wages, but still relying on assumed time-use factors to isolate own-account software work. Across all five, then, the estimate rests on a parameter that none of them observes (the share of working time devoted to own-account software).

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<sup>6</sup><https://www.ons.gov.uk/economy/economicoutputandproductivity/productivitymeasures/bulletins/investmentinintangibleassetsintheuk/2023>

<sup>7</sup> [https://apps.bea.gov/iTable/?reqid=19&step=3&isuri=1&nipa\\_table\\_list=331&categories=survey](https://apps.bea.gov/iTable/?reqid=19&step=3&isuri=1&nipa_table_list=331&categories=survey)

<sup>8</sup> Italy, France and Germany's statistical offices do not publish the full own-account software series, unlike the UK and the US. We therefore take the French and German figures directly from methodological documentation, for different reference years, and do not report a figure for Italy. To give an idea of the evolution of own account software over time, in the US it was \$65.6 billion in 2017, \$71.2 billion in 2019 and \$97.4 billion in 2024; in the UK it was £23.0 billion in 2016, £27.4 billion in 2019 and £42.9 billion in 2023.

**Table 2. Concordance of software estimation methods across national statistical systems**

| Dimension                                         | France                                                                                                                                                                                                                               | Germany                                                                                                                                                   | Italy                                                                                                                                                                                                                                              | UK                                                                                                                                                            | US                                                                                                                                                    |
|---------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1. Own-account software: estimation method</b> | Wage-based: gross wage bill from DSN payroll records, with time-use coefficients for IT-profession software work. Non-wage costs imputed from IT-sector ratios. External IT consulting added separately. ( <i>INSEE 2024, p. 2</i> ) | Head-count-based: software occupations from the Mikrozensus × involvement rate × imputed labor cost, plus mark-up. ( <i>Destatis 2016, §5.337–5.345</i> ) | Head-count -based: LFS employment shares by IT occupation, adjusted by OECD-Manual time coefficients x per-capita labor costs. Other cost components from the software sector (Division 62) structure. ( <i>Istat 2025, §4.18.4, pp. 213–214</i> ) | Wage-based (“sum of costs”): ASHE wages by occupation, with non-wage labor costs (ABS) and non-labor costs (supply-use tables). ( <i>ONS, 2026, pp. 5.9</i> ) | Hybrid: software-development occupations (BLS OEWS) × industry wage, reduced by occupation-based time-use factors. ( <i>BEA 2024, pp. 6-37/6-38</i> ) |
| <b>2. IT consulting</b>                           | Reclassified from direct GFCF to intermediate consumption (2020 benchmark), but is re-added as a cost component of own-account output (+€7.2 bn in 2019). ( <i>INSEE 2024, p. 3</i> )                                                | Excluded from purchased software: IT consulting, training and other services (and hardware-integrated software). ( <i>Destatis 2022, §5.434, p. 329</i> ) | IT consultancy (CPA 6202) and IT-equipment management (CPA 6203) fall outside software GFCF; subcontracted programming also excluded. ( <i>Istat 2025, §4.18.5, p. 215</i> )                                                                       | <i>Not addressed in source.</i>                                                                                                                               | No separate “IT consulting” boundary defined in BEA documentation. ( <i>BEA 2024, pp. 6-37/6-38</i> )                                                 |
| <b>3. SaaS / cloud</b>                            | Recurring usage fees (software packages, hosting, SaaS) recorded as intermediate consumption, GFCF only if used >1 year. ( <i>INSEE 2024, pp. 1, 3</i> )                                                                             | SaaS usage fees recorded as intermediate consumption, not GFCF. ( <i>Destatis 2022, §5.434, p. 329</i> )                                                  | <i>Not addressed (general &gt;1-year rule present; nothing SaaS-specific).</i>                                                                                                                                                                     | <i>Not addressed in source.</i>                                                                                                                               | <i>Not addressed in source.</i>                                                                                                                       |
| <b>4. Primary data source</b>                     | Individual-level administrative records (DSN), filed by employers. ( <i>INSEE 2024, p. 2</i> )                                                                                                                                       | Individual-level household survey (Mikrozensus). ( <i>Destatis 2016, §5.339</i> )                                                                         | Household survey (LFS) for the head-count, business data (Frame-SBS) for cost structure. ( <i>Istat 2025, pp. 213–214</i> )                                                                                                                        | Employer survey (ASHE). Respondents are the employers of sampled employees. ( <i>Martin 2024, p. 940</i> )                                                    | Establishment survey (BLS OEWS). ( <i>BEA 2024, p. 6-38</i> )                                                                                         |
| <i>Occupational classification</i>                | <i>Not specified in source (IT professions via DSN)</i>                                                                                                                                                                              | <i>National occupational codes (KldB), not mappable to ISCO. (Destatis 2022, §5.442)</i>                                                                  | <i>LFS occupational data (national classification, not specified as ISCO in source)</i>                                                                                                                                                            | <i>SOC (Martin 2024, p. 940)</i>                                                                                                                              | <i>SOC (BEA selects specific software occupations; p. 6-38, note 30)</i>                                                                              |

**Notes:** Cells report the treatment documented in each country’s primary methodological sources. Page and paragraph references are provided for verification. “Not addressed” means the consulted source is silent on the issue. The table documents the estimation methods: the resulting differences help explain why the magnitudes reported in the text are not directly comparable across countries.

Moreover, a further axis of variation is the underlying data source: household surveys in Germany and Italy, employer or administrative records in France<sup>9</sup>, the UK<sup>10</sup> and the US.

The treatment of purchased software adds two further contested boundaries: IT consulting and cloud/SaaS. Countries draw the line differently: France reclassified IT consulting to intermediate consumption yet let it re-enter its own-account estimates indirectly, whereas Italy excludes IT consultancy from software capital formation outright, and SaaS usage fees are increasingly recorded outside investment altogether. Table 2 documents each country's treatment, with sources. The point here is that these are definitional choices, not economic differences, yet they materially shape the measured aggregates.

## 5.2 Distinguishing R&D and Software Activities

Another source of measurement uncertainty relates to the distinction between R&D and software investment. At the firm level, the two categories are difficult to disentangle: in many large firms, software developers are employed within R&D departments and contribute simultaneously to product development and software production. For instance, large industrial corporations often employ software engineers within their R&D workforce, reflecting the increasing importance of digital components in industrial innovation.

In national accounts, R&D and software are treated as separate assets. However, because their estimation relies on a mix of employment data and enterprise surveys, the same underlying activity may potentially be captured in both categories, creating a risk of double counting (Eurostat, 2014, p. 28). For example, a developer's salary might be reported as R&D investment based on the Frascati survey methodology (Eurostat, 2014, p.22), while the same activity may also be captured as own-account software through employment data from household or employer surveys (OECD, 2010, p. 116), as discussed in the previous subsection.

International guidelines address this overlap by requiring deductions between the two categories. When custom software is produced as part of an R&D activity, the final product is classified as software, while the embedded R&D component is treated as intermediate

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<sup>9</sup> Potential harmonization issues in software investment measurements have also been implicitly acknowledged in France, where INSEE revised its estimates and published a methodological note on the changes introduced with the 2020 benchmark revision (INSEE, 2024).

<sup>10</sup> The ONS has itself acknowledged these discrepancies, noting that differences in data sources lead to different estimates of intangible investment for the UK despite the conceptual comparability, and reporting that it is in early discussions with the Luiss team to investigate the reasons (ONS, 2024).

consumption in the software estimate.<sup>11</sup> The conceptual need to avoid double counting is therefore universal, but its practical implementation may differ considerably. Some statistical offices apply detailed, sector-specific deductions, while others rely on broader sectoral adjustments or more aggregate assumptions.

For example, Germany applies explicitly sectoral deductions, particularly in R&D-intensive industries. In WZ 72, for instance, software output is reclassified as R&D GFCF because of the high share of basic research in the sector (Destatis, 2016, para. 5.343).<sup>12</sup> Other countries apply adjustments at a more aggregate level. These differences in implementation are not neutral: because the boundary between R&D and software is drawn differently across statistical systems, part of the observed cross-country variation in these two assets may reflect methodological differences rather than genuine differences in economic activity.

These measurement challenges are consistent with the pattern observed in firm-level survey data discussed in the previous section, where respondents often report difficulty distinguishing between software development and R&D activities (Martin, 2024).

### **5.3 Measurement of Organizational Capital**

Organizational capital is another category estimated almost entirely by indirect methods. Following CHS (2005, 2009), it is measured as the sum of two components: an own-account part, the value of management time spent improving the organization, and a purchased part, expenditure on management consulting. EUKLEMS estimates the own-account component as a share of managerial labor costs, using occupational employment and a time-use assumption (Bontadini et al., 2023), and the purchased component from intermediate consumption of management-consulting services (CPA M69-M70, refined using the consulting share of NACE M702) (Bontadini et al., 2023, pp. 23-24, 27-28). The release applies the CHS convention of attributing a fixed one-fifth of managerial pay to organizational development, a fraction the original authors describe as “admittedly arbitrary” (CHS, 2005, p.29), using the Structure of Earnings Survey (Bontadini et al., 2023).

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<sup>11</sup> “It is most practical to consider the final product as software. So in this case, the R&D will be embedded in the final software product, and should be treated as intermediate consumption in the estimation of the software IPP” (Eurostat, 2014, p. 28).

<sup>12</sup> “Deductions in WZ 72 (research and development), due to the high ratio of basic research, which cannot be reported under software in accordance with ES VG 2010, but rather under GFCF in research and development” (Destatis, 2016, para. 5.343).

Because the estimate rests on an assumed share of managerial time, it is sensitive to how managers are counted and paid. Differences in occupational classification, survey coverage, and labor-market structures can therefore drive differences in organizational capital across countries that have nothing to do with firms' actual organizational investment. Firm-level survey evidence corroborates this fragility directly: in linked UK business surveys, "business process improvement", the survey counterpart of organizational capital, is the least consistently reported of all intangible assets, and markedly less consistent than R&D (Martin, 2024, p.948).

Two mechanisms illustrate how measurement, rather than economic behavior, shapes the results. The first is classification: the measured share of managerial occupation can reflect where taxonomies draw their boundaries rather than real differences in organizational structure. For example, in France, a national occupational classification records a managerial share of around 22% (Nonnis, Roth and Bounfour, 2026), well above what the harmonized ISCO-1 managerial category used in Section 6 implies. The second is compensation: the own-account component is a share of managerial pay, and it can therefore be inflated by executive-salary differentials rather than by more organizational investment. For example, the US records a high organizational capital share despite a relatively low managerial employment share, a pattern more consistent with its wage structure than with genuinely higher organizational investment.

Taken together, these features indicate that the measurement of intangible investment is highly sensitive to statistical implementation choices, particularly for assets like software and organizational capital, whose estimation relies on indirect data sources and modelling assumptions. The large differences in macro-level intangible investment between countries documented in Section 3 are unlikely to reflect economic behavior alone, and appear in part to be driven by measurement artifacts.

## 6 External Validation Using Harmonized Occupation and Wage Data

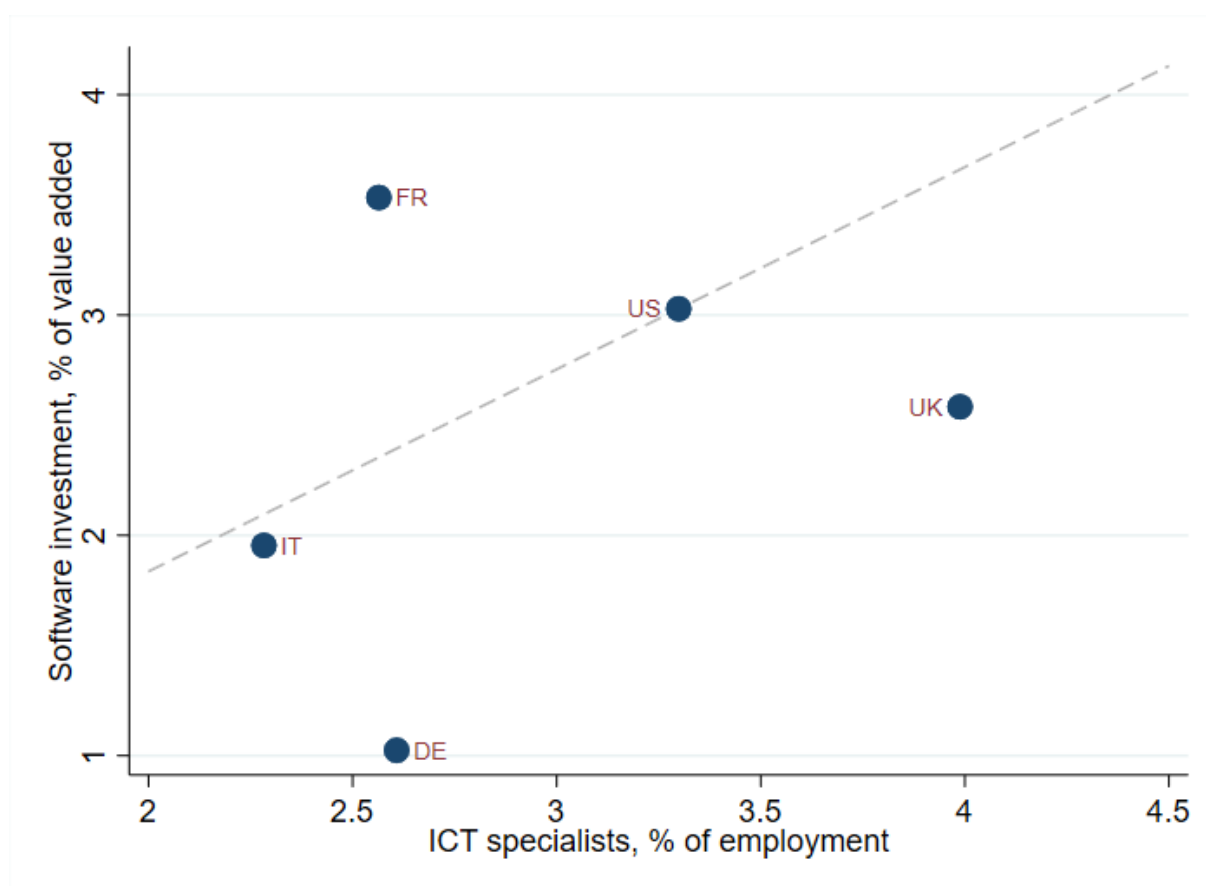
### 6.1 Software Investment and the ICT Workforce

As shown in Section 3, own-account software appears to be overestimated in some countries in national accounts. Section 5 showed that part of these discrepancies may be the result of differences in estimation methodologies, which rely on employment in the ICT sector but differ in whether employment or wages are used as main basis for estimation. It is therefore useful to compare software aggregates with a more independent and internationally comparable measure, such as the number of ICT specialists.

Figure 6 provides an input-output perspective by plotting the number of ICT specialists as a share of total employment on the x-axis against national-account software investment in the y-axis for 2019. We use ILOSTAT data for ICT specialists (ILO, 2026) and EUKLEMS data for software investment. We focus on 2019 rather than on the 1995-2021 averages used elsewhere in the paper because it is the only year for which data on ICT specialists are available for all countries in our sample. Reported investment levels are therefore not directly comparable with the period averages reported in Section 3, which cover 1995-2021 and, in Figure 3, use the standard value-added denominator.

Figure 6 provides further evidence of cross-country measurement issues in software investment, particularly between France and Germany. The two countries have a nearly identical share of ICT specialists (2.6% of total employment), who are expected to constitute an important input of own-account software, yet France reports software investment relative to value added more than three times higher than Germany. Because the two shares of ICT specialists are almost identical, this ratio is essentially unchanged when software investment is scaled by the share of ICT specialists (3.5 in 2019), and is close to the 3.2-fold difference documented by Nonnis et al. (2025) for the average over the sample period. More broadly, Germany appears as an outlier in the figure, with a level of software investment considerably below that of other countries despite a relatively similar share of ICT specialists. France, by contrast, appears only moderately above the other countries in the sample. Its position is nevertheless difficult to reconcile with economic priors when compared with the US: France reports higher software investment than the US, which would arguably be expected to lead in this respect.

Figure 6. Software Investment and ICT Specialists, 2019



**Notes:** The x-axis shows the number of ICT specialists as a share of total employment in 2019, source: ILO (2026). ICT specialists are defined as workers belonging to ISCO-08 major groups 25 (ICT professionals) and 35 (ICT technicians). For the US, ICT specialists are derived from ILOSTAT's harmonization of SOC occupations to ISCO-08. The y-axis reports total software investment as a percentage of real gross value added adjusted for intangibles (chained linked volumes, 2020). We use 2019 because it is the only year for which comparable data on ICT specialists are available for all five countries. ILOSTAT also reports a break in the French series in 2021, when the national total of ICT specialists rises by roughly 32% following a change in the underlying classification, so later years would not be comparable over time for France.

The comparison can also be performed at the sectoral level. Although ILOSTAT does not provide a sectoral breakdown of ICT specialists, comparable data for France, Germany and Italy are available from Eurostat (2026a, dataset isoc\_sks\_itspn2). In the manufacturing sector (sector C), the share of ICT specialists in 2019 was of the same order of magnitude in the three countries (5.4% of sectoral employment in France, 4.8% in Germany, 3.7% in Italy), whereas software investment in the sector is reported to differ almost five-fold (Nonnis et al., 2025). A difference in input of this size cannot account for a difference in recorded output of that magnitude, reinforcing the interpretation that at least part of the observed gap reflects accounting and measurement differences rather than genuine disparities in software investment. The Italian series, which displays no breaks over the period, remains stable throughout and

suggests that the observed discontinuities are country-specific rather than a general feature of the underlying data.

A related issue concerns the possible classification of software developers employed in R&D departments in Germany, as discussed in Section 5. Data from the OECD Analytical Business Enterprise Research and Development (ANBERD) database (OECD, 2026) provide evidence that is consistent with this interpretation. Table 3 reports OECD estimates of enterprise R&D expenditure in 2019, measured at US PPP prices, by sector and as a share of total business enterprise (BERD). Germany has the highest share of enterprise R&D expenditure in manufacturing (84.9%) and one of the lowest shares in the ICT sector (5.7%). The comparison with the US, where 57.8% of enterprise R&D investment is performed in manufacturing and 26.6% in the ICT sector, provides a useful benchmark and further highlights the distinctive sectoral composition of German R&D. This pattern is consistent with the possibility that software-related activities carried out within manufacturing firms and R&D departments may be captured differently in national accounts across countries.

The table also highlights the particularly low share of enterprise R&D expenditure in manufacturing in the UK (25.2%), compared with 27.3% in the ICT sector. This is broadly consistent with the UK's greater specialization in market services, although the absence of data for sector M72 should be taken into account when interpreting these figures.

Table 3. Business R&D Expenditure by Sector, 2019 (% of total BERD)

| Country | Manufacturing (C) | ICT (J) | R&D as service (M72) |
|---------|-------------------|---------|----------------------|
| Germany | 84.9%             | 5.7%    | 4.1%                 |
| France  | 61.8%             | 12.4%   | 7.0%                 |
| Italy   | 66.2%             | 11.4%   | 6.9%                 |
| UK      | 25.2%             | 27.3%   | -                    |
| US      | 57.8%             | 26.6%   | 4.3%                 |

**Notes:** Source: OECD ANBERD (OECD, 2026), ISIC Rev.4, current PPP prices, 2019. Figures are shares of total business enterprise R&D. Values for France (manufacturing and ICT services) are OECD estimates, all other cells are final values.

To further investigate the possibility of a misclassification between R&D and software in national accounts, particularly in the manufacturing sector, it is useful to consider the aggregate of R&D and software investment jointly. We take the two asset series from EUKLEMS and sum them, as reported in Table 4, which shows R&D, software, and the sum of the two

components as a share of sectoral gross value added, both for the market economy as a whole and for sectors C (manufacturing) and J (ICT), in 2019, for consistency with this section.

The comparison between France and Germany is once again particularly informative. In the manufacturing sector, France invests more than five times as much as Germany in software (3.35% vs. 0.66% of value added), but about 30% less in R&D (6.14% vs. 8.91%). When the two components are combined, however, the figures almost coincide (9.48% vs. 9.57%), and are also very close to the corresponding figure for the UK (9.18%).

The pattern is specific to manufacturing. In Sector J, by contrast, R&D is already similar across the two countries (2.38% vs. 2.52%, a ratio of 0.94), while software is higher in France (9.41% vs 5.5%) and the combined measure therefore remains above unity (1.4). The near perfect cancellation observed in manufacturing does not appear here, which is itself informative: the offsetting of R&D and software is concentrated in the sector where Germany R&D is overwhelmingly located, rather than being a general feature of the data.

Table 4. R&D and software investment as a share of gross value added, 2019: market economy, manufacturing (C), and ICT services (J).

| Sector                      | Intangibles    | France | Germany | Italy | UK   | US    | Coefficient of variation |
|-----------------------------|----------------|--------|---------|-------|------|-------|--------------------------|
| Market Economy              | R&D            | 2.58   | 3.52    | 2.12  | 1.62 | 3.37  | 0.31                     |
|                             | Software       | 3.53   | 1.02    | 1.95  | 2.58 | 3.03  | 0.40                     |
|                             | R&D + Software | 6.12   | 4.55    | 4.07  | 4.20 | 6.40  | 0.22                     |
| Manufacturing<br>(Sector C) | R&D            | 6.14   | 8.91    | 4.56  | 7.40 | 12.04 | 0.37                     |
|                             | Software       | 3.35   | 0.66    | 2.06  | 1.78 | 1.36  | 0.54                     |
|                             | R&D + Software | 9.48   | 9.57    | 6.62  | 9.18 | 13.40 | 0.25                     |
| ICT<br>(Sector J)           | R&D            | 2.38   | 2.52    | 3.06  | 2.32 | 5.55  | 0.43                     |
|                             | Software       | 9.41   | 5.50    | 9.36  | 4.84 | 6.34  | 0.31                     |
|                             | R&D + Software | 11.79  | 8.02    | 12.42 | 7.16 | 11.89 | 0.24                     |

**Notes:** Figures are gross fixed capital formation in R&D and computer software and databases as a percentage of real gross value added adjusted for intangibles (chained linked volumes, 2020). “R&D + Software” is the sum of the two asset series. The coefficient of variation is computed as standard deviation over mean. Sectoral value-added denominators differ across the three panels, so levels are not comparable across sectors. The denominator here is value added adjusted for non-national-account-intangibles, whereas Figure 3 uses the standard measure of value added, so levels are not directly comparable with that figure either. Source: Authors’ calculations based on the EUKLEMS/INTANProd 2025 database (Bontadini et al., 2023).

More generally, the five-country coefficient of variation reported in the last column of Table 4 is lower for the combined measure than for either component in all three sectors (falling, for

the combined measure, in a narrow 0.22-0.25 range), suggesting that the aggregate of R&D and software is considerably more stable across countries than either component taken separately. This is consistent with, though it does not on its own establish, part of the cross-country variation in each component reflecting how the boundary between the two is drawn rather than genuine differences in innovative activity.

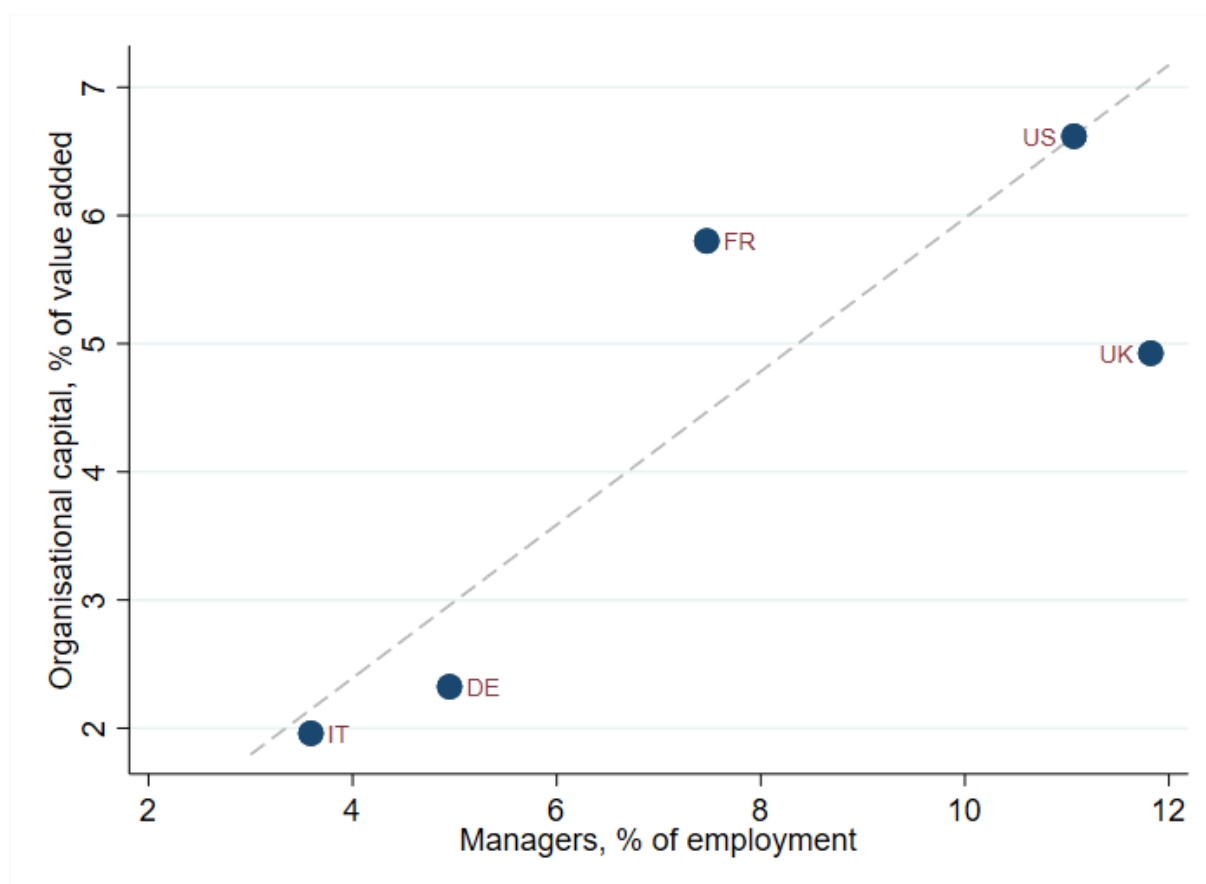
## 6.2 Organizational Capital and the Managerial Wage Structure

Figure 7 provides the same input-output exercise as in Figure 6, but for organizational capital. The x-axis reports the share of managers in total employment based on ILOSTAT data and the ISCO classification, while the y-axis reports the organizational capital investment as a share of value added from EUKLEMS for 2019. The figure shows that a part of the superior investment in organizational capital for France (5.8% of value added) is explained by its higher share of managers (7.5%, while Germany has 5.0% and Italy about 3%), but not totally, as France lies above the line implied by the US conversion. A similar pattern can be observed for the US, whose higher investment is compatible with a higher managerial share if compared to France, but not to Germany and Italy. Put another way, while for software in Figure 6 the gap between countries was essentially unchanged when investment was scaled by the share of ICT specialists, here scaling organizational capital by the share of managers reduces the France-Germany gap from 2.50 to 1.65, that is, less than half of the gap is accounted for by the higher French managerial share, while the remainder is not.<sup>13</sup>

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<sup>13</sup> The input-output comparison is not exact, as the manager share is an input only to the own-account component of organizational capital, whereas the y-axis also includes a purchased component (management consulting). The scatter is therefore descriptive, the accounting relationship is examined directly below. For France, reported organizational capital of 5.9% of value added implies managerial compensation of 29.5% of value added under the 20% rule, which, given a labor share of 0.55 and a managerial employment share of 7.5%, corresponds to a managerial wage premium of about 7.1, the value reported in Table 5. The figure plots the real series (5.8% of value added), whereas the premium calculation uses nominal values throughout, since both the compensation share and the value-added denominator are nominal.

Figure 7. Organizational Capital and Managerial Employment



**Notes:** The x-axis shows the number of managers as a share of total employment in 2019, source: ILO (2026). Managers are defined as workers belonging to ISCO-08 major group 1. For the US, managers correspond to the SOC “Management” category, which is not perfectly comparable to ISCO-1. The y-axis reports total organizational capital investment as a percentage of real gross value added adjusted for intangibles (chained linked volumes, 2020).

A further test can be obtained by comparing EUKLEMS organizational capital investment with directly observed wage data from the Structure of Earnings Survey (SES).<sup>14</sup> The SES provides the observed managerial wage premium as the ratio of the average managerial wage to the average wage across all workers in each country. This measures how much more each manager earns than the average worker, and can be compared with the premium implied by the EUKLEMS figures. As explained in Section 5, own-account organizational capital is measured in EUKLEMS as 20% of managerial compensation. Inverting this relationship, implied managerial compensation is five times the reported organizational capital. Expressing this as a share of value added, dividing by the share of employee compensation in value added, and then by the share of managers in employment yields the implied wage premium, that is, the premium

<sup>14</sup> 2018 wage, the closest available to our reference year.

that managerial pay would need to take for the reported level of organizational capital to be consistent with the 20% rule.<sup>15</sup>

The results are reported in Table 5. According to EUKLEMS data, the implied managerial wage premium in France is 7.14 times the average workers' wage, whereas the observed premium in the SES data is only 1.88. Again, the implied premia derived from EUKLEMS should not, however, be interpreted as actual managerial wage premia, since the calculation attributes the entire organizational capital investment to own-account production, whereas EUKLEMS also includes a purchased component related to management consulting services. This assumption inflates the implied premium in all countries.

Table 5. Implied and Observed Managerial Wage Premia

| Country | Implied premium<br>(EUKLEMS estimates) | Observed<br>premium | Discrepancy<br>factor | Source of<br>observed premium |
|---------|----------------------------------------|---------------------|-----------------------|-------------------------------|
| France  | 7.14×                                  | 1.88×               | 3.8                   | SES 2018, ISCO-1              |
| Germany | 4.05×                                  | 2.33×               | 1.7                   | SES 2018, ISCO-1              |
| Italy   | 6.40×                                  | 3.37×               | 1.9                   | SES 2018, ISCO-1              |
| UK      | 4.26×                                  | 1.67×               | 2.5                   | SES 2018, ISCO-1              |
| US      | 5.40×                                  | 2.34×               | 2.3                   | OES 2018, SOC 11-0000         |

**Notes:** The implied premium (column 2) is the managerial wage premium consistent with the organizational capital reported by EUKLEMS, whereby own-account organizational capital equals 20% of managerial compensation. It is obtained as five times the organizational capital-to-value-added ratio, divided by the share of employee compensation in value added and by the share of managers in employment. Because organizational capital also includes a purchased component, the implied premium is an upper bound and its level is not directly interpretable. The observed premium (column 3) is the ratio of mean managerial earnings to mean earnings across all workers, from the Structure of Earnings Survey, 2018 wave (Eurostat, 2026b, dataset `earn_ses_annual`), and the Occupational Employment Statistics, May 2018 (BLS, 2019) for the US. For the European countries managers are defined as ISCO-08 major group 1, for the US as SOC "Management" occupations, which are not perfectly comparable. The discrepancy factor (column 4) is the ratio of implied to observed premium, which is comparable across countries.

The cross-country comparison is nevertheless informative. We therefore focus on the discrepancy factor, reported in the fourth column of Table 5 and calculated as the ratio between the implied and observed wage premia. The discrepancy factor is particularly high for France,

<sup>15</sup> The implied premium is an upper bound: it attributes the whole organizational capital to own-account production, whereas EUKLEMS also includes a purchased component (management consulting services) that does not pass through managerial pay. This inflates the implied premium in all countries and by a broadly similar factor, so its level should not be read as a wage premium in the ordinary sense. The informative quantity is instead the cross-country comparison of the gap between implied and observed premia, where the common inflation from the purchased component largely cancels out.

at 3.8, whereas the other countries range from 1.7 in Germany to 2.5 in the UK.<sup>16</sup> The discrepancy factor points to a component of organizational capital that managerial pay does not explain. A natural candidate is the purchased component itself. Under the EUKLEMS methodology, purchased organizational capital is derived from intermediate consumption of legal, accounting, head-office and management-consulting services (NACE M69\_M70), rescaled by the share of management consulting (M702) in that aggregate. This share, computed from Structural Business Statistics (SBS, Eurostat, 2026c, dataset sbs\_na\_1a\_se\_r2) for 2019, is markedly higher in France (37%) than in Germany (23.8%), with Italy in between (28.7%). A higher share mechanically raises the purchased component of organizational capital attributed to France, independently of the number or pay of its managers. Across the three EU countries for which the share is available on a comparable basis, the consulting share and the discrepancy factor line up: both are the highest in France, lowest in Germany, with Italy in between.<sup>17</sup>

Taken together, the manager share, the wage premium, and the consulting share point to the same conclusion from three independent angles: the organizational capital reported for France exceeds what its managerial structure and pay can account for, and the excess aligns with features of how the methodology is implemented rather than with real differences in organizational investment.

## 7 Micro-Informed Recalibration of Intangible Investment and Productivity

In this section, we use the ratios presented in Section 4 to construct counterfactual macroeconomic series. The recalibration is limited to the four countries covered by EIBIS. The UK, which the survey does not cover, is therefore excluded from this exercise. The resulting series should not be interpreted as revisions of official national accounts but rather they provide a rigorous micro-informed benchmark to illustrate the magnitude of potential measurement biases and their implications for LPG. Because the recalibration relies on EIBIS ratios, which are not directly comparable in levels with the macro data, the exercise is deliberately illustrative, and it gauges orders of magnitude rather than producing point estimates.

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<sup>16</sup> The particularly high observed premium for Italy should be interpreted with caution, given the prevalence of SMEs in the Italian economy and the potential limitations of the SES in capturing managerial compensation in smaller firms. The US figure should also be interpreted with caution, as managers are identified using the SOC rather than ISCO classification, potentially resulting in a narrower occupational category with higher average wages.

<sup>17</sup> The comparison is limited to these three countries as the UK series is discontinued from 2019, and the US purchased component is constructed from national sources (BEA) that are not comparable with the SBS-based figures

Defining recalibration factors  $\varphi_{i,j}$  for country  $i$  and asset  $j$  based on macro-micro discrepancies as:

$$\varphi_{i,j} = \frac{r_{i,j}^{EIBIS}}{r_{i,j}^{EUKLEMS}}$$

Where  $r_{i,j}^{EIBIS}$  denotes the ratio derived from EIBIS for country  $i$  and asset  $j$ , while  $r_{i,j}^{EUKLEMS}$  denotes the corresponding ratio derived from EUKLEMS. The ratios are taken from Table 1 and are benchmarked against the EU average.<sup>18</sup>

The recalibrated investment series for country  $i$  and asset  $j$  is therefore defined as:

$$Iq_{i,j,t}^{corr} = \varphi_{i,j} Iq_{i,j,t}$$

Where  $Iq_{i,j,t}^{corr}$  denotes the corrected investment series, while  $Iq_{i,j,t}$  the original series.

Using this recalibration, we can also derive illustrative revised series for labor productivity:

$$LP_{i,t}^{corr} = \frac{VA_{i,t} - Iq_{i,j,t} + Iq_{i,j,t}^{corr}}{EMP_{i,t}}$$

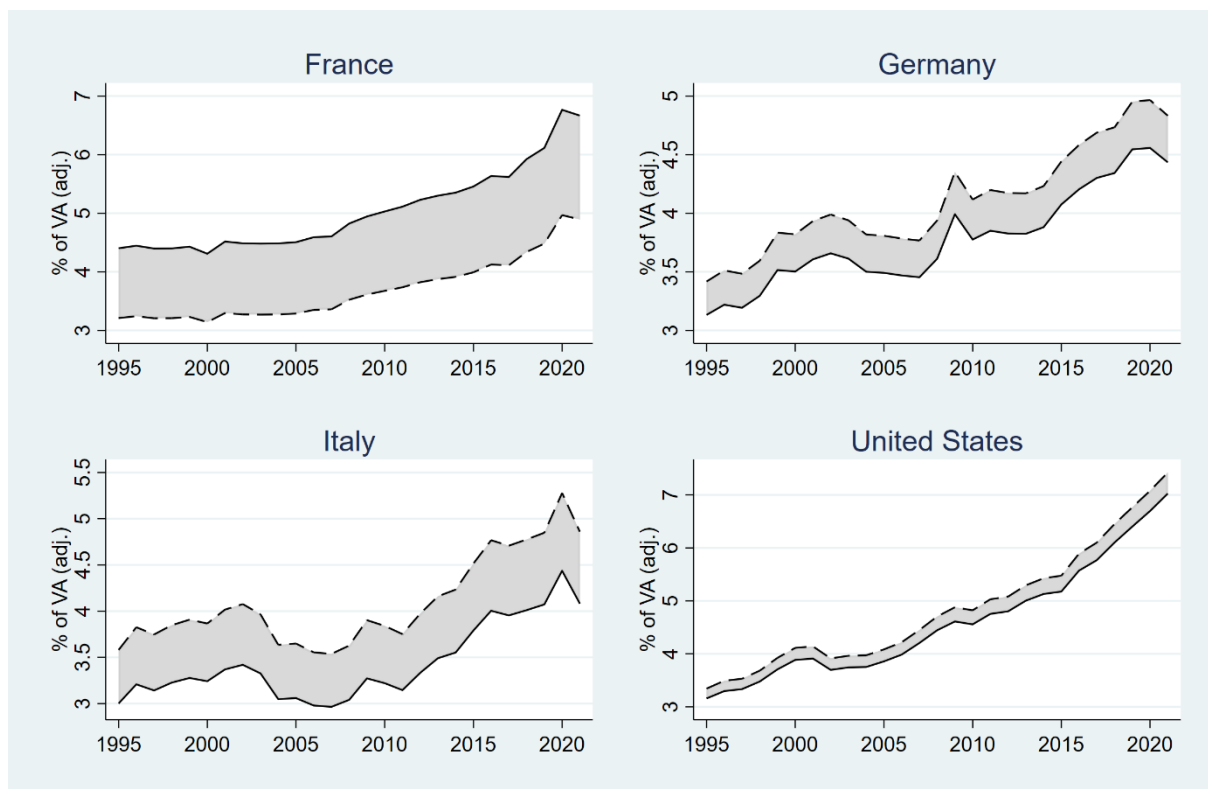
Where  $LP$  denotes labor productivity,  $VA$  value added (either original or adjusted) and  $EMP$  employment, measured as total hours worked.

Given that the most problematic assets in our data appear to be software and organizational capital, we focus on these two categories. Moreover, given the evidence presented in Section 5 on the difficulty of disentangling R&D and software in firm-level data, we consider these two assets jointly. Figure 8 therefore presents the recalibrated series for the combined R&D and software investment share over value added, while Figure 9 reports the same exercise for organizational capital. The shaded bands represent the range between the original EUKLEMS series and the recalibrated values implied by EIBIS ratios, which can be interpreted as an illustrative upper bound of the potential adjustment.

Figure 8. Recalibrated R&D and Software Investment Shares

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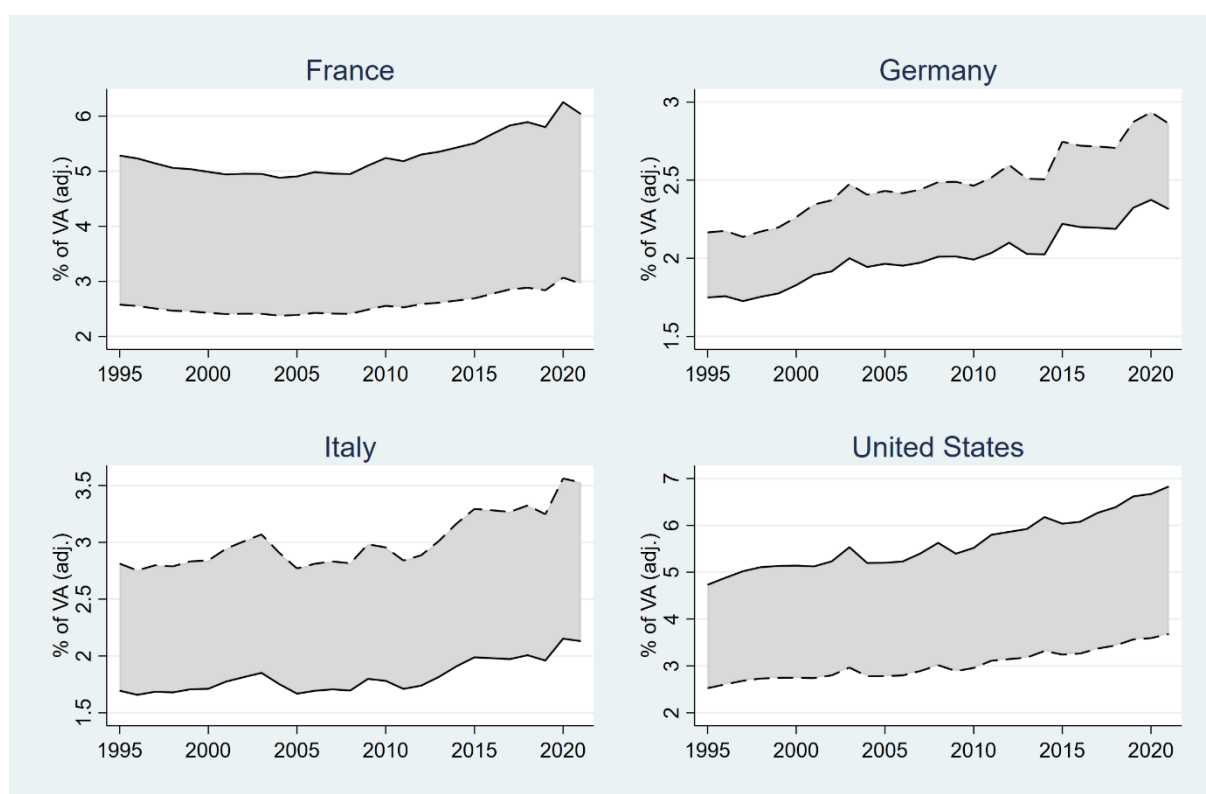
<sup>18</sup> Because the EU and US benchmarks yield similar signals in Section 4, we rely on the EU benchmark in the recalibration exercise. This choice is mainly pragmatic, as it allows us to derive correction factors for all countries in the sample, including the US. Given the different definition of the EU aggregate in the two sources, the resulting corrections should be interpreted as counterfactual estimations rather than exact point estimates.



**Notes:** The figures present the original and counterfactual investment shares for R&D and software combined, expressed as a percentage of real gross value added (corrected for non-national-account intangibles). The solid lines represent the original EUKLEMS macroeconomic series, while the dashed lines the recalibrated series. The shaded areas illustrate the magnitude of the potential measurement bias. All variables are expressed in real terms using chained linked volumes (2020).

Figure 8 indicates that a relatively large downward adjustment in R&D and software investment may be plausible for France, where the recalibrated band reaches on average 1.3 percentage points of value added. The results suggest potential upward adjustments in Italy (0.6 percentage points on average) and Germany (0.35 percentage points), while the series for the US appears comparatively stable, with a small upward adjustment of 0.2 percentage points on average.

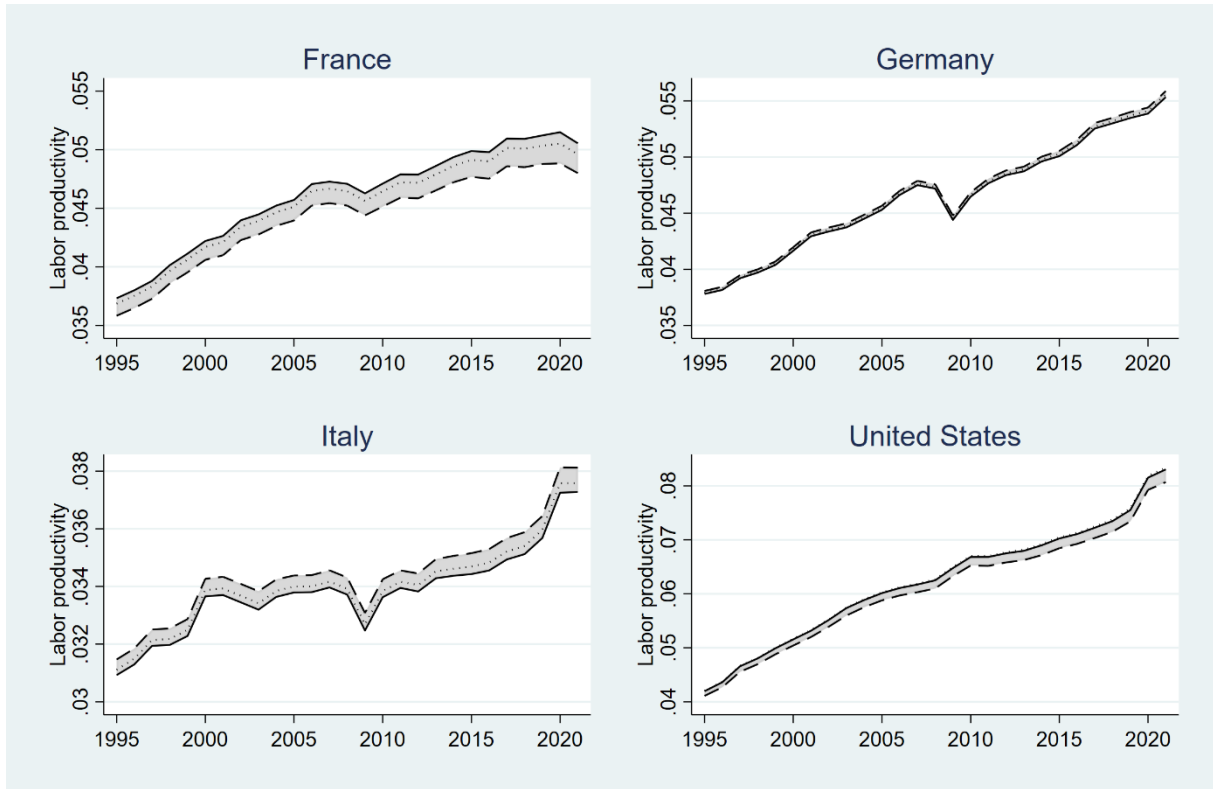
Figure 9. Recalibrated Organizational Capital Shares



**Notes:** The figures present the original and counterfactual investment shares for organizational capital, expressed as a percentage of real gross value added (corrected for non-national-account intangibles). The solid lines represent the original EUKLEMS macroeconomic series, while the dashed lines the recalibrated series. The shaded areas illustrate the magnitude of the potential measurement bias. All variables are expressed in real terms using chained linked volumes (2020).

Figure 9 reports the same exercise for organizational capital. In this case, the recalibrated series diverge considerably in France and the US, where corrected values are more than 2.5 percentage points lower than the EUKLEMS series on average. As before, the recalibration suggests moderately higher levels in Italy (1.2 percentage points) and Germany (0.5 percentage points). These differences are consistent with the measurement challenges associated with organizational capital discussed in the previous sections, and, importantly, do not directly affect productivity measures recorded in official national accounts.

Figure 10. Labor Productivity under Alternative Recalibration Scenarios



**Notes:** The figures present the original and counterfactual levels of labor productivity, computed as real gross value added (corrected for non-national-account intangibles) divided by the total hours worked by employees. The solid lines represent the original Euklems series. The dotted lines denote the partial recalibration scenario (adjusting exclusively for R&D and software), while the dashed lines represent the full recalibration scenario (incorporating organizational capital). The shaded areas illustrate the magnitude of the potential measurement bias.

Finally, Figure 10 illustrates the potential implications for labor productivity in the four countries. The figure reports productivity computed using value added adjusted for non-national-account intangibles and compares the original series with two alternative recalibration scenarios: one based on the adjustment of R&D and software only, and a broader scenario that also includes organizational capital. For ease of interpretation, the results are expressed as percentage changes relative to the original productivity series.

As summarized in Table 6, on average over the sample period, the full recalibration implies a reduction in LP of around 4% in France, compared with a 0.9% increase in Germany and 2% in Italy, while the US exhibits a 2.4% decrease once organizational capital is included.

Table 6. Illustrative Effects of Micro-Informed Recalibration on LP and LPG

| LP      |              |                 | LPG          |              |                 |
|---------|--------------|-----------------|--------------|--------------|-----------------|
| Country | R&D+Software |                 | Original (%) | R&D+Software |                 |
|         | adjustment   | Full adjustment |              | adjustment   | Full adjustment |
| France  | -1.43        | -4.22           | 1.18         | 1.16         | 1.13            |
| Germany | 0.35         | 0.86            | 1.49         | 1.50         | 1.50            |
| Italy   | 0.70         | 1.97            | 0.73         | 0.74         | 0.74            |
| US      | 0.28         | -2.42           | 2.67         | 2.68         | 2.60            |

**Notes:** The table reports average percentage changes in labor productivity levels implied by the recalibration exercise over the sample period relative to the original EUKLEMS series. The last two columns translate these changes into approximate adjustments to average LPG rates using the baseline values reported in Section 3.

These adjustments are non-negligible. A downward revision of roughly 4% in French labor productivity and an upward revision for Germany and Italy would narrow the perceived macroeconomic gap among these European economies. These results suggest that a fraction of the productivity divergence observed over the last decades may stem in part from heterogeneous accounting and measurement practices, rather than underlying structural differences in technological adoption or managerial efficiency. These findings reinforce the need for caution when comparing macroeconomic performance across countries on the basis of current intangible estimates.

## 8 Conclusion

Intangible capital has become a central production factor in advanced economies, and its role is likely to grow further with the diffusion of artificial intelligence. Accurately measuring intangible investment is therefore essential both to understand productivity dynamics within countries and to compare macroeconomic performance across them. This paper has argued that current estimates are less comparable across countries than their widespread use implies.

Focusing on five major economies (France, Germany, Italy, the UK, and the US), we documented large differences in measured intangible investment that are difficult to reconcile with observed productivity patterns or with the structural similarities of the economies concerned. Distinguishing between intangibles included in national accounts, which contribute to official GDP calculations, and analytical extensions that do not, we identified software and

organizational capital as the categories where these differences are largest and most difficult to attribute to economic behavior.

Our main contribution is methodological. Rather than treating the reported figures as given, we assessed them against independent, internationally harmonized sources: occupational data on ICT specialists and managers, wage data from the Structure of Earnings Survey, and R&D composition from ANBERD. This external validation reveals that several of the most striking gaps are hard to reconcile with the underlying distribution of inputs. France and Germany employ a nearly identical share of ICT specialists, yet France records approximately three times more software investment. Moreover, in manufacturing the two countries record almost the same combined total of R&D and software (around 9.5% of value added) while allocating it very differently between the two categories (France predominantly as software, Germany predominantly as R&D), a pattern that mirrors the concentration of German enterprise R&D in manufacturing shown by ANBERD. Similarly, the higher organizational capital attributed to France is not matched by a corresponding higher managerial wage structure. These patterns are more consistent with differences in how national statistical institutes implement common methodologies, in the estimation of own-account software, the boundary between R&D and software, and the measurement of organizational capital, than with real differences in intangible accumulation.

To examine what such measurement differences might imply, we drew on firm-level survey data to construct a micro-informed recalibration of the macroeconomic series. Under illustrative assumptions, the exercise points to a potential overstatement of French labor productivity of the order of 4%, alongside modest understatements for Germany and Italy. Because this exercise relies on survey data (EIBIS) that are not directly comparable in levels with the macro aggregates, its magnitudes should be read as indicative rather than definitive, and their value lies in showing that plausible measurement differences are large enough to affect cross-country comparisons materially.

Taken together, these findings carry important implications for research and policy. They point to the need for greater harmonization of intangible measurement across national statistical agencies, particularly for software and organizational capital, and for caution in drawing conclusions about relative technological or productivity performance from current estimates. In the case of the R&D-software boundary in particular, the implication is not necessarily that aggregate investment is mismeasured, since both assets already enter GDP, but that cross-

country comparisons of R&D intensity and of software investment taken separately may be misleading with direct consequences for indicators used to benchmark national innovation performance. Results also suggest that assets such as organizational capital, which produce benefits over multiple periods like any other form of capital, deserve more consistent treatment if they are to be used in productivity analysis.

## Data availability statement

The data used in this study are publicly available and can be downloaded from the online sources cited in the article. The study relies exclusively on publicly accessible data.

## Disclosure statement

The authors declare no conflict of interest.

During the preparation of this work, the authors used ChatGPT and Claude to improve the grammar and readability of the manuscript and to assist with the optimization and debugging of code used for the empirical analysis. The authors subsequently reviewed and revised the AI-assisted outputs and assume full responsibility for the content of the publication and the results reported.

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