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THE ANATOMY OF CAPITAL ACCUMULATION IN ITALY AND IN THE MAIN EURO-AREA COUNTRIES

by Rosalia Greco* and Roberto Torrini*

Abstract

This paper analyses the determinants of weak capital accumulation in Italy through a comparison with Germany, France and Spain since 2000. It decomposes capital stock growth into the gross investment rate and the depreciation rate, considering both the total economy and the private sector, with a focus on productive (total fixed assets net of residential buildings) and non-construction assets. Only in Italy did the global financial crisis and the sovereign debt crisis lead to a prolonged decline in the capital stock, particularly in productive assets, lasting until 2020. Although capital accumulation recovered after the COVID-19 crisis, overall growth has remained weaker than in the other main euro-area countries.

The results show that the sources of under-accumulation differ across country comparisons. Relative to Spain, Italy's gap mainly reflects higher depreciation rates; relative to Germany and France, it is chiefly explained by lower gross investment rates. These differences reflect both developments in investment intensity and changes in capital productivity. However, France's systematically higher investment rate appears to depend less on a greater propensity to invest than on a value-added-to-capital ratio that is markedly higher than in all the other countries considered. This pattern suggests a possible heterogeneity in the measurement of capital stocks across countries and raises concerns about the comparability of standard decompositions of labour productivity growth into capital deepening and total factor productivity.

JEL Classification: E01, E22, O47, O57.

Keywords: capital accumulation, capital stock measurement, gross investment, depreciation, productivity.

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1. Introduction¹

Since 2000, labour productivity growth has contributed far less to value added growth in Italy than in its European peers. Over the period 2000–2014, total factor productivity (TFP) was the main drag on growth, while capital deepening (i.e. the increase in capital intensity, measured as net fixed capital per hour worked) made a positive contribution, as in the other major euro area economies. Since 2014, however, this pattern has reversed: TFP growth has recovered, but declining capital intensity has become the main constraint on Italy's productivity performance. Such a prolonged period of capital shallowing, lasting for more than a decade, sets Italy apart from France and Germany.

This paper investigates the sources of Italy's weak capital accumulation through a systematic cross-country comparison with Germany, France and Spain. It decomposes capital stock growth into its two proximate drivers – the gross investment rate and the depreciation rate – and analyses the sources of cross-country differences in each, both for the total economy and for the private sector. The analysis distinguishes between productive assets (i.e. fixed assets excluding dwellings) and, within these, non-construction assets. For gross investment rates, the paper further separates the contribution of the investment share of value added (propensity to invest) from that of the value added-to-capital ratio (capital productivity), which captures the resources available to sustain capital accumulation. The analysis covers the period since 2000 to the most recent years and draws on Eurostat and Istat national accounts data.

The main findings can be summarised as follows:

1. Only in Italy did the double (financial and sovereign debt) crisis lead to a sustained and prolonged decline in the capital stock, particularly in productive and non-construction assets, lasting until 2020. The slowdown in capital accumulation was pervasive across sectors and asset types and cannot be attributed to compositional effects. Following the Covid-19 crisis, capital accumulation recovered, but overall capital stock growth since the onset of the global financial crisis has remained significantly weaker than in the other countries, reflecting the sharp contraction during the crisis years.
2. The sources of under-accumulation differ across country comparisons: higher depreciation rates account for Italy's gap relative to Spain, while lower gross investment rates explain the gap vis-à-vis Germany and France.
3. Italy's lower gross investment rate relative to Germany is largely explained by country-specific shocks. Prior to the double crisis, Italy's investment rate exceeded Germany's, reflecting both the compression of credit spreads following the introduction of the euro and Germany's post-reunification restructuring. The reversal after 2010 reflects the disproportionate impact of the global financial crisis and the sovereign debt crisis on Italian firms.
4. A similar pattern emerges in the comparison with France following the financial and sovereign debt crises. However, France exhibits a systematically higher investment rate than both Italy and Germany. This structural difference reflects, in part, a smaller capital stock relative to value added, rather than a higher propensity to invest. This is largely due to a lower stock of non-residential buildings in France, which in turn reflects a much higher depreciation rate applied to this category of capital compared with Italy and the other countries considered. This difference is difficult to justify on economic grounds and is likely to reflect differences in statistical practices. It thus points to a broader lack of standardisation in the measurement of capital stocks across countries.

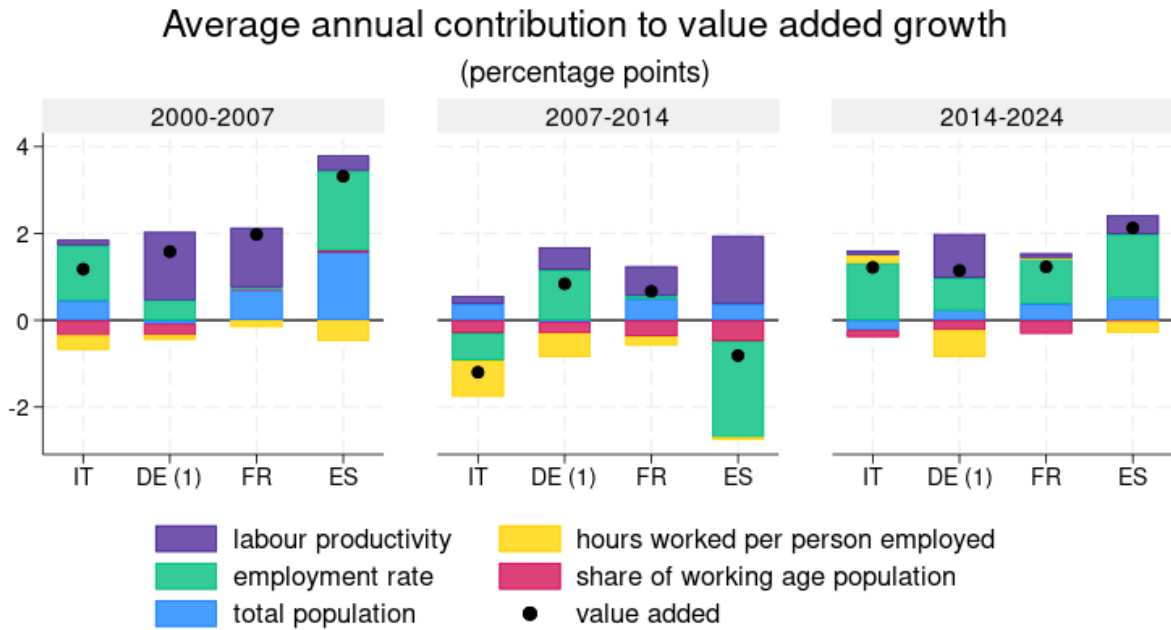
¹ The authors would like to thank Fabio Bertolotti, Federico Cingano, Francesco D'Amuri, Carmine Fimiani, Andrea Linarello, Francesca Lotti, Elena Mattevi, Tiziano Ropele, Filippo Scoccianti e Francesco Zollino for helpful discussions, comments and suggestions.

5. These cross-country differences in the measurement of capital stocks raise concerns about the reliability and comparability of standard decompositions of labour productivity growth into the contributions of total factor productivity and capital deepening (i.e. the capital–labour ratio).

2. Value added and labour productivity growth accounting

Since 2000, the contribution of productivity growth to value added growth accounting has been significantly weaker in Italy than in its European counterparts, and it further declined in the last decade (Figure 1 and Table A1 in Appendix A).²

Figure 1



Source: elaborations on AMECO data.
Growth rates are calculated as log-differences. Average growth rates are calculated as arithmetic means of annual growth rates.
(1) Data for years 2022-2024 are missing. Averages are calculated over the remaining years.

Labour productivity growth can be decomposed into two components: TFP growth and capital deepening.³ Figure 2 illustrates a clear inversion in their relative contributions in Italy, both in the total economy and in the

² Figure 1 is based on the following decomposition of the growth rate of real value added:

$$g_Y = g_{Y/H} + g_{H/L} + g_{L/N} + g_{N/P} + g_P$$

Where g denotes growth rates (approximated by log-differences), Y is real value added, H is hours worked, L is total employment, N is working age (15-64 years old) population, and P is population. Consequently, Y/H is labour productivity (real value added per hour worked), H/L is hours worked per worker, L/N is the employment rate and N/P is the share of working age population. The expression derives from the following decomposition of real value added:

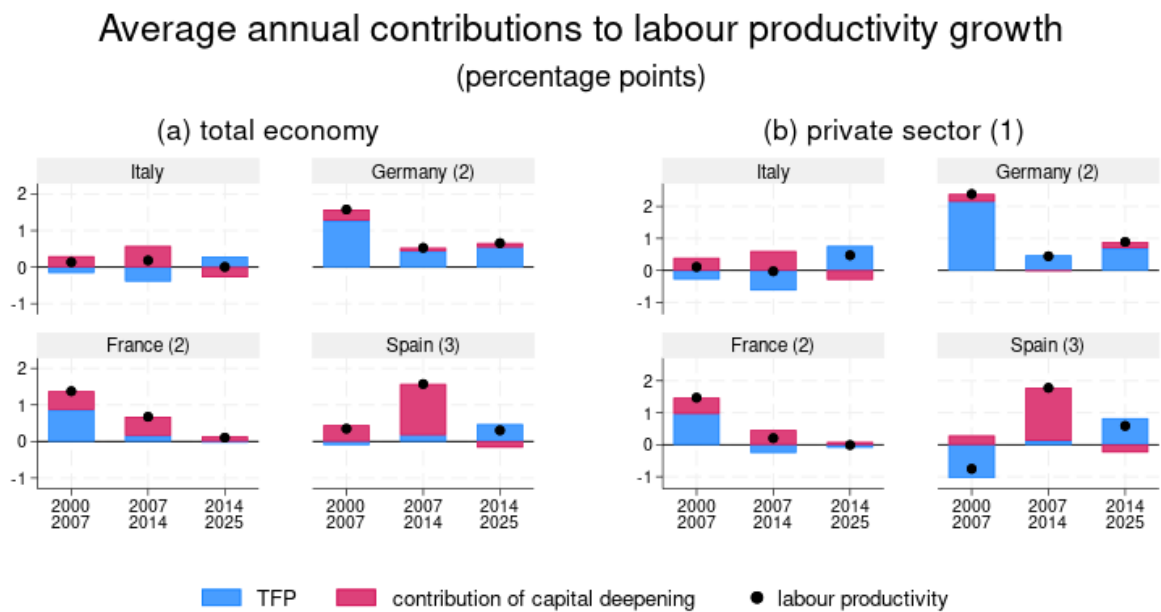
$$Y = \frac{Y}{H} \cdot \frac{H}{L} \cdot \frac{L}{N} \cdot \frac{N}{P} \cdot P$$

and is obtained by taking logs, then calculating the derivatives with respect to time and finally noticing that such derivatives approximate the growth rates between two consecutive periods.

³ TFP growth reflects improvements in an economy's productive efficiency and captures the portion of output growth that cannot be attributed to changes in primary inputs. In practice, TFP is calculated as a residual from the production function and is therefore affected by measurement issues, including the accurate estimation of input prices and quantities (Jorgenson and Griliches, 1967), and the impact of capital assets which are not currently included in national accounts (Corrado et al., 2022). It is also influenced by secular

private sector. In the period 2000–2014, TFP growth in Italy was negative, or at best negligible, while the contribution of capital deepening was positive across all major European countries.^{4,5} In Italy, capital deepening remained positive even during the acute phase of the global financial crisis (GFC) and the sovereign debt crisis (SDC): the collapse in labour input raised capital per hour worked substantially, despite the severe deterioration of investment. Since 2014, the pattern has reversed: TFP growth has turned positive, while the contribution of capital deepening has become negative, driven by the prolonged decline in the capital stock documented in the following section. Italy's trajectory stands out: in Germany, France and Spain, the transition between the two phases was less sharp and the negative contribution of capital deepening after 2014 either absent or far less pronounced.

Figure 2



Source: elaborations on Eurostat and Istat data.
 Growth rates are calculated as log-differences. Average growth rates are calculated as arithmetic means of annual growth rates.
 (1) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).
 (2) Data for 2025 are missing. Averages are calculated over the remaining years.
 (3) Data for 2024 and 2025 are missing. Averages are calculated over the remaining years.

Since 2014, capital intensity in Italy has been on a steady downward trajectory (Figure 3). Recently, the upswing in capital accumulation since 2021 (see *infra*) has been accompanied with a more than proportional increase in hours worked, driven in part by a decline in the relative price of labour compared to other production inputs, such as capital and intermediate goods (Colonna et al., 2025). This has mechanically contributed to the decline in capital intensity up to 2024. In 2025, capital intensity has remained to the 2024 level in the total economy and has slightly increased in the private sector, going back to the 2022 level.

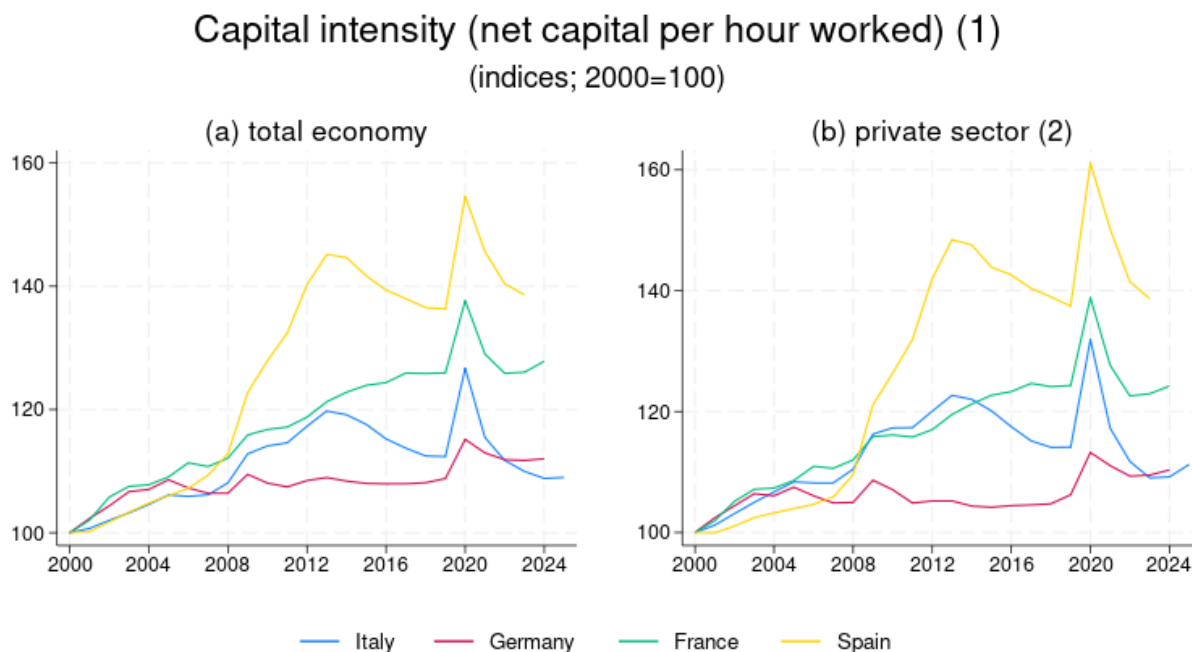
improvements in input quality (see Griliches, 1960; 1970) and cyclical factors such as the degree of capacity utilization (Basu et al., 2001; Comin et al., 2025). For a comprehensive review of TFP and its measurement, see Griliches (2018) and Hulten (2001).

⁴ The contribution of TFP and capital deepening to labour productivity growth are calculated under the assumption of constant factor shares. For all countries and sectors, the capital share is set at 0.35, while the labour share is set at 0.65.

⁵ In this work, the private sector is defined as the private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).

The reduction in capital intensity observed over the past decade was of a similar extent in the total economy and in the private sector and has been broad-based across industries (Figure 4), with ICT services representing a notable exception during the pre-pandemic period.⁶

Figure 3

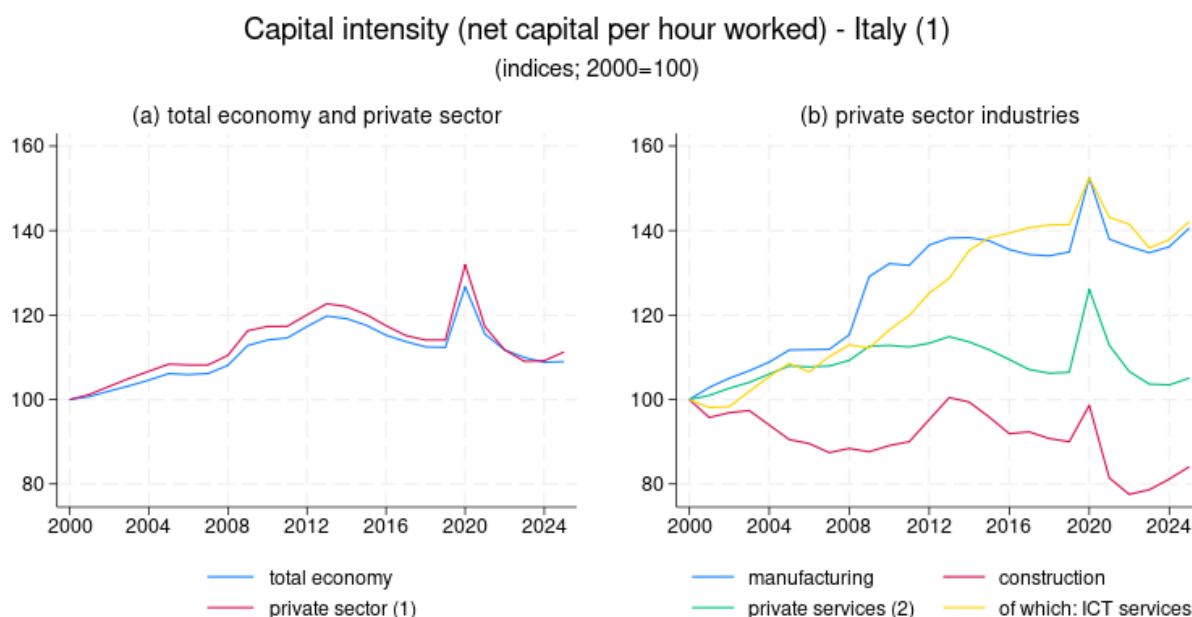


Source: elaborations on Eurostat and Istat data.

(1) Capital stock of total fixed assets.

(2) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).

⁶ The sharp post-pandemic drop in capital intensity within the construction sector likely reflects cyclical factors. The construction sector has experienced a substantial increase in demand in recent years, mostly in connection with government policies introduced in response to the pandemic. These measures provided a significant boost to production following a prolonged period of decline; according to Istat national accounts data, output in the sector fell by over 40 percent in real terms between 2007 and 2019. Although data on capacity utilization for firms in the construction sector are not available, it is plausible that the sector operated with low levels of capacity utilization at the onset of the pandemic. In such conditions, firms can meet the increased demand by raising the utilization of existing productive capacity, with capital adjustments occurring less than proportionally. Increasing capacity utilization contributes to measured TFP growth; indeed, TFP in the construction sector grew at an average annual rate of 2 percent per year between 2019 and 2025, compared to 0.4 in the private sector.



Source: elaborations on Istat data.

(1) Capital stock of total fixed assets.

(2) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).

(3) Private nonfinancial services, net of real estate (NACE: G-N, excl. K, L).

3. Explaining capital intensity: hours worked and capital stock

Since 2014, the growth rate of hours worked places Italy – together with France – between the two extremes: Germany, where labour input moved little, and Spain, where its growth was remarkable (Table 1). The evolution of the capital stock sets instead Italy apart.

After expanding steadily until 2011, the capital stock entered a prolonged period of contraction during the SDC and followed a downward trajectory for roughly a decade, with a reversal only beginning in 2021. The decline in Italy's capital stock was particularly pronounced for productive capital (namely fixed assets excluding dwellings) and for non-construction capital (notably, for its machinery and equipment component; Figure 5 and Table A2 in Appendix A).⁷ The recovery of this latter type of capital started relatively earlier and was more sustained. In contrast, in the other major Euro area economies, capital accumulation remained positive in most sectors throughout the period (Table 2).

⁷ The asset classification used in national accounts data is provided in Appendix B. Across the main European economies, productive capital (total fixed assets excluding dwellings) represents between 40 and 60 percent of total fixed assets and virtually the entire capital stock held by the private sector, while non-construction assets (machinery, equipment and weapons systems, and IPPs) only amount to less than one fifth of total fixed capital (and to roughly one third of productive capital). See Appendix C for a discussion of cross-country differences in capital asset composition and an analysis of their impact on capital accumulation. The main conclusion of that analysis is that cross-country differences in sectoral and asset composition play a limited role in explaining differences in capital accumulation rates.

Table 1

Average annual contribution to capital deepening (1)								
<i>(percentage points)</i>								
	net capital stock in fixed assets (2)				hours worked			
	Italy	Germany	France	Spain	Italy	Germany	France	Spain
(a) total economy								
2000-2007	1.9	0.9	2.1	4.2	1.0	0.0	0.6	3.0
2007-2014	0.3	0.6	1.5	1.6	-1.4	0.3	0.0	-2.4
2014-2025	0.3	0.6	1.5	1.2	1.1	0.2	1.0	1.7
(b) private sector (3)								
2000-2007	2.5	0.5	2.3	4.3	1.3	-0.1	0.8	3.5
2007-2014	-0.1	0.2	1.2	1.1	-1.8	0.3	-0.1	-3.6
2014-2025	0.5	0.6	1.7	1.1	1.3	-0.1	1.3	1.9

Source: elaborations on Eurostat and Istat data.

(1) Growth rates are calculated as log-differences. Average growth rates are calculated as arithmetic means of annual growth rates.

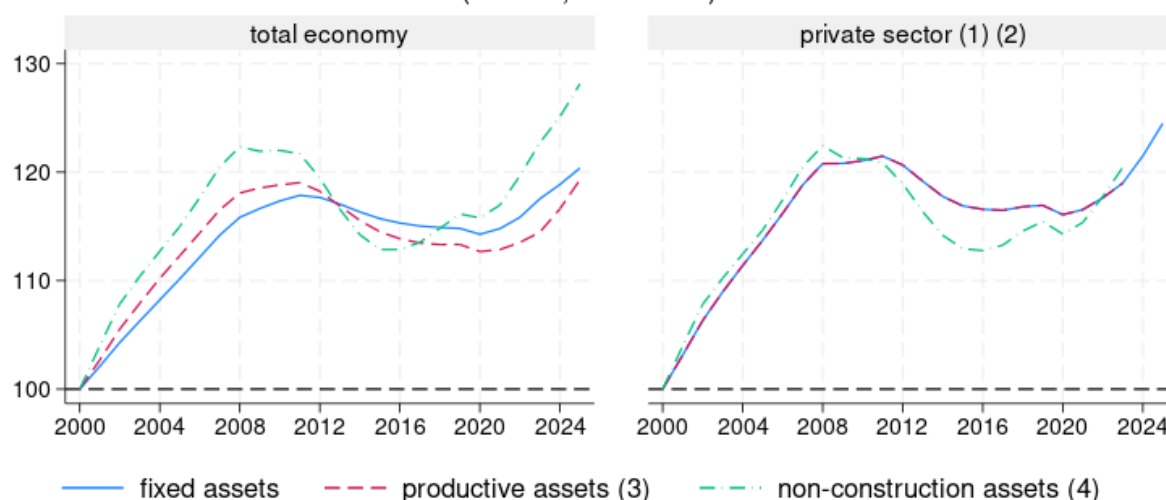
(2) Data for 2025 are missing for Germany and France. Data for 2024 and 2025 are missing for Spain. For these countries averages are calculated over the remaining years.

(3) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).

Figure 5

Net capital stock in fixed, productive and non-construction assets - Italy

(indices; 2000=100)



Source: elaborations on Istat data.

(1) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).

(2) Since productive assets are the totality of fixed assets in the private sector, the solid and dashed lines coincide.

(3) Total fixed assets, minus residential buildings.

(4) Productive assets, minus non-residential buildings and structures.

Table 2

Average annual growth rate of net capital stock by sector and type of assets

(percentage points)

	fixed capital			productive capital (1)			non-construction capital (2)		
	2000- 2007	2007- 2014	2014- 2023	2000- 2007	2007- 2014	2014- 2023	2000- 2007	2007- 2014	2014- 2023
(a) Italy									
total economy	1.9	0.3	0.1	2.7	-0.8	0.8	2.2	-0.1	-0.1
private sector (3)	2.5	-0.1	0.1	2.7	-0.8	0.6	2.5	-0.1	0.1
- of which: manufacturing	1.5	-0.5	0.4	2.3	-0.2	1.0	1.5	-0.5	0.4
- of which: construction	2.3	-2.6	0.2	3.7	-4.0	1.1	2.3	-2.6	0.2
- of which: private services	2.7	0.1	0.4	2.9	-1.1	0.9	2.7	0.1	0.4
-- of which: ICT services	2.8	1.6	2.2	1.9	2.0	2.3	2.8	1.6	2.2
(b) Germany									
total economy	0.9	0.6	0.6	1.6	1.4	2.0	0.6	0.4	0.4
private sector (3)	0.5	0.2	0.7	1.4	1.1	1.8	0.5	0.2	0.7
- of which: manufacturing	-0.2	0.2	1.3	0.5	0.9	2.0	-0.2	0.2	1.3
- of which: construction	-4.1	-0.1	2.8	-6.0	1.3	4.9	-4.1	-0.1	2.8
- of which: private services	1.8	0.7	0.6	3.1	1.6	1.4	1.8	0.7	0.6
-- of which: ICT services	0.0	-0.7	1.3	2.4	2.7	4.2	0.0	-0.7	1.3
(c) France									
total economy	2.1	1.5	1.4	2.5	1.2	1.8	1.8	1.0	1.0
private sector (3)	2.3	1.2	1.7	3.0	1.1	2.0	2.3	1.2	1.7
- of which: manufacturing	1.5	-0.1	0.4	1.9	-0.1	0.4	1.5	-0.1	0.4
- of which: construction	2.1	-0.1	1.0	3.2	-1.8	1.4	2.1	-0.1	1.0
- of which: private services	3.0	1.6	2.2	4.1	1.5	2.6	3.0	1.6	2.2
-- of which: ICT services	4.6	2.8	3.7	5.6	3.2	4.3	4.6	2.8	3.7
(d) Spain									
total economy	4.2	1.6	1.2	5.0	1.1	1.7	4.1	1.5	0.7
private sector (3)	4.3	1.1	1.1	5.1	1.2	1.9	4.2	1.2	1.2
- of which: manufacturing	2.6	-0.4	3.1	2.9	-1.3	3.4	2.6	-0.4	3.1
- of which: construction	5.3	-0.1	0.0	10.0	-2.3	-1.5	6.1	-0.4	-0.6
- of which: private services	4.8	1.1	1.1	6.4	1.1	2.2	4.8	1.1	1.1
-- of which: ICT services	2.8	0.4	0.9	2.9	0.6	2.9	2.8	0.4	0.9

Source: elaboration on Eurostat and Istat data. Growth rates are calculated as log-differences. Average growth rates are calculated as arithmetic means of annual growth rates. - (1) Total fixed assets minus residential buildings (dwellings). - (2) Productive assets minus non-residential buildings and structures. - (3) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).

4. The gears of capital accumulation: gross investment and depreciation rates

The evolution of the capital stock is governed by the standard capital accumulation equation: the real growth rate of capital between $t-1$ and t is the difference between the gross investment and depreciation rates:

$$\frac{\Delta K_t}{K_{t-1}} = g_t^K = \frac{I_t}{K_{t-1}} - \frac{D_t}{K_{t-1}} = i_t - \delta_t$$

where K denotes the net capital stock, I gross fixed capital formation, and D depreciation, while i is the gross investment rate and δ is the corresponding depreciation rate.

Given the interest in firms' capital accumulation decisions, from now the analysis will focus on the private sector and on the assets that make up its capital, namely productive assets (and the non-construction subset of them).⁸

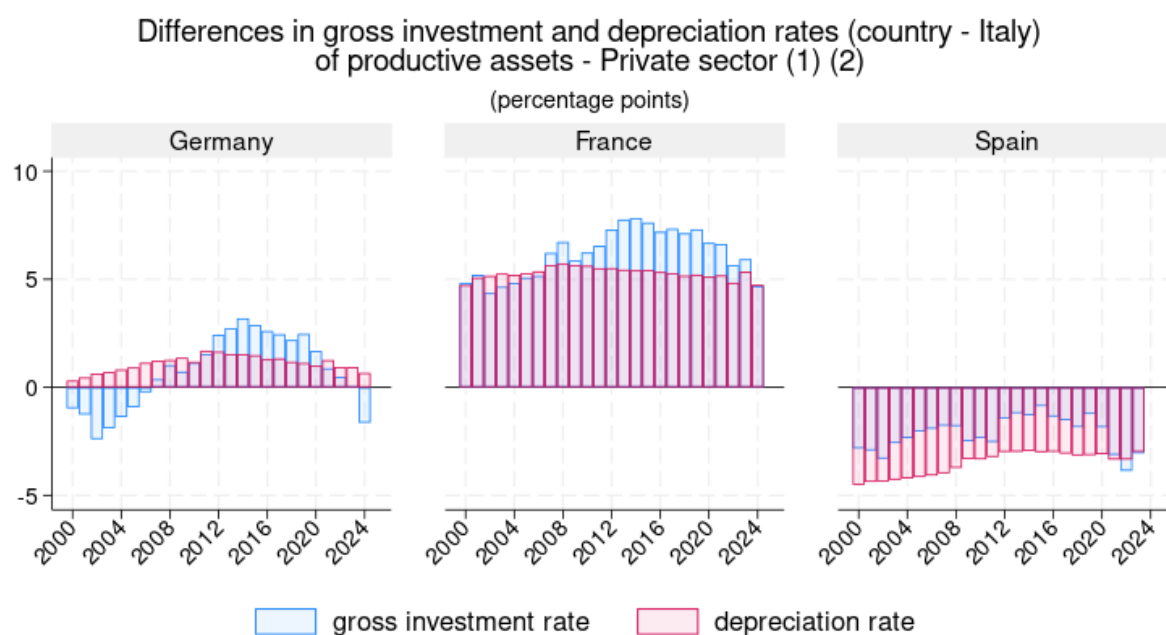
Figure 6 shows the difference between Italy and the comparison countries' growth rate of productive capital; such a difference is decomposed according to the formula above. The elements that drive Italy's relative performance change with the comparison country. While cross-country systematic differences in depreciation rates are detected when comparing Italy with Spain and France, differences in depreciation are subdued when referring to Germany. Conversely, gross investment rates drive much of the differential capital accumulation with respect to Germany and France, while they play no big role when comparing Italy with Spain.

Since 2000, depreciation rates in Spain have been on average lower than in Italy, causing capital to accumulate more rapidly in Spain, despite lower gross investment rates.

At the opposite end of the spectrum, depreciation rates have been historically similar in Germany and Italy, and observed differences in capital accumulation must be almost entirely traced back to gross investment rates. Cross-country differences in gross investment rates are much more volatile than differences in depreciation rates, as the former are also affected by cyclical factors.

In a somewhat intermediate position, differences with France derive from both gross investment and depreciation rates. On the one hand, depreciation rates are on average higher in France than in Italy and this – per se – makes capital accumulation faster in Italy. On the other hand, however, gross investment rates are higher, too, and counterbalance the effect of depreciation rates. Starting from the GFC years, France's advantage in gross investment rates more than offset its disadvantage in depreciation rates, generating the positive differential observed ever since.

⁸ Decomposing the growth rate of capital in this fashion requires data on gross investment and depreciation by sector and asset type. Istat provides such depreciation data for Italy, but Eurostat only provides depreciation data for total fixed assets. Therefore, to ensure cross-country comparability, depreciation for all countries is calculated as the difference between gross and net investment; the latter being approximated by the change in net capital between two consecutive years. More specifically, gross investment and depreciation rates are calculated as $i_t = I_t^{PYP} / K_{t-1}^{CP}$ and $\delta_t = [I_t^{PYP} - (K_t^{PYP} - K_{t-1}^{CP})] / K_{t-1}^{CP}$, respectively, where CP indicates values at current prices (current replacement costs, in the case of the capital stock) and PYP indicates values at previous year's prices (previous year's replacement costs, in the case of the capital stock).



Source: elaborations on Eurostat and Istat data.

(1) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).

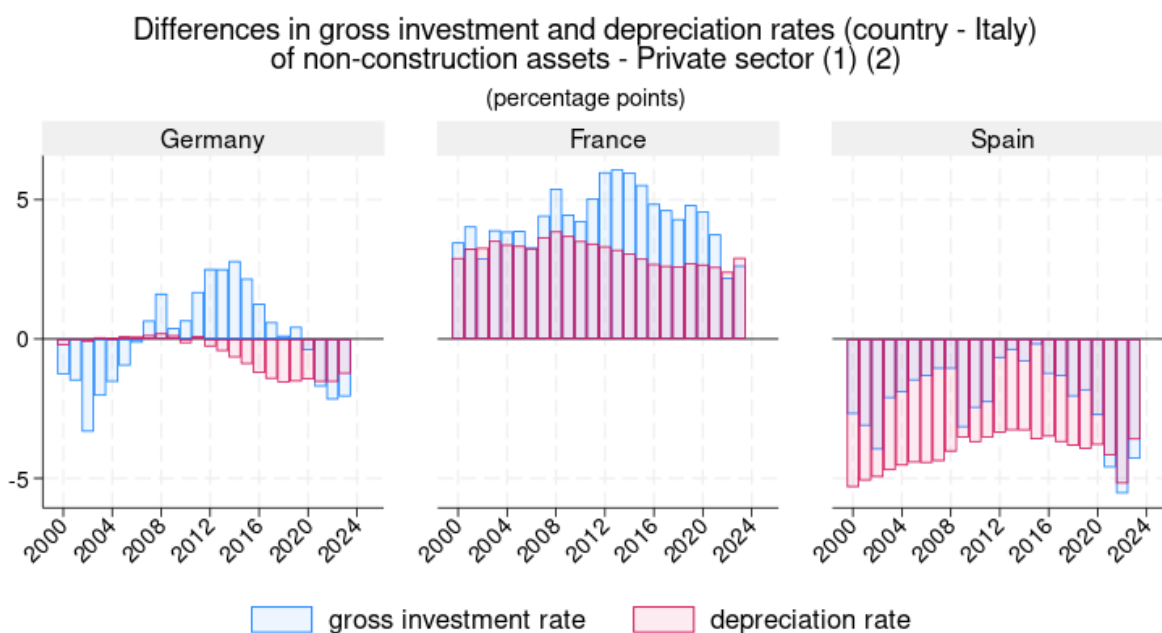
(2) Positive values indicate that the country's rate is higher than Italy's.

The above considerations remain valid when focusing on the non-construction part of productive capital (Figure 7). Interestingly, differences in depreciation rates have been evolving over time: in particular, Italy's depreciation rates for non-construction assets have been on the rise since the GFC (see Appendix D), increasing the difference with the rates observed in Germany and attenuating the gap with respect to France.

The observed cross-country systematic differences cannot be traced back to compositional effects; in other words, there is no evidence that capital in Italy is (or has become over time) systematically more concentrated in low-investing sectors or made of faster-depreciating assets; rather, the country has been accumulating capital more slowly across sectors and assets, especially after the GFC. For an analysis of the sectoral distribution of the capital stock and its asset composition, as well as of their effect on capital accumulation dynamics, see Appendix C.

This evidence identifies the double – financial and sovereign debt – crisis as an important watershed in capital accumulation in Italy relative to Germany and France. Up to those years, Italy enjoyed either similar or relatively faster capital accumulation, but the trend reversed afterwards. The causes are multifaceted: while a relative decrease in gross investment rates played the most prominent role, an increase in relative depreciation rates of non-construction assets also contributed to further slow accumulation down in Italy.

Appendix D provides a focus on the sources of differences in depreciation rates across countries and over time, while the following section will discuss more in depth the dynamics of gross investment rates and some of the factors that may drive it.



Source: elaborations on Eurostat and Istat data.

(1) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).

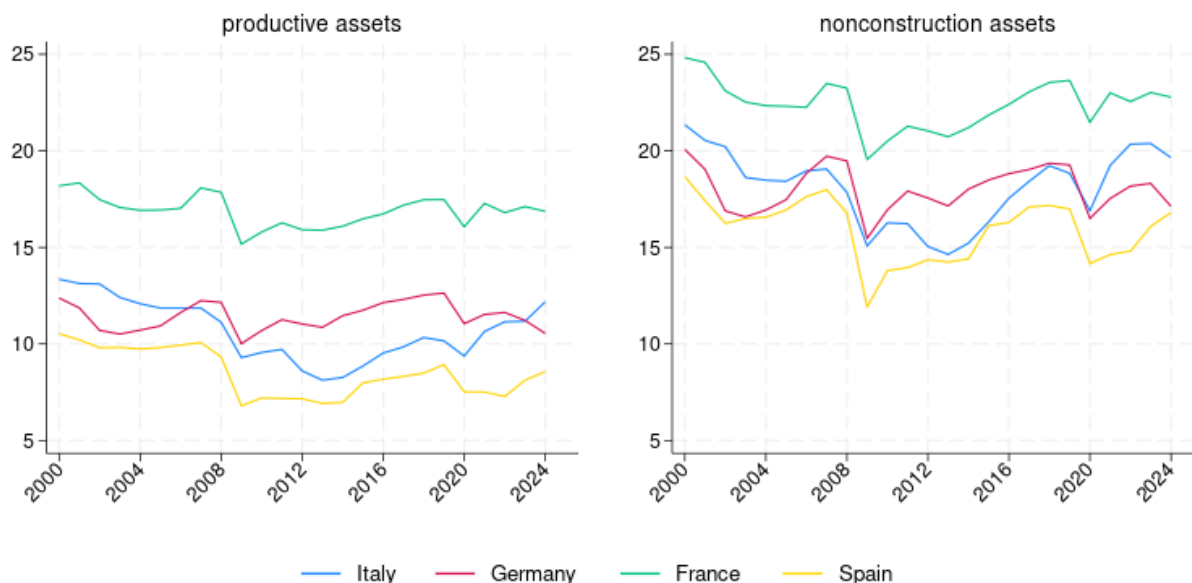
(2) Positive values indicate that the country's rate is higher than Italy's.

5. Cross-country heterogeneity in gross investment rates

Analysing cross-country differences in gross investment rates is a complex task. Differently from depreciation rates, which are closely linked to the technical deterioration of the pre-determined capital stock (although its estimation is subject to several caveats), the decision to invest is affected by the business cycle, entails considerations about the desired future productive capacity and the likelihood of the expected scenarios, and responds to credit conditions, as well as to structural reforms, and fiscal and monetary policy. In this section, we will analyse how much business cycle and economic shocks affect the investment rate in the different countries and will propose some explanations for the remaining differences once these factors are accounted for.

Although gross investment rates are the primary driver of under-accumulation of capital in Italy relative to both Germany and France, the comparisons with the two countries display markedly different patterns. In the case of Germany, the differential in gross investment rates changes sign over the sample period: up to the GFC, Italy's investment rate exceeded Germany's, while the opposite held thereafter. This reversal is consistent with shock-driven explanations, as discussed below. In the case of France, the differential is positive throughout the entire 2000–2024 period, indicating a structural gap that cannot be attributed to cyclical fluctuations or to shocks alone (Figure 8). These two distinct patterns call for different explanations.

Gross investment rate in productive and nonconstruction assets - Private sector (1) (percentage points)



Source: elaborations on Eurostat and Istat data.

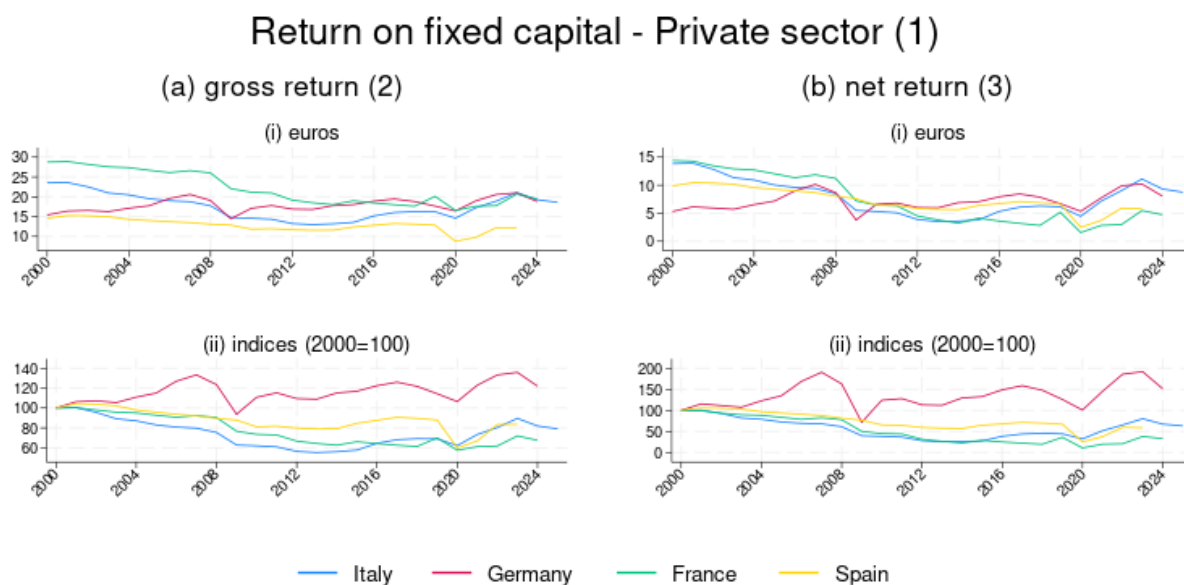
(1) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).

The Italian advantage relative to Germany in the pre-crisis period may largely reflect conditions on the financing side. The introduction of the euro and the ensuing convergence of interest rates towards German levels substantially reduced the cost of external financing for Italian firms, which historically faced higher borrowing costs than their German counterparts (Franks et al., 2018). This compression of credit spreads likely sustained investment, even as the return on capital was already in secular decline in Italy (Figure 9).

On the German side, the same period was characterised by a protracted process of post-reunification restructuring. Throughout the late 1990s and early 2000s, Germany was often described as the “sick man of Europe”, burdened by the costs of reunification and weak domestic demand (Barysch, 2003). A series of fiscal and labour market reforms were implemented since 1999 which proved successful in boosting macroeconomic variables, including investment (Gadatsch et al., 2016).⁹ At the same time, China’s entry in the WTO and its – and other emerging countries’ – rapid industrialisation spurred an exceptionally strong external demand for German capital goods, calling for an expansion of productive capacity: the spike observed between 2003 and 2007 in the gross investment rate for machinery and equipment has no counterpart in any of the other countries examined (Figure 10). The special juncture experienced by Germany is reflected in the return-on-capital indices, which reached their highest values precisely in this window, at a time in which returns were falling in all other main Euro area countries.

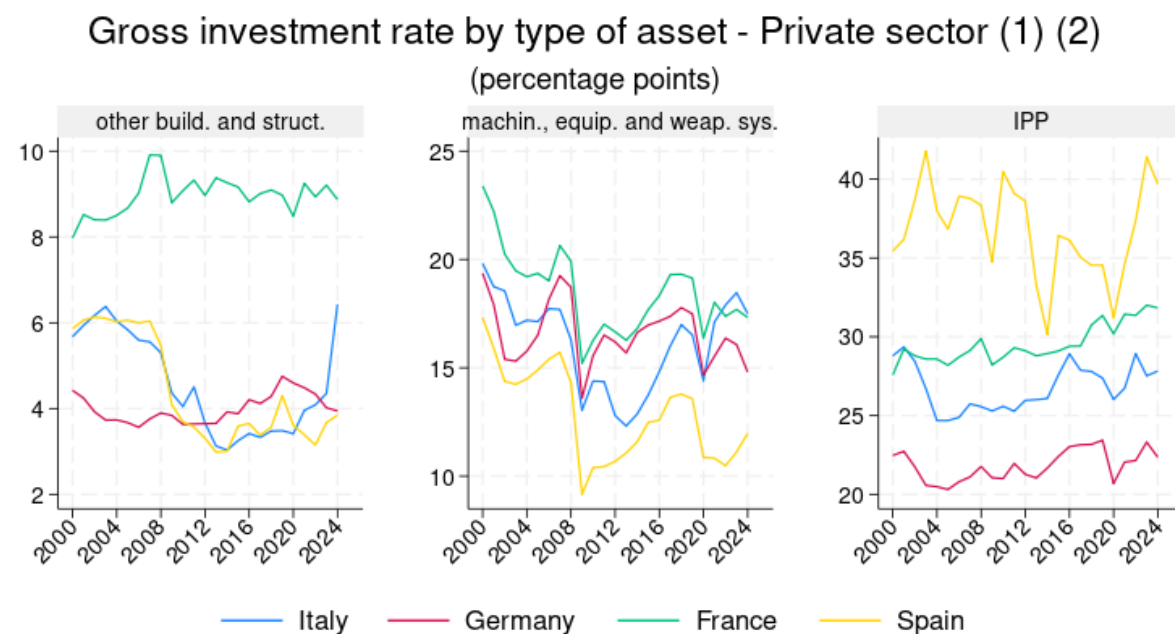
⁹ The most prominent reform of this series was the Hartz labour market reforms (2003-2005), which reduced unit labour costs and improved competitiveness. Theoretically, reductions in real wages, like those induced by the Hartz reforms, generate two competing effects on investment: on the one hand, lower labour cost provides firms with an incentive to substitute capital for labour; on the other hand, improved competitiveness increases exports and the need for additional productive capacity to meet foreign demand. In the case of the German reforms in the 2000s, the latter effect dominated the former.

Figure 9



Source: elaborations on Eurostat and Istat data.
 (1) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).
 (2) Gross profit at current prices, divided by net capital stock of fixed assets at current replacement costs. Gross profit is calculated as value added minus labour cost. Labour cost is the sum of the compensation of employees and self-employed, estimated under the assumption of equality of hourly wage between the two types of workers.
 (3) Net profit at current prices, divided by net capital stock of fixed assets at current replacement costs. Net profit is calculated as gross profit minus consumption of fixed capital.

Figure 10

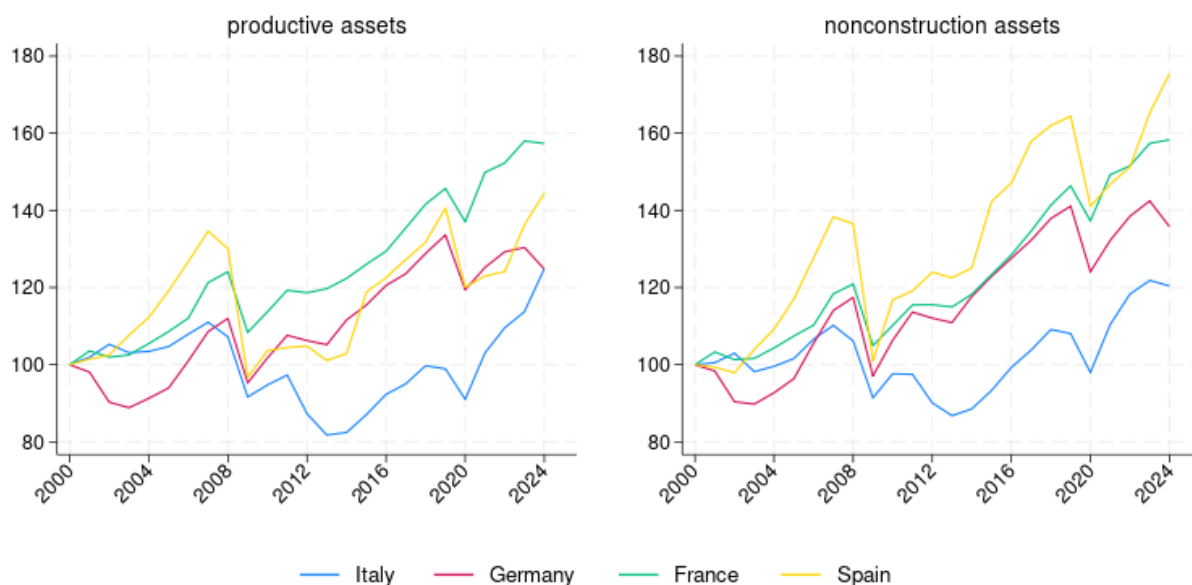


Source: elaborations on Eurostat and Istat data.
 (1) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).
 (2) Cultivated biological resources are excluded.

The reversal of the differential after 2010 is more straightforwardly explained. The GFC and the subsequent SDC had a markedly more severe impact on investment in Italy than in Germany, where the decline was comparatively modest and short-lived (Figure 11).

Figure 11

Gross investment in productive and nonconstruction assets - Private sector (1)
(indices; 2000=100)



Source: elaborations on Eurostat and Istat data.

(1) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).

The double crisis triggered a sharp contraction in bank credit supply internationally, which reduced investment (Bottero et al., 2020; De Marco, 2019). The effect was especially strong in Italy, given its larger exposure to the SDC and its productive structure, predominantly made of small and medium-sized enterprises with limited access to bond markets and historically high reliance on bank lending.

Unlike the Germany-Italy comparison, the France-Italy differential in the gross investment rate does not display a sign reversal. France's gross investment rate exceeds Italy's (and all other comparison countries') in productive and non-construction assets throughout the entire period considered, although the gap widened in the GFC and SDC years. This suggests that both structural and shorter-term forces must be at play.

To identify the nature of these differences, it is useful to decompose the gross investment rate algebraically as:

$$i_t = \frac{I_t}{VA_t} \cdot \frac{VA_t}{K_{t-1}}$$

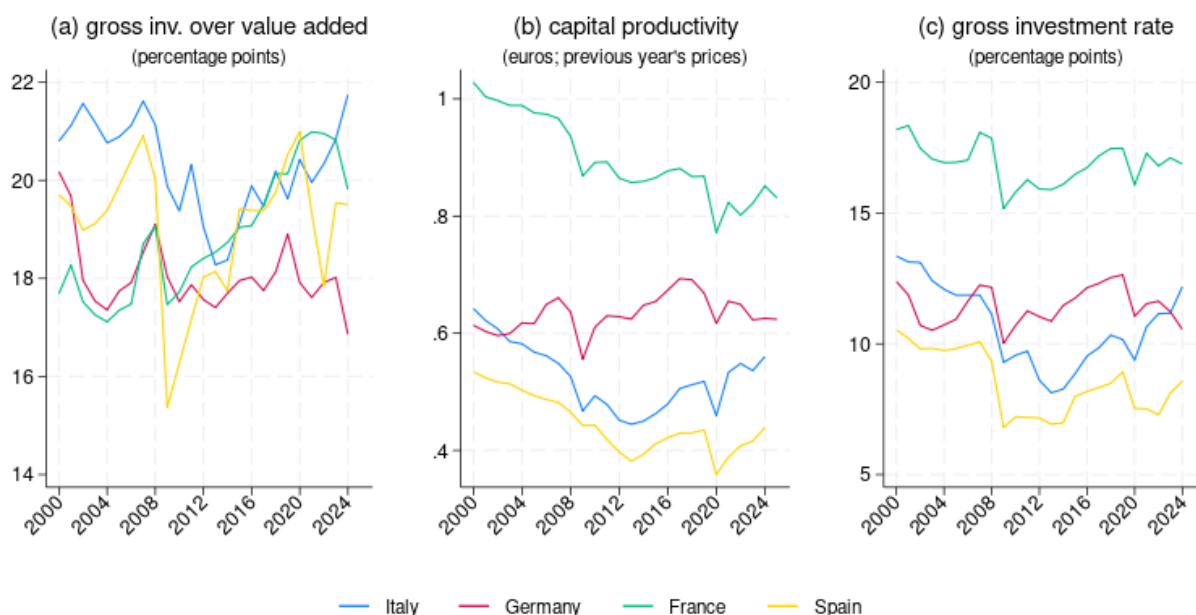
where I and K are gross investment and net capital stock, as above, and VA is the value added.¹⁰ The first term, I/VA , captures the share of value added allocated to investment. The second term, VA/K , represents the value-added-to-capital ratio and provides a measure of the productivity of the capital stock. Accordingly, economies characterized by higher value added per unit of capital tend to exhibit higher capital accumulation rates, for any given propensity to invest. Moreover, adverse shocks that compress value added constrain the resources available for investment, thereby limiting capital accumulation.

Figures 12 and 13 display the results of the decomposition for productive and non-construction capital, respectively.

¹⁰ The investment rate is defined as $i_t = I_t^{PYP}/K_{t-1}^{CP}$. The decomposition is therefore calculated as $i_t = (I_t^{PYP}/VA_t^{PYP}) \cdot (VA_t^{PYP}/K_{t-1}^{CP})$.

Figure 12

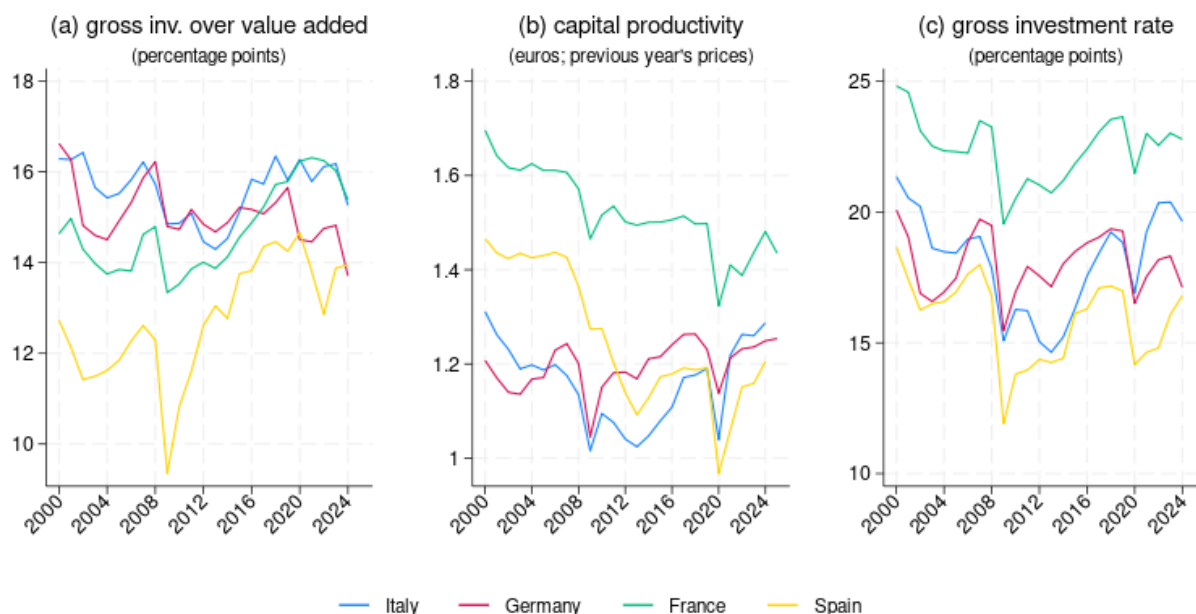
Decomposition of gross investment rate in productive assets - Private sector (1)



Source: elaborations on Eurostat and Istat data.
 (1) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).

Figure 13

Decomposition of gross investment rate in non-construction assets - Private sector (1)



Source: elaborations on Eurostat and Istat data.
 (1) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).

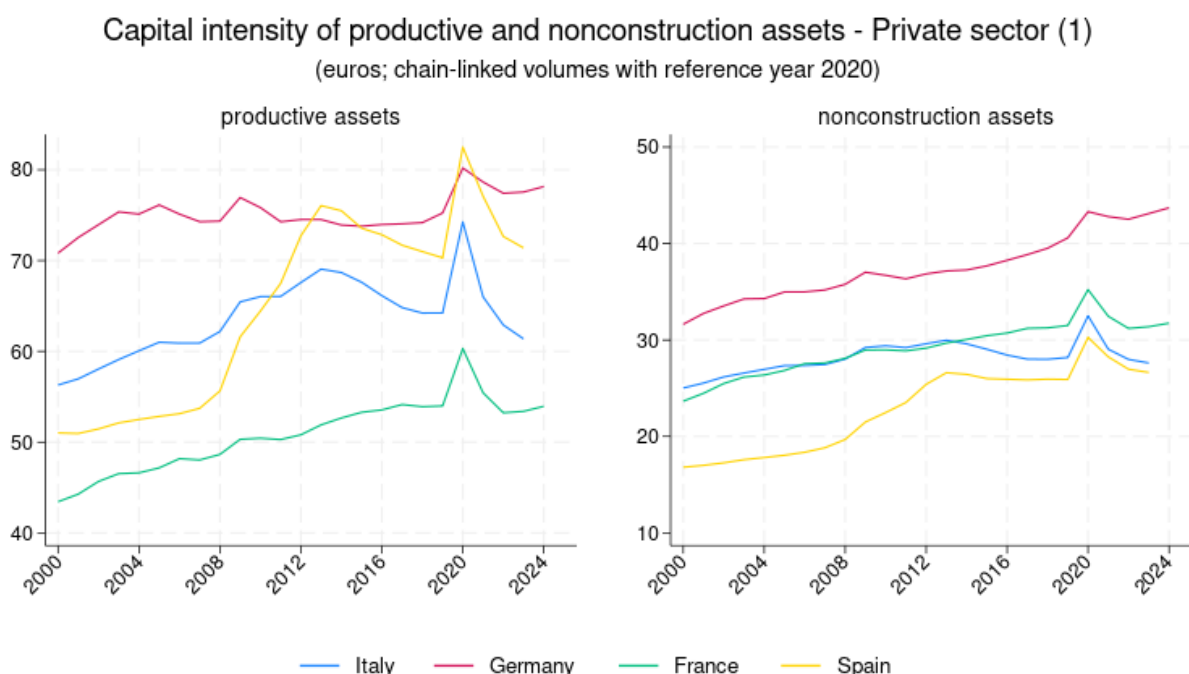
It emerges that during the double crisis capital accumulation in Italy was penalized both by a decline in the propensity to invest (investment relative to value added), which had been relatively high before the crisis, and

by a decline in the ratio of value added to capital stock, which limited the resources available to sustain capital growth.

France’s higher investment rate is not explained by a greater propensity to invest (investment relative to value added); it rather reflects a higher ratio of value added to capital stock (capital productivity), which – given the same propensity to invest – translates into a higher level of investment relative to capital.

Differences in capital productivity reflect both labour productivity and capital intensity levels.¹¹ Capital productivity is mechanically inflated in the case of high labour productivity or low capital intensity. Relative to Italy, France displays both higher labour productivity (Figure A1 in Appendix A) and lower capital intensity (Figure 14). With respect to this latter indicator, the differences are entirely driven by non-residential buildings, which are the type of productive assets least conducive to productivity growth. Once they are deducted from the stock of assets, it turns out that the level of capital intensity in Italy and France was roughly the same since at least 2000 and up to 2014, when Italy’s capital intensity has started to decline.

Figure 14



Source: elaborations on Eurostat and Istat data.
(1) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).

In other words, the difference in the size of the capital stock between Italy and France almost entirely lies in the stock of non-residential construction, which is smaller in France than in Italy. The lower level of the stock in France essentially reflects higher depreciation rates compared with both Italy and the other countries considered, which offset a relatively high ratio of investment to capital in this type of asset.

Depreciation rates are not directly measured; rather, they are the product of a complex calculation embedded in the perpetual inventory method (PIM), which is the internationally accepted methodology used to estimate the capital stock. As discussed in Appendix D, the depreciation rates used in the PIM differ across countries, sectors, asset types, and over time. In particular, the depreciation rate for non-residential construction assets in France – which is almost twice as high as the second-highest one (8 per cent against 4 per cent in Italy and

¹¹ As capital productivity is equal to (nominal) labour productivity, divided by (nominal) capital intensity.

Germany and 3 in Spain) – results in a particularly slow accumulation of these assets in France relative to the other countries.

Additionally, the parameters governing the retirement distribution – that is, the probability that an asset is removed from the productive system before the end of its natural service life – are typically assumed to be invariant to the business cycle. During recessions, by contrast, the probability increases that firms exit the market without being able to resell their assets as second-hand capital goods, thereby raising the amount of unobserved asset retirements.¹² Major crises may therefore leave behind substantial amounts of idle capital, which is *de facto* outside of the productive system, but still accounted for in national accounts data, thereby depressing subsequent measured capital accumulation through the impact on depreciation. This mechanism would be especially relevant and persistent for construction assets, given that they depreciate slowly and would be especially relevant for Italy and Spain, the two countries most severely hit by the GFC and the SDC.

Unfortunately, no data are available to quantify the magnitude of this potential bias. Statistics on capacity utilisation are not an adequate proxy for idle capital of this kind, as they are collected only from firms that remain active in the market and are available solely for the manufacturing sector. The scale of firm exit during the Great Recession provides a partial gauge of the potential magnitude of the bias: according to SBS data, between 2008 and 2014 the number of firms declined by 6 percent in Italy and by nearly 10 percent in Spain, whereas it increased by 33 percent in Germany and 35 percent in France.¹³

6. Discussion and conclusions

Over the past decade, labour productivity growth in Italy has been held back by a decline in capital intensity, which has partially offset the increase in TFP. The decrease in capital per hour worked can be traced back to a prolonged contraction in the capital stock following the GFC and the SDC, mainly due to the sharp fall in investment flows, which for several years remained below depreciation. Both the decline in investment propensity (investment relative to value added) and the fall in the ratio of value added to the capital stock, which reduced the resources available for accumulation, contributed to the contraction in the capital stock.

Following the Covid-19 crisis, capital accumulation recovered; however, overall capital stock growth since the onset of the global financial crisis has remained significantly weaker than in other countries, and capital deepening has continued to decline.

Cross-country comparisons highlight, however, the existence of systematic differences in both the dynamics and the levels of the capital stock, which are not fully explained by differences in the propensity to invest or in business cycle conditions, and are likely to reflect differences in the measurement of capital.

More specifically, we show that the assumptions underlying the depreciation rates applied in the PIM are not homogeneous across countries. Moreover, because the capital depreciation is assumed to be constant over the business cycle, a severe recession that reduces the effective service life of assets can lead to an overestimation of the capital stock.

Both systematic cross-country differences in the depreciation rates, and the possible overestimation of the service life of assets in the case of severe recessions, can lead to a mismeasurement of the capital stock and reduce the comparability of capital stock statistics.

This has direct implications for the interpretation of TFP, which is widely regarded as a summary measure of productive efficiency. The decomposition of labour productivity growth into TFP and capital deepening plays a central role in policy analysis: a weakening TFP contribution calls for structural policies aimed at technology

¹² Sales of assets as second-hand goods for continued use in production (“disposals”) do not generate an upward bias in capital measurement. They are explicitly accounted for in gross fixed capital formation, which is defined as “the acquisition, less disposals, of fixed assets plus major improvements to, and transfer costs on, land and other non-produced assets.”

¹³ SBS data refer to the sectors of the total business economy, including the repair of computers, personal and household goods, and excluding financial and insurance activities.

adoption and resource reallocation, while a shortfall in capital deepening points to barriers to investment. Yet, TFP is a residual and is therefore sensitive to errors in the measurement of capital deepening. Crucially, any overestimation of the capital stock implies that measured capital growth falls short of the growth of the true productive capital stock, understating the contribution of capital deepening and correspondingly overstating the residual attributed to TFP, with the opposite distortion arising as the bias unwinds.

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Appendix A

Table A1

Average annual growth rate of main economic variables												
<i>(percentage points)</i>												
	value added				hours worked				labour productivity			
	2000-2025	2000-2007	2007-2014	2014-2025	2000-2025	2000-2007	2007-2014	2014-2025	2000-2025	2000-2007	2007-2014	2014-2025
(a) Italy												
total economy	0.5	1.2	-1.2	1.1	0.4	1.0	-1.4	1.1	0.1	0.1	0.2	0.0
private sector (1)	0.7	1.5	-1.9	1.8	0.5	1.3	-1.8	1.4	0.2	0.1	0.0	0.5
- of which: manufacturing	0.0	0.9	-2.6	1.0	-0.8	-0.1	-3.5	0.5	0.8	1.1	1.0	0.5
- of which: construction	0.4	2.4	-6.4	3.8	1.1	4.3	-4.3	2.7	-0.7	-1.8	-2.2	1.0
- of which: private services	1.2	1.8	-0.7	2.0	0.9	1.6	-0.7	1.4	0.3	0.2	0.0	0.5
-- of which: ICT services	2.3	4.8	-0.5	2.6	0.8	1.4	-1.4	1.8	1.5	3.3	0.9	0.8
(b) Germany												
total economy	1.0	1.6	0.8	0.8	0.2	0.0	0.3	0.2	0.9	1.6	0.5	0.6
private sector (1)	1.2	2.3	0.8	0.8	0.0	-0.1	0.3	-0.1	1.2	2.4	0.4	0.9
- of which: manufacturing	1.1	2.6	0.8	0.3	-0.6	-1.0	0.0	-0.8	1.7	3.6	0.8	1.1
- of which: construction	-1.9	-3.5	0.4	-2.4	-0.7	-2.8	0.3	0.0	-1.2	-0.7	0.1	-2.3
- of which: private services	1.9	3.2	0.7	1.8	0.5	0.9	0.5	0.2	1.4	2.2	0.3	1.6
-- of which: ICT services	4.1	4.9	3.9	3.7	1.4	1.7	0.2	2.0	2.6	3.1	3.7	1.6
(c) France												
total economy	1.3	2.0	0.7	1.2	0.6	0.6	0.0	1.0	0.7	1.4	0.7	0.2
private sector (1)	1.3	2.3	0.1	1.4	0.8	0.8	-0.1	1.3	0.5	1.5	0.2	0.1
- of which: manufacturing	0.6	1.7	-0.4	0.7	-1.0	-1.9	-2.0	0.2	1.7	3.7	1.7	0.4
- of which: construction	-0.1	2.5	-2.4	-0.1	1.1	2.9	-0.3	0.8	-1.1	-0.4	-2.1	-0.9
- of which: private services	1.8	2.6	0.8	2.0	1.3	1.4	0.5	1.7	0.6	1.2	0.3	0.3
-- of which: ICT services	4.4	6.1	2.3	4.6	1.8	0.8	1.1	2.9	2.5	5.2	1.2	1.7
(d) Spain												
total economy	1.7	3.4	-0.8	2.2	0.9	3.0	-2.4	1.7	0.8	0.4	1.6	0.5
private sector (1)	1.4	2.7	-1.9	2.7	0.8	3.5	-3.6	2.0	0.6	-0.8	1.8	0.7
- of which: manufacturing	0.3	1.0	-3.1	2.0	-1.2	-1.4	-5.2	1.5	1.5	2.4	2.2	0.5
- of which: construction	-0.7	3.4	-8.6	2.0	-0.8	6.0	-13.4	3.7	0.1	-2.4	5.6	-1.7
- of which: private services	2.5	3.2	0.2	3.4	1.8	4.7	-0.9	1.8	0.6	-1.4	1.1	1.6
-- of which: ICT services	4.2	4.7	2.2	5.2	2.9	2.5	-0.4	5.2	1.3	2.1	2.6	0.0

Source: elaborations on Eurostat and Istat data. (1) Private nonfarm, non-financial sector, excluding real estate (NACE: B-N, excl. K, L).

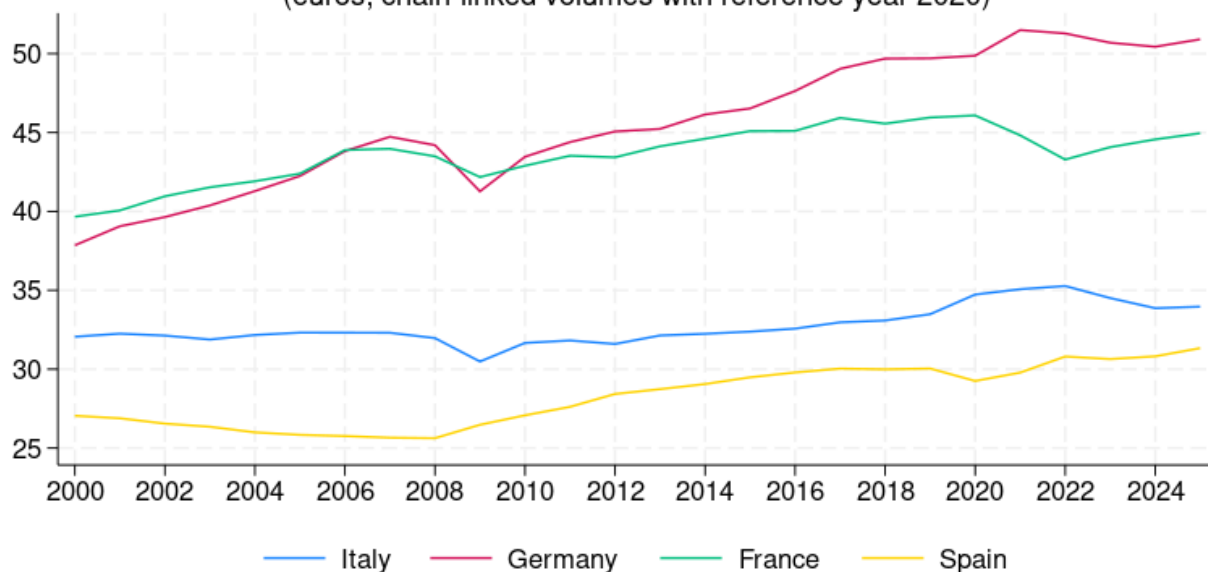
Average annual growth rate of net capital stock by sector and detailed type of assets

	<i>(percentage points)</i>															
	residential construction (1)				non-residential construction (2)				machinery and equipment, and weapons systems				IPPs			
	2000-2007	2007-2014	2014-2023	2000-2023	2000-2007	2007-2014	2014-2023	2000-2023	2000-2007	2007-2014	2014-2023	2000-2023	2000-2007	2007-2014	2014-2023	2000-2023
(a) Italy																
total economy	1.5	0.7	0.4	0.8	1.9	0.2	-0.5	0.4	2.9	-1.1	0.3	0.7	1.3	0.8	2.8	1.7
private sector (3)	..	..	..	..	2.3	0.4	-0.3	0.7	2.9	-1.2	0.0	0.5	1.3	1.1	2.8	1.8
- of which: manufacturing	..	..	..	..	-0.8	-1.5	-1.4	-1.3	2.5	-0.7	0.4	0.7	1.2	2.3	3.6	2.5
- of which: construction	..	..	..	..	0.3	-0.9	-0.9	-0.5	3.8	-4.1	0.8	0.2	0.2	2.3	8.3	4.0
- of which: private services	..	..	..	..	2.5	0.7	0.1	1.0	3.4	-1.5	0.4	0.7	1.5	0.5	2.1	1.4
-- of which: ICT services	..	..	..	..	3.8	1.1	2.2	2.4	3.4	2.6	2.9	3.0	0.8	1.6	1.9	1.5
(b) Germany																
total economy	1.2	0.8	0.8	0.9	0.1	-0.2	-0.5	-0.2	1.5	1.2	1.6	1.4	2.0	2.3	3.2	2.6
private sector (3)	..	..	..	..	-0.4	-0.8	-0.6	-0.6	1.2	0.8	1.1	1.1	1.8	2.1	3.2	2.5
- of which: manufacturing	..	..	..	..	-2.7	-2.4	-2.1	-2.4	-0.5	-0.1	0.6	0.1	2.1	2.1	3.5	2.6
- of which: construction	..	..	..	..	-1.8	-1.5	0.3	-0.9	-6.3	1.3	5.0	0.4	2.1	2.3	2.4	2.3
- of which: private services	..	..	..	..	0.6	-0.2	-0.1	0.1	3.4	1.5	1.1	1.9	1.3	1.8	2.7	2.0
-- of which: ICT services	..	..	..	..	-2.3	-4.4	-3.8	-3.5	3.3	2.7	4.3	3.5	1.2	2.7	4.2	2.8
(c) France																
total economy	2.3	1.8	1.7	1.9	1.4	1.0	0.6	1.0	2.7	0.8	1.3	1.6	2.7	2.2	3.1	2.7
private sector (3)	..	..	..	..	1.0	1.3	1.3	1.2	3.2	0.4	1.5	1.7	2.7	2.5	3.0	2.7
- of which: manufacturing	..	..	..	..	0.3	-0.2	0.3	0.2	1.6	-1.4	0.0	0.1	2.4	1.6	0.8	1.5
- of which: construction	..	..	..	..	1.1	1.2	0.7	1.0	3.3	-2.0	1.1	0.8	1.3	3.2	5.6	3.6
- of which: private services	..	..	..	..	1.3	1.8	1.8	1.7	4.2	0.2	1.5	1.9	3.8	3.7	4.1	3.9
-- of which: ICT services	..	..	..	..	2.5	1.9	2.1	2.2	5.8	2.4	2.7	3.6	5.5	3.9	5.6	5.1
(d) Spain																
total economy	4.4	1.7	1.7	2.5	3.8	1.7	0.3	1.8	4.5	0.5	1.3	2.0	4.5	0.5	0.5	5.3
private sector (3)	4.7	0.4	0.5	1.8	3.7	1.2	0.8	1.8	4.8	0.5	1.4	2.2	4.8	0.5	0.5	6.0
- of which: manufacturing	..	..	..	..	2.4	0.4	2.8	1.9	2.4	-2.3	3.2	1.3	2.4	-2.3	-2.3	5.2
- of which: construction	4.7	0.4	0.5	1.8	5.5	-0.1	-0.4	1.5	10.0	-2.3	-1.2	1.9	10.0	-2.3	-2.3	0.0
- of which: private services	..	..	..	..	3.7	1.1	0.3	1.6	6.2	0.2	1.7	2.6	6.2	0.2	0.2	6.4
-- of which: ICT services	..	..	..	..	2.8	0.3	-0.8	0.6	0.9	-1.6	0.9	0.1	0.9	-1.6	-1.6	6.7

Source: elaboration on Eurostat and Istat data. Growth rates are calculated as log-differences. Average growth rates are calculated as arithmetic means of annual growth rates. - (1) Dwellings. - (2) Other buildings and structures. - (3) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).

Figure A1

Value added per hour worked - Private sector (1)
 (euros; chain-linked volumes with reference year 2020)



Source: elaborations on Istat and Eurostat data.

(1) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).

Appendix B

Istat data are used for Italy and Eurostat data are used for the other countries. The availability of Istat and Eurostat data on net capital, gross investment and depreciation by asset and sector is summarized in the tables below.¹⁴

Given the constraints on data availability and in order to maximize cross-country coverage of gross investment and net capital stock data, cross-country comparisons are limited to the following asset classification:

- Total fixed assets
 - o Dwellings
 - o Other buildings and structures
 - o Machinery and equipment, and weapon systems
 - o Cultivated biological resources
 - o Intellectual property products

Because of the unavailability of Eurostat data on consumption of fixed capital by asset type, depreciation is estimated according to the methodology described in Appendix D.

Net capital stock

Hierarchy	Description	Italy		Germany		France		Spain	
		Total economy	A*10 industries	Total economy	A*10 industries	Total economy	A*10 industries	Total economy	A*10 industries
TOT	Total fixed assets	X	X	X	X	X	X	X	X
1	Total construction	X	X	X	X	X	X	X	X
1.a	Dwellings	X	X	X	X	X	X	X	X
1.b	Other buildings and structures	X	X	X	X	X	X	X	X
2	Machinery and equipment, and weapon systems	X	X	X	X	X	X	X	X
2.a	Transport equipment	X	X	X	X	X	X	X	X
2.b	ICT equipment	X	X	X	X	X	X	X	
2.b.i	Computer hardware	X	X	X		X	X	X	
2.b.ii	Telecommunications equipment	X	X	X		X	X	X	
2.c	Other machinery and equipment, and weapon systems	X	X	X		X	X	X	
3	Cultivated biological resources	X	X	X	X	X	X	X	X
4	Intellectual property products	X	X	X	X	X	X	X	X
4.a	Research and development	X	X	X	X	X	X	X	
4.b	Computer software and databases	X	X	X	X	X	X	X	
4.c	Mineral exploration and evaluation; entertainment, literary or artistic originals	X	X						

¹⁴ A*10 industries are (NACE codes in parenthesis): Agriculture, forestry and fishing (A), Industry (except construction) (B-E), Manufacturing (C), Construction (F), Wholesale and retail trade, transport, accommodation and food service activities (G-I), Information and communication (J), Financial and insurance activities (K), Real estate activities (L), Professional, scientific and technical activities; administrative and support service activities (M_N), Public administration, defence, education, human health and social work activities (O-Q), Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies (R-U).

Gross investment

Hierarchy	Description	Italy		Germany		France		Spain	
		Total economy	A*10 industries	Total economy	A*10 industries	Total economy	A*10 industries	Total economy	A*10 industries
TOT	Total fixed assets	X	X	X	X	X	X	X	X
1	Total construction	X	X	X	X	X	X	X	X
1.a	Dwellings	X	X	X	X	X	X	X	X
1.b	Other buildings and structures	X	X	X	X	X	X	X	X
2	Machinery and equipment, and weapon systems	X	X	X	X	X	X	X	X
2.a	Transport equipment	X	X	X	X	X	X	X	X
2.b	ICT equipment	X	X	X	X	X	X	X	X
2.b.i	Computer hardware	X	X	X	X	X	X	X	X
2.b.ii	Telecommunications equipment	X	X	X	X	X	X	X	X
2.c	Other machinery and equipment, and weapon systems	X	X	X	X	X	X	X	X
3	Cultivated biological resources	X	X	X	X	X	X	X	X
4	Intellectual property products	X	X	X	X	X	X	X	X
4.a	Research and development	X	X	X	X	X	X	X	X
4.b	Computer software and databases	X	X	X	X	X	X	X	X
4.c	Mineral exploration and evaluation; entertainment, literary or artistic originals	X	X						

Depreciation

Hierarchy	Description	Italy		Germany		France		Spain	
		Total economy	A*10 industries	Total economy	A*10 industries	Total economy	A*10 industries	Total economy	A*10 industries
TOT	Total fixed assets	X	X	X	X	X	X	X	X
1	Total construction	X	X						
1.a	Dwellings	X	X						
1.b	Other buildings and structures	X	X						
2	Machinery and equipment, and weapon systems	X	X						
2.a	Transport equipment	X	X						
2.b	ICT equipment	X	X						
2.b.i	Computer hardware	X	X						
2.b.ii	Telecommunications equipment	X	X						
2.c	Other machinery and equipment, and weapon systems	X	X						
3	Cultivated biological resources	X	X						
4	Intellectual property products	X	X						
4.a	Research and development	X	X						
4.b	Computer software and databases	X	X						
4.c	Mineral exploration and evaluation; entertainment, literary or artistic originals	X	X						

Appendix C

Across the main European economies, productive capital represents between 40 and 60 percent of total fixed assets, and its share has declined slightly over time in all countries except Spain (Table C1). Productive capital accounts for virtually the entire capital stock held by the private sector, although its internal composition varies markedly across countries and sectors.¹⁵ Non-residential construction assets represent a substantial share of productive capital: in all countries, non-construction productive assets only amount to less than one fifth of total fixed capital (and roughly one third of productive capital). Their incidence is higher in manufacturing than in services.

Table C1

Productive and non-construction assets as a share of a sector's total fixed assets								
<i>(percentage points)</i>								
	Italy		Germany		France		Spain	
	producti ve assets	non- constructi on assets	producti ve assets	non- constructi on assets	producti ve assets	non- constructi on assets	producti ve assets	non- constructi on assets
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
(a) 2000								
total economy	55.2	19.6	53.6	18.8	46.7	16.2	55.2	16.7
private sector (3)	100.0	49.3	100.0	51.5	100.0	61.1	86.0	31.4
- of which:								
manufacturing	100.0	72.3	100.0	77.3	100.0	72.2	100.0	51.4
- of which:								
construction	100.0	56.4	100.0	58.9	100.0	49.1	45.6	6.3
- of which: private								
services	100.0	43.0	100.0	49.6	100.0	59.5	100.0	38.3
-- of which: ICT								
services	100.0	58.9	100.0	45.5	100.0	66.8	100.0	43.2
(b) 2023								
total economy	51.5	16.5	47.2	16.0	40.7	13.1	56.1	16.7
private sector (3)	100.0	43.6	100.0	50.1	100.0	57.5	88.5	32.3
- of which:								
manufacturing	100.0	77.9	100.0	82.5	100.0	68.3	100.0	44.4
- of which:								
construction	100.0	54.5	100.0	55.0	100.0	42.5	48.7	6.1
- of which: private								
services	100.0	36.0	100.0	46.2	100.0	56.1	100.0	42.7
-- of which: ICT								
services	100.0	45.6	100.0	65.3	100.0	70.4	100.0	47.9

Source: elaboration on Eurostat and Istat data.

(1) Total fixed assets minus residential buildings (dwellings). - (2) Productive assets minus non-residential buildings and structures.

- (3) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).

¹⁵ In all countries, virtually all residential construction is attributed to the real estate sector, which is excluded for the definition of private sector used in this work; only in Spain non-real estate industries detain some residential construction capital.

Turning to a more granular breakdown of the assets that compose productive capital, the largest cross-country differences concern the share of intellectual property products (IPPs; Table C2). IPP assets are particularly prominent in Germany and France.¹⁶

Significant differences in asset composition also arise within countries, across sectors. As expected, the asset mix mirrors the technological and operational characteristics of each sector: in all economies considered, manufacturing is characterised by a high incidence of machinery and IPPs, whereas the ICT services sector is dominated by intangible capital.

Asset shares have gradually evolved over time across countries and sectors, with the share of machinery and equipment declining in many sectors in favour of IPPs. The pace of this structural transformation, however, is highly heterogeneous.¹⁷ The rising share of IPPs generally reflects real-term increases in their stock across all sectors and countries, while the contraction in machinery and equipment derives from a decrease in its relative weight, despite real-term growth in the underlying stock between 2000 and 2023 (Table A2 in Appendix A). Additional differences are observed in sectoral capital accumulation rates, with accumulation in private services being on average higher (Table 2 in the main text).

¹⁶ Although with country-specific profiles: R&D is especially significant in Germany, while in France IPP capital is more heavily concentrated in software and databases. Italy, by contrast, lies at the lower end of the distribution, with R&D amounting to roughly 2 percent of total fixed assets and software and databases accounting for about 1 percent. Separate data on R&D and on software and databases for Germany and Spain are available only at the level of the total economy. For this reason, the cross-country sectoral analysis presented here focuses on total IPPs. IPPs also include other asset categories, such as mineral exploration and artistic originals. Although Eurostat does not report these items separately, Istat data indicate that they account for a negligible share of Italy's capital stock (approximately 0.3–0.5 percent of total net productive capital and less than 5 percent of IPP net capital). It is reasonable to assume that their share is similarly small in other European countries.

¹⁷ A notable exception to the general upward trend in IPPs is the ICT services sector in Italy, where the share of intangible assets – primarily software and databases – fell by over 8 percentage points between 2000 and 2023.

Composition of productive capital by asset type (1)

(percentage points)

	non- res. constr	Italy mach, equip and weap. sys.	IPPs	non- res. constr	Germany mach, equip and weap. sys.	IPPs	non- res. constr	France mach, equip and weap. sys.	IPPs	non- res. constr	Spain mach, equip and weap. sys.	IPPs
(a) 2000												
total economy	64.6	29.4	5.8	64.9	27.0	7.8	65.4	23.1	10.4	69.7	27.4	2.7
private sector (2)	50.7	40.9	8.3	48.5	39.6	11.9	38.9	40.6	20.5	63.5	33.8	2.7
- of which: manufacturing	27.7	61.8	10.6	22.7	50.7	26.6	27.8	44.8	27.4	48.6	47.1	4.3
- of which: construction	43.6	55.2	1.2	41.1	57.2	1.8	50.9	46.8	2.3	86.2	13.3	0.5
- of which: private services	57.0	33.1	9.9	50.4	41.7	7.9	40.5	38.4	21.0	61.7	35.2	3.1
-- of which: ICT services	41.1	25.7	33.2	54.5	25.8	19.7	33.2	32.6	34.1	56.8	36.4	6.8
(b) 2023												
total economy	67.9	25.8	6.2	66.0	24.0	9.9	67.8	20.5	11.1	70.1	23.7	5.4
private sector (2)	56.4	34.5	9.0	49.9	34.7	15.4	42.5	35.9	21.6	63.5	30.1	6.4
- of which: manufacturing	22.1	62.4	15.5	17.5	41.1	41.4	31.7	36.9	31.5	55.6	35.6	8.8
- of which: construction	45.5	51.7	2.7	45.0	53.0	2.0	57.5	39.4	3.1	87.6	12.1	0.3
- of which: private services	64.0	26.9	9.1	53.8	38.4	7.8	43.9	32.0	24.1	57.3	34.8	7.9
-- of which: ICT services	54.4	20.6	25.1	34.7	36.1	29.2	29.6	29.7	40.7	52.1	24.2	23.8

Source: elaboration on Eurostat and Istat data.

(1) Cultivated biological resources account for less than 1 percent of productive assets in all countries and are concentrated in the agricultural sector; they are therefore excluded. - (2) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).

To assess the impact of sectoral and asset composition on capital accumulation, we introduce a novel decomposition framework. The approach isolates the contributions of cross-country differences in asset and sectoral composition from those arising from differential sector-asset-specific capital dynamics. More specifically, the real growth rate of capital can be expressed as a weighted average of the sector-asset-specific accumulation rates:

$$\frac{\Delta K_t}{K_{t-1}} = g_t^K = \sum_j \sum_w g_{jw,t} a_{jw,t-1} s_{j,t-1}$$

Where $g_{jw,t}$ is the real growth rate of asset w in sector j between $t-1$ and t , $a_{jw,t-1} = K_{jw,t-1}/K_{j,t-1}$ is the share of asset w in the capital stock of sector j at time $t-1$, and $s_{j,t-1} = K_{j,t-1}/K_{t-1}$ is the share of the overall capital stock which is held by sector j . Differences in the rate of growth of the capital stock between two countries, A and B , can be then expressed as:

$$g_t^{K,A} - g_t^{K,B} = AS + SS + SAG$$

with:

$$\begin{aligned} AS &= \sum_j \sum_w g_{jw,t}^A s_{j,t-1}^A (a_{jw,t-1}^A - a_{jw,t-1}^B) \\ SS &= \sum_j \sum_w g_{jw,t}^A a_{jw,t-1}^B (s_{j,t-1}^A - s_{j,t-1}^B) \\ SAG &= \sum_j \sum_w (g_{jw,t}^A - g_{jw,t}^B) a_{jw,t-1}^B s_{j,t-1}^B \end{aligned}$$

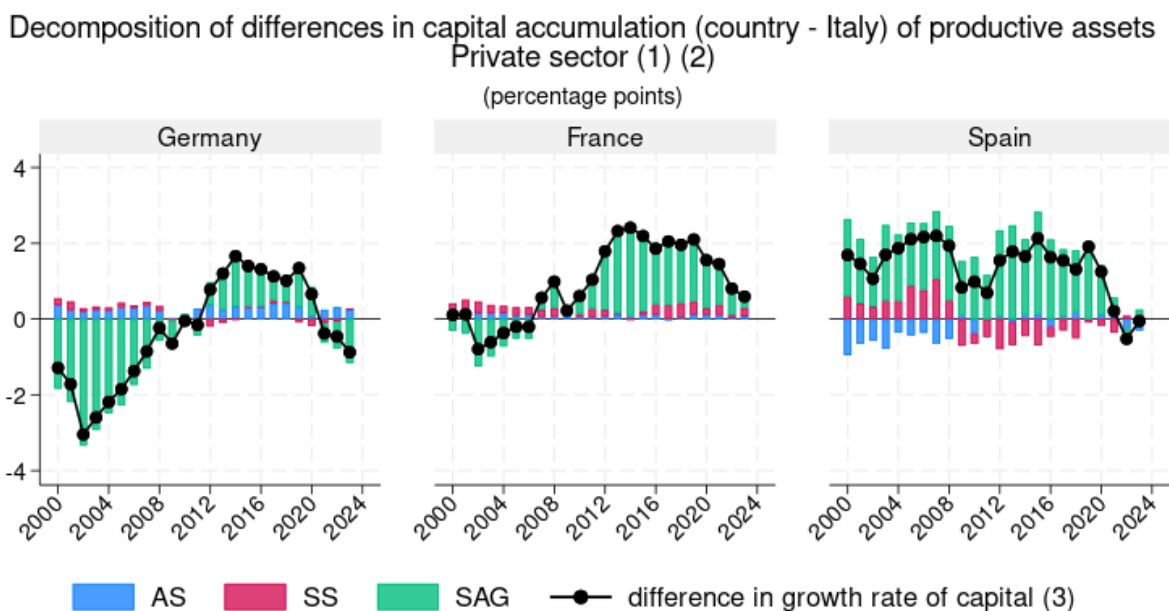
where the AS (asset shares) component captures the portion of the difference attributable to cross-country variation in within-sector asset composition; the SS (sector shares) component reflects differences in the sectoral distribution of the overall capital stock; and the SAG (sectoral asset growth) component measures the contribution arising from differences in sector-asset-specific capital growth rates. The derivation is provided at the end of this Appendix.

A positive value of the AS component means that country *A*'s asset composition is more tilted towards faster-accumulating assets than country *B*'s. Similarly, a positive SS component indicates that country *A*'s sectoral composition is relatively more skewed towards sectors displaying high growth rate of capital. Finally, a positive value of the SAG component denotes that accumulation of capital across sectors and asset types is on average higher in country *A* than in country *B*.

Figure C1 shows the results of the decomposition for productive capital in the private sector across the main European economies, relative to Italy. The SAG component emerges as the principal driver of cross-country differences in all cases. The SAG component is positive in the comparison to Spain in all years, meaning that the growth rate of capital in Spain has been on average higher than in Italy across sectors and assets at least since 2000. Conversely, the SAG components for Germany and France indicate that up to the onset of the double crisis, sector-asset-specific capital accumulation was stronger in Italy than in these countries. The situation flipped with the crisis: the relatively more subdued capital accumulation in Italy lasted for almost a decade and only dampened in the post-Covid years.

By contrast, compositional effects (captured by the SS and AS components) play a much more limited role. Although it is possible to detect some systematic differences, their impact is extremely limited.¹⁸

Figure C1

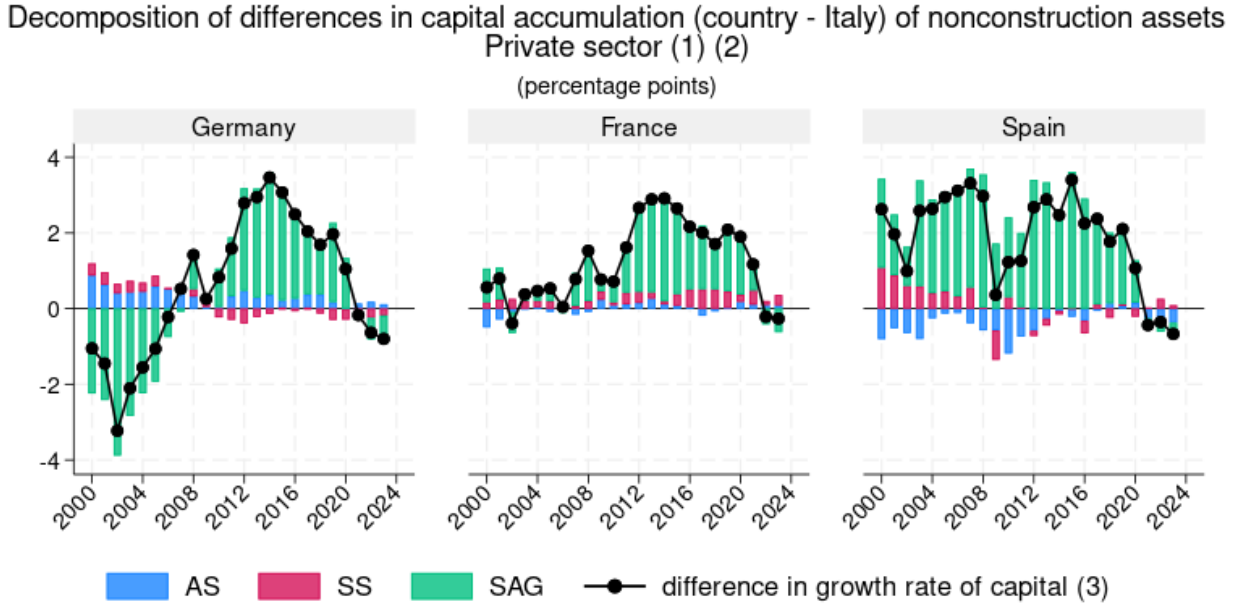


Source: elaborations on Eurostat and Istat data.
(1) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).
(2) Productive assets are total fixed assets minus residential buildings (dwellings).
(3) Positive values indicate that the country's growth rate of capital is higher than Italy's.

¹⁸ The two components are much more volatile when comparing Italy with Spain, as they reflect the sizable structural change that occurred in the latter country over the last 30 years.

The results are qualitatively unchanged when the focus is on non-construction assets (Figure C2).

Figure C2



Source: elaborations on Eurostat and Istat data.

- (1) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).
- (2) Nonconstruction assets are productive assets minus nonresidential buildings and structures.
- (3) Positive values indicate that the country's growth rate of capital is higher than Italy's.

Mathematical derivation of the AS-SS-SAG decomposition

When valued at current prices (CP) or previous year's prices (PYP), the stock of capital at time t can be expressed as the sum of all assets held by all sectors of the economy:

$$K_t = \sum_j \sum_w K_{jw,t}$$

where $K_{jw,t}$ is the stock of asset w held by sector j at time t .

Considering the capital stock valued at previous year's prices (PYP) and multiplying and dividing the terms of the sum by the corresponding capital stock at time $t-1$ valued at current prices, one obtains:

$$K_t^{PYP} = \sum_j \sum_w \frac{K_{jw,t}^{PYP}}{K_{jw,t-1}^{CP}} K_{jw,t-1}^{CP} = \sum_j \sum_w (1 + g_{jw,t}^{CLV}) K_{jw,t-1}^{CP}$$

where $g_{jw,t}^{CLV}$ is the annual real growth rate between $t-1$ and t of sector j 's stock of asset w , since chain-linking implies: $K_{jw,t}^{PYP}/K_{jw,t-1}^{CP} = K_{jw,t}^{CLV}/K_{jw,t-1}^{CLV} = 1 + g_{jw,t}^{CLV}$.

Again, multiplying and dividing the terms by the total capital stock of sector j and by the total capital stock of the economy in the previous period, both valued at current prices, the expression becomes:

$$K_t^{PYP} = \sum_j \sum_w (1 + g_{jw,t}^{CLV}) \frac{K_{jw,t-1}^{CP}}{K_{j,t-1}^{CP}} \frac{K_{j,t-1}^{CP}}{K_{t-1}^{CP}} K_{t-1}^{CP} = \sum_j \sum_w (1 + g_{jw,t}^{CLV}) a_{jw,t-1} s_{j,t-1} K_{t-1}^{CP}$$

where $a_{jw,t-1} = K_{jw,t-1}^{CP}/K_{j,t-1}^{CP}$ is the share of asset w in the capital stock of sector j at time $t-1$, and $s_{j,t-1} = K_{j,t-1}^{CP}/K_{t-1}^{CP}$ is the share of the overall capital stock of the economy which is held by sector j , with:

$$\sum_w a_{jw,t-1} = 1, \quad \forall j, t$$

and

$$\sum_j s_{j,t-1} = 1, \quad \forall t$$

The two above expressions imply:

$$\sum_j \sum_w a_{jw,t-1} s_{j,t-1} = 1, \quad \forall t$$

Therefore, the real growth rate of the aggregate capital stock in country c can be expressed as:

$$\begin{aligned} g_t^{K,CLV} &= \frac{K_t^{PYP} - K_{t-1}^{CP}}{K_{t-1}^{CP}} = \left[\sum_j \sum_w (1 + g_{jw,t}^{CLV}) a_{jw,t-1} s_{j,t-1} \right] - 1 \\ &= \sum_j \sum_w g_{jw,t}^{CLV} a_{jw,t-1} s_{j,t-1} \end{aligned}$$

Suppressing the CLV apex for readability, the difference in the real growth rate of the capital stock between two countries, A and B , can be then expressed as:

$$g_t^{K,A} - g_t^{K,B} = \sum_j \sum_w [g_{jw,t}^A a_{jw,t-1}^A s_{j,t-1}^A - g_{jw,t}^B a_{jw,t-1}^B s_{j,t-1}^B]$$

By adding and subtracting from the expression in parenthesis $g_{jw,t}^A a_{jw,t-1}^B s_{j,t-1}^A$, the above expression can be written as:

$$g_t^{K,A} - g_t^{K,B} = \sum_j \sum_w [g_{jw,t}^A s_{j,t-1}^A (a_{jw,t-1}^A - a_{jw,t-1}^B) + g_{jw,t}^A a_{jw,t-1}^B s_{j,t-1}^A - g_{jw,t}^B a_{jw,t-1}^B s_{j,t-1}^B]$$

Finally, by adding and subtracting $g_{jw,t}^A a_{jw,t-1}^B s_{j,t-1}^B$, the above expression can be expressed as the sum of three components:

$$g_t^{K,A} - g_t^{K,B} = AS + SS + SAG$$

where AS stands for “asset shares” and is the part of the difference explained by cross-country differences in within-sector asset composition, SS stands for “sector shares” and is the part of the difference explained by differences in the sectoral composition of the capital stock and SAG stands for “sectoral asset growth” and is the part of the difference explained by differences in sector-asset-specific capital growth rates. The components are defined as:

$$\begin{aligned} AS &= \sum_j \sum_w g_{jw,t}^A s_{j,t-1}^A (a_{jw,t-1}^A - a_{jw,t-1}^B) \\ SS &= \sum_j \sum_w g_{jw,t}^A a_{jw,t-1}^B (s_{j,t-1}^A - s_{j,t-1}^B) \\ SAG &= \sum_j \sum_w (g_{jw,t}^A - g_{jw,t}^B) a_{jw,t-1}^B s_{j,t-1}^B \end{aligned}$$

Appendix D

The stock of capital in national accounts is estimated in all European countries according to the globally accepted perpetual inventory method (PIM), which indirectly measures year-to-year capital variation combining data on gross investment with estimates of depreciation.¹⁹

Asset- and sector-specific depreciation rates display substantial heterogeneity across countries and over time. They largely reflect the service lives of assets, which depend on the period over which assets provide productive services: the longer the service life, the lower the depreciation rate. Service lives are influenced by a range of country-specific factors, including the relative prices of capital and labour, interest rates, climate conditions, and public investment policies (OECD, 2009). Differences in asset quality further contribute to dispersion in depreciation rates, as higher-quality assets typically exhibit longer service lives. They are also shaped by sector-specific characteristics, such as operating conditions, intensity of use, maintenance practices, and industry-specific regulation. Moreover, embodied technological change in newly installed assets can accelerate the obsolescence of older vintages, thereby shortening the service lives of previously installed assets of the same type and generating changes in depreciation rates over time.

Recent evidence for Italy provided by Mattevi and Modugno (2023), based on micro-data for the period 2014–2018, confirms the presence of both cross-sectoral and temporal variation in asset service lives. Their findings indicate that (i) service lives tend to be longer in manufacturing than in services, and (ii) service lives have shortened over time for most asset classes. Macroeconomic data on a longer time span corroborate this temporal pattern, showing a trend toward shorter service lives in tangible assets (Table D1).

¹⁹ It is important to acknowledge the longstanding challenges associated with defining and measuring capital stock (Hulten, 1991). In the context of productivity analysis, these challenges are well documented in the literature (see, among others, Collard-Wexler and De Loecker, 2021; Brunaccini et al., 2023).

Table D1

Asset-specific depreciation rates - Italy						
<i>(percentage points)</i>						
total economy	private sector (1)	- of which: manufacturing	- of which: construction	- of which: private services	-- of which: ICT services	
(a) 2000						
dwellings	2.4	..	..	..	..	..
other buildings and structures	3.5	3.6	6.0	5.0	3.1	2.7
transport equipment	14.6	14.4	19.6	19.0	13.4	18.8
computer hardware	30.2	30.7	29.8	29.3	31.1	32.5
telecommunicati ons equipment	29.8	29.9	29.7	29.8	29.7	29.3
other machinery, equipment and weapons systems	13.7	13.8	12.9	18.4	16.5	16.1
cultivated biological resources	5.5	..	..	..	..	..
R&D	20.0	20.0	20.0	20.0	20.0	20.0
computer software and databases	35.9	35.9	35.7	35.6	36.0	36.1
mineral exploration and evaluation; entertainment, literary or artistic originals	15.9	15.0	..	..	18.9	18.9
(b) 2023						
dwellings	2.7	..	..	..	..	..
other buildings and structures	4.1	4.0	6.0	5.7	3.7	3.2
transport equipment	13.0	13.0	15.9	14.5	12.7	9.6
computer hardware	30.8	31.1	31.7	30.7	30.9	32.0
telecommunicati ons equipment	31.1	31.4	32.9	34.7	30.7	30.6
other machinery, equipment and weapons systems	15.2	16.1	15.1	19.9	16.8	15.6
cultivated biological resources	6.1	..	..	..	..	..
R&D	20.0	20.0	20.0	20.0	20.0	20.0
computer software and databases	35.8	35.8	36.3	36.3	35.4	34.9
mineral exploration and evaluation; entertainment, literary or artistic originals	16.3	15.5	..	..	19.5	19.5

Source: elaborations on Istat data. (1) Private nonfarm, non-financial sector, excluding real estate (NACE: B-N, excl. K, L).

It is worth emphasising that intangible assets typically exhibit higher depreciation rates than tangibles. The combined effect of shortening service lives and the ongoing structural shift toward more digital and intangible-intensive production (OECD, 2024; Belo et al., 2023) suggests that aggregate depreciation rates are likely to rise further in the future.

Although international statistical standards provide harmonised guidelines on asset coverage and on the construction of capital stock series, PIM's depreciation estimates rely on a series of assumptions, which are

not fully comparable across countries.²⁰ Cross-country variation in depreciation rates may therefore also arise from methodological differences in the assumptions underpinning the depreciation functions used for capital stock estimation. The depreciation function governs how an asset's value declines over time. For example, a straight-line depreciation function assumes that an asset's value decreases by a constant amount each year, implying that the depreciation rate rises as the asset ages. By contrast, a geometric depreciation function assumes a constant proportional rate of decline, implying that the age of the capital vintage does not affect the depreciation rate. Additionally, the PIM incorporates retirement functions to account for the probability that assets are removed from the productive system before the end of their maximum service life (OECD, 2009).²¹ Giordano and Zollino (2021) provide evidence that different assumptions on the retirement pattern produce very different estimates of the depreciation rate, even when holding assets' service lives constant. They show that excluding the possibility that assets are retired before the end of their service life substantially decreases Italy's estimated depreciation rates, holding all other parameters fixed, and argue that differences in the assumptions regarding the retirement pattern might explain why Italy's estimated depreciation rates are substantially higher than Spain's.

The same logic applies, in the opposite direction, to the comparison between Italy and France. If INSEE used more aggressive retirement assumptions than Istat (implying faster removal of assets from the measured stock and correspondingly higher depreciation rates), France's capital stock would be systematically understated relative to Italy's, independently of any real difference in productive capacity. This possibility is discussed in Section 5 in the context of France's outlier position in the cross-country distribution of capital-to-value-added ratios and represents a further instance of how methodological heterogeneity across national statistical agencies may hinder the international comparability of capital and productivity measures.

Substantial efforts have been made in recent decades to standardise national accounting practices. Nonetheless, methodological uniformity across statistical agencies is not assured, as choices regarding depreciation functions are often constrained by data availability. This issue persists even within the European Union. The ESA 2010 manual provides harmonised guidelines for compiling national accounts, but it allows national statistical offices some discretion (Eurostat, 2013, pp. 76–77).

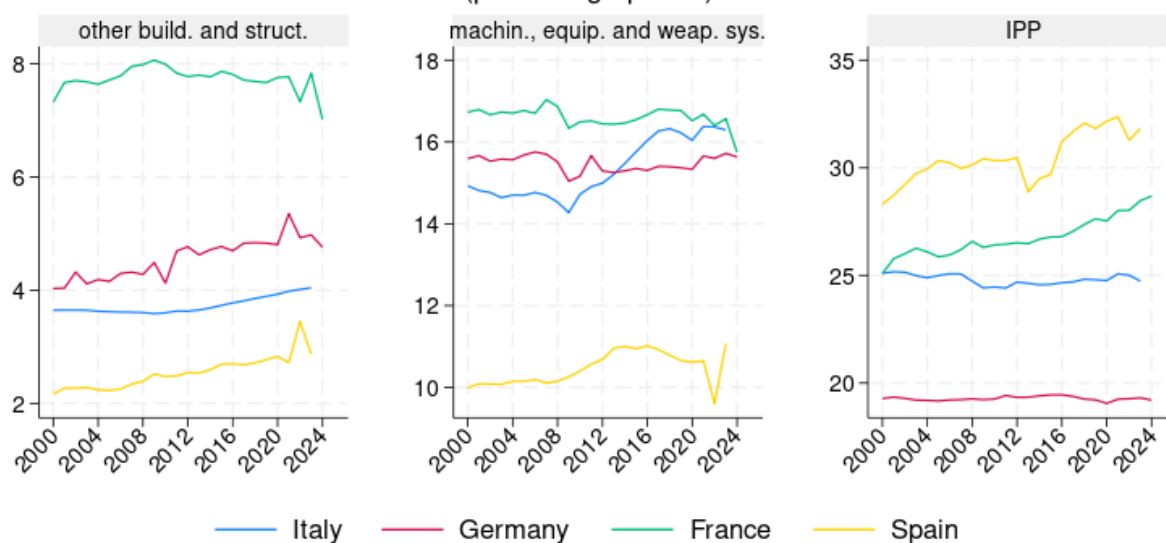
To make sense of the increase in Italy's depreciation rate of non-construction assets relative to Germany and France, it is useful to look at asset-specific depreciation rates in the different countries and at their evolution over time (Figure D1). The behaviour of the aggregate depreciation rate is determined by the sharp increase in that of machinery and equipment in Italy since 2010, in the face of comparatively constant rates in Germany and France.²²

²⁰ Additionally, difficulties persist in reconciling national accounts estimates with capital measures derived from firm-level data. For Italy, this problem has been highlighted by Lotti and Rosolia (2011) and Bontempi (2011). Measurement concerns have become increasingly salient in recent decades, particularly with regards to intangible assets and their expanding role in investment and productivity growth. On the one hand, some forms of intangible investment are not fully captured in official national accounts statistics (Bontadini et al., 2023; Brynjolfsson et al., 2021). On the other hand, even for those intangibles that are included, methodological differences across national statistical agencies may hinder cross-country comparability (Nonnis et al., 2025).

²¹ The OECD (2009) manual on capital estimation makes a distinction between “retirements” and “disposals”. “Retirements” or “discards” refer to the removal of an asset from the capital stock, with the asset being exported, sold for scrap, dismantled, pulled down or simply abandoned. Conversely, “disposals” includes sales of assets as second-hand goods for continued use in production.

²² Machinery and equipment represent most non-construction capital in all economies (in 2023, it ranged from 62 percent of the private sector's non-construction capital in France to 82 percent in Spain), and therefore its evolution disproportionately affect the overall non-construction capital depreciation rate.

Depreciation rate by type of asset - Private sector (1) (2) (percentage points)



Source: elaborations on Eurostat and Istat data.

(1) Private nonfarm, nonfinancial sector, net of real estate (NACE: B-N, excl. K, L).

(2) Cultivated biological resources are excluded.

The underlying reason of this divergent evolution cannot be identified with certainty. Beyond the country-specific factors discussed earlier, the increase in Italy's depreciation rate may indicate that its capital stock has been more heavily affected by embodied technological change, which accelerates the obsolescence of existing assets. Another possible explanation is a divergence in asset quality, potentially deteriorating in Italy. A third hypothesis is that capital assets in Italy are, on average, older than those in Germany and France. However, in the absence of embodied technological change, differences in asset vintages would influence depreciation rates only if countries employed straight-line depreciation functions, which imply rising depreciation rates as assets age. Although straight-line functions are commonly used across the European Union for many asset categories, national statistical agencies retain some discretion, and no publicly available cross-country information ensures uniformity in these practices.