Intangible capital, markups, and productivity growth

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Abstract

In this paper, we explore whether and to what extent the interplay between intangible capital and markups contributed to labour productivity growth paths across a sample of European economies and the US over the years 1995-2020. Both the US and the EU have experienced a prolonged productivity slowdown, but the US productivity growth remains more sustained, despite rising market power concerns. Using new EUKLEMS&INTANProd country-sector data, we show that the EU economies are characterized by slightly declining markups, whereas the opposite is true for the US. Similar diverging trends can be observed for productivity, especially if we consider the intangible-intensive sectors. We also find a positive correlation between intangibles and markups and show that the contribution of intangible capital accumulation to labour productivity growth is larger where markups are higher (in the US). Our findings suggest that the synergies between intangible capital accumulation and market power are critical elements to better understand productivity growth differentials and the factors determining the productivity slowdown.

Keywords: intangibles, market power, markup, productivity.

JEL codes: E22, E01, O47.

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1 Introduction

Over the last decade, many advanced economies have simultaneously experienced a prolonged productivity slowdown, mixed trends towards rising market power, and changes in the composition of investment, with intangibles outpacing physical capital (De Ridder 2019; Corrado et al., 2005, 2009, 2016) but with sizeable differences across countries and industries.[1]

Most studies exploring the linkages between productivity and market power focus on the US and show that increasing market concentration is often associated with a productivity slowdown and rising profits among top firms. Evidence for European economies is instead more scant. Additionally, existing studies are mostly at the firm level, so the macroeconomic effects of higher markups on aggregate productivity growth are largely unexplored, and even more so in a framework also considering investment in intangible assets.

Despite the slowdown, US productivity growth is relatively higher than in the main European economies. At the same time, the US experienced rising market power and faster shifts towards intangible capital. How these trends are connected and why they differ between the US and Europe is an open question.

In this paper, we contribute to the understanding of the macroeconomic relations between intangibles, markups, and labour productivity. We explore to what extent the interplay between intangibles and markups might have contributed to the different productivity growth paths in Europe and the US.

Intangibles, markups and labour productivity are likely to influence each other via multiple channels. Intangibles are commonly found to be positively correlated with productivity, but their increasing pace has been accompanied by mounting concerns about concentration and market power, as measured by markups. Additionally, at the macroeconomic level, the linkages between markup and intangibles are still to be better explored as possible simultaneous effects and

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[1] Intangible capital refers to a series of assets that play an economic role as physical capital but lack a physical dimension. We use the classification by Corrado et al (2005) including computerized information (software and databases), R&D, design and other nonscience-based new product development costs, brand equity, firm-specific training, and business process reorganization.

feedback between markup and productivity, and between markup and intangibles might affect the analysis. Thus, key questions become: Do intangibles contribute to labour productivity growth as well as foster market power by increasing markups? And, to what extent the different productivity trends observed in the EU and the US are related to the interplay between intangible investment and markups?

To answer these questions, we first review the multiple economic linkages between intangibles, productivity and markup identified in the literature. We then discuss a theoretical framework based on a production function approach and present some research hypotheses. Finally, we evaluate some measurement issues and provide empirical evidence on the role of intangibles exploiting the EUKLEMS&INTANProd database.

The existing literature highlights several channels. Markups may affect both intangible investment and productivity. This is because markups can provide the financial resources to finance intangible investments; moreover, the power to maintain high markups is likely to reduce the incentives to increase productivity. On the opposite side, productivity positively affects markup inasmuch highly productive firms tend to operate with lower marginal costs therefore setting higher markups and gaining higher market shares. We review these channels in detail and clarify how allowing for market power implies an indirect role of markup in the production function.

Estimating a production function extended with intangible capital and markups, we show that markup and factor shares enter the production function estimation multiplicatively so that it is possible and theoretically consistent to observe increasing intangibles contributions to labour productivity growth and increasing markups. In other words, the synergy between intangibles and markup might enhance the productivity impact of intangibles.

Empirically, there are two main challenges. The first refers to the appropriate measure of intangibles within a consistent accounting framework and the measurement of aggregate markups. Our data source provides accurate national accounts data adjusted for intangibles and allows measuring aggregate markups according to standard national accounting practices. The second is related to the several simultaneous effects potentially affecting the estimation of the contribution of intangibles to productivity and markup. We address this issue using a log-difference specification with several fixed effects and testing the results with several estimators, including Generalized Least Squares and the General Method of Moments, which help solve endogeneity issues.

The empirical analysis is based on the EUKLEMS&INTANProd database which provides market sector productivity data for 27 European economies, the UK, the US, and Japan. Our sample includes Austria, Germany, Spain, Finland, France, Italy, Netherlands, Sweden, and the US over the years 1995-2020.

Our results suggest heterogeneous patterns of intangibles, markups, and productivity across sectors and countries highlighting relevant differences between the EU and the US.

Besides both the US and the EU experienced a productivity slowdown, the sectoral dynamics of markups and productivity greatly differ especially in the intangible-intensive industries. The superior productivity performance of the US can be partly attributed to the earlier and faster investment in intangibles. But at the same time, the US faced increasing markups, especially in the high-tech (intangible-intensive) industries. While the same EU sectors lagged behind and showed decreasing markups. Overall, our findings indicate that higher markups favour larger productivity returns in highly intangible-intensive sectors.

The paper is organized as follows. Section 2 presents the conceptual framework and Section 3 describes the data and deals with some measurement issues. Section 4 presents the main descriptive analysis while section 5 reports our econometric results. Section 6 provides some conclusions and policy insights.

2 Background and research hypotheses

A critical issue for the debated evidence about rising markups and productivity slowdown in advanced economies refers to the exclusion of intangible assets from the asset boundary of GDP, income, and financial capital accounting. Ignoring them implies an underestimation of the sources of economic growth but also a misinterpretation of the observed rising markups. Increasing markups might simply reflect that more resources are devoted to innovation and not an actual increase in market power (Corrado et al 2022).

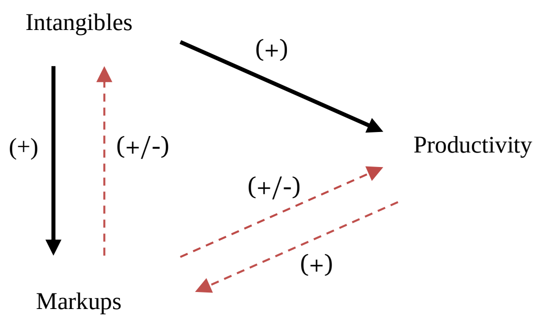
This is why, to better investigate the relationships between intangibles, markups and productivity we resort to productivity data augmented with intangibles.

Figure 1 shows the main mechanisms possibly linking intangibles, markups and productivity where solid arrows denote the effects of intangibles on markups and productivity growth that will be the focus of the empirical analysis illustrated in section 5.

The channels through which intangibles affect productivity have been deeply investigated in the literature (Corrado et al 2017; Corrado et al 2022), while the possible linkages between intangibles and market power and their joint impact on productivity[2] are relatively unexplored.

In the next subsections, we discuss these economic mechanisms in detail.[3]

Figure 1 – Intangibles, markups, and productivity: what linkages?



Note: solid arrows represent the effects of intangibles on markups and productivity growth that are the focus of our empirical analysis; dashed arrows represent other possible economic linkages identified in the literature.

2.1 How do intangibles enhance productivity growth?

Intangibles might contribute to firm-level productivity growth via the supply or the demand side. On the supply side, whereby intangible capital is an input for production, it contributes to expanding the production capacity of a company and

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[2] Among the possible mechanisms linking intangibles and markups and then productivity, there is also the possibility of reverse causality with productivity being a source of changes in markup.

[3] Further detail, left out for simplicity, would include the role of other variables as well as the distinction between direct and indirect effects. For instance, intangibles can be thought of as affecting productivity both directly, i.e. within firms, as well as through spillovers due to knowledge diffusion from other firms and other sectors. The arrows in our scheme represent the resulting aggregate effects.

thus its labour productivity; moreover, intangibles are potentially a source of increasing returns and endogenous growth due to their fixed cost component and spillover effects (de Ridder, 2021). On the demand side, instead, intangible assets provide value to consumers which in turn might increase demand and their willingness to pay. Thus intangibles can be seen as demand shifters and product differentiation tools (Hulten, 2010).[4]

Additionally, intangible assets can generate spillovers favouring knowledge diffusion and innovation (Corrado et al., 2017). However, the scope for knowledge spillovers is differentiated across the assets and countries, also depending on national regulatory framework and innovation ecosystems and the productivity impact is possibly moderated by the changing composition of intangibles over time (Corrado, Haskel, Iommi, Jona-Lasinio, 2022). In this respect, the increasing use of highly appropriable intangible assets – such as databases, formulas, and code, often regarded as trade secrets and protected by law – is likely to have enhanced investor's productivity and increased incumbents' market power, while simultaneously reducing the diffusion and the adoption of innovation in the rest of the economy. The changes in the composition of intangibles might induce lower knowledge spillovers thus reducing the contribution of intangibles to productivity growth and favouring a widening gap between the innovators and the rest of the firms (Andrews et al., 2019). The research on the implications of a shifting of intangibles composition is still at the beginning (Corrado, Haskel, Iommi, et al., 2023), but it has the potential to improve our understanding of the productivity slowdown in advanced economies (Adler et al., 2017), as well as about the role of rising market power (De Loecker & Eeckhout, 2018; Gutiérrez & Philippon, 2017), and increasing profit rates (De Loecker et al., 2020). Summing up, intangibles are expected to positively contribute to aggregate productivity growth, but this effect can be moderated by

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[4] While this effect can be conceptualized as demand driven, it also implies that intangible-intensive firms might be able to extract more value, therefore resulting more productive in terms of value-added given costs and use of factors. Investment in intangibles, in this case, while not directly altering production costs, increases the capacity of the firm to generate value-added.

the scope for diffusion, which in turn depends on the type of intangible asset and the institutional framework.

2.2 How do intangibles affect markups?

Intangibles may affect the market structure by reducing the extent of competition, favouring firms to increase markups. Existing evidence suggests a causal relationship between intangibles, market concentration, and firm-level markups (Bajgar et al., 2021). Intangibles can affect markups, via productivity improvements (supply side) or product differentiation and quality (demand side). On the supply side, if intangible capital is scalable, and thus duplicable at low marginal cost (Haskel & Westlake, 2018), or if it is complementary to other assets, such as digital technologies (Tambe et al., 2020), then intangible intensive (superstar) firms may create asymmetries and generate barriers to entry. Intangibles can also be a source of increasing returns, widening the gap between leading firms and laggards; but as they are often proprietary and costly to replicate, they can deter entry and diffusion (Bessen, 2017; Corrado et al., 2021). These characteristics favour increasing market power of incumbents and larger aggregate markups, negatively affecting market sector productivity growth in the long run (De Ridder, 2021).

Intangibles can be a source of market power also from the demand side, they contribute to improving product quality thus fostering consumers' willingness to pay, especially if the intangible assets hold some degree of appropriability by the original investor (Corrado, Haskel, Iommi, et al., 2022; Crouzet & Eberly, 2019; Syverson, 2019). These effects can lead to larger demand and/or to smaller demand elasticity (which in turn may lead to higher firm-level markups under variable elasticity). In this case, rather than (or on top of) being a direct barrier to entry, intangibles are a source of product differentiation, so that the market equilibrium implies higher market power.

Intangibles can also affect market power through their effects on knowledge diffusion. If new intangible assets diminish knowledge diffusion, market leaders gain market power and raise markups; this, in turn, has relevant consequences: laggards can get discouraged, so the productivity gap widens, while markets become more concentrated with higher profit shares and lower labour shares of GDP (Akcigit & Ates, 2019, 2021).

2.3 Other channels

2.3.1 How do markups affect intangibles and productivity?

Market conditions characterized by barriers to entry or low contestability may facilitate positive extra profits for incumbent firms. On one side, the expectation to gain a competitive advantage leading to higher profits is a primary incentive to invest in intangibles (De Ridder, 2021); on the other, profits support remuneration and financing of intangible investment (Altomonte et al., 2020; Falato et al., 2022). Therefore, market power may spur intangible investment. On the contrary, if firms have persistently large market power, e.g. exploiting barriers to entry, the incentives to keep investing in productivity-enhancing intangibles might be reduced, while a defensive and strategic use of assets might become relatively more relevant (Covarrubias et al., 2020), and incumbents may use intellectual property rights anticompetitively (Akcigit & Ates, 2019, 2021). Therefore, there are two possible opposite channels, operating at different moments in time, through which market power (markups) affects intangibles and productivity.

In the early stages, firms with high productivity and markups have strong incentives to invest in intangibles to gain market shares; however, over time, intangible-intensive incumbents increasingly represent a barrier to entry because of the rising cost of successful innovation for the potential competitors, and this, in turn, and together with declining returns to innovation, might weaken the incentives to keep investing in intangible assets and, therefore, slow productivity growth (De Ridder, 2021).

2.3.2 How does productivity increase markups?

Higher productivity is often associated with higher markups, a key measure of market power. This correlation is corroborated by several empirical findings (De Loecker & Warzynski, 2012). The causal effect of productivity on markups is easily explained with standard theoretical models. Firms with lower marginal costs will set higher markups provided that the elasticity of demand decreases with sales.[5] Another crucial mechanism affecting aggregate productivity is self-selection (Melitz, 2003). More productive firms, i.e. those with lower marginal costs (or better-quality products), are better equipped to pay higher fixed costs, benefit from larger market shares, and charge higher markup[6]. Therefore, more productive firms are expected to have higher markups; moreover, also thanks to selection effects, as aggregate productivity increases also aggregate markup increases. So if productivity can increase markups at the firm and aggregate level, and given that intangibles enhance productivity, then intangibles increase the markup both directly, as discussed above, as well as indirectly through productivity growth. A positive feedback between productivity, markup and intangibles is possible. Moreover, any source of productivity enhancement may affect the markup, not just those due to intangible investment. When firms become more productive for reasons other than intangibles, they not only tend to set a higher markup and operate at a larger scale, but they will also invest more in intangibles, which typically require a high fixed cost; and, in turn, intangibles may allow the firm to further reduce marginal costs (i.e., they are a source of economies of scale) (Hsieh & Rossi-Hansberg, 2019). The higher fixed cost and lower marginal cost provided by intangible investment lead to a stronger reallocation of market shares toward the most productive firms. Because these firms gain economic relevance, aggregate productivity will be higher, and the same will happen to aggregate investment in intangibles, and aggregate markup (Baqee et al., 2019). Interestingly, these aggregate changes can be entirely due to a change in the composition of firms and arise even if firm-level productivity, intangibles, and markups remain constant (de Ridder, 2021). Therefore, at the macro level, productivity positively affects markup in two ways, either because it allows firms to set higher markup or through market share recomposition towards high markup firms.

[5] This is also referred to as Marshall's second law of demand or subconvexity (Mrazova and Neary, 2017). A linear demand curve or any demand that is less convex than a CES demand has this property. Note that markup increases driven by marginal cost reductions are even compatible with prices reductions.

[6] This effect arises, for instance, under variable demand elasticity, e.g. linear demand, where a lower marginal cost translates into lower price with higher markup, i.e. the pass-through of the marginal cost reduction is incomplete (Burstein & Gopinath, 2014; Melitz & Ottaviano, 2008).

The next section illustrates the theoretical framework and discusses the main hypotheses tested in the empirical analysis below.

2.4 Conceptual framework

Consider a Cobb-Douglas production function augmented with intangibles (Corrado et al., 2005; 2009):

$$Q = AF(L, K, R) = AL^{\epsilon_L}K^{\epsilon_K}R^{\epsilon_R} \tag{1}$$

where Q is output; A is Hicks-neutral total factor productivity; R is intangible capital stock; K is tangible capital stock; L is labour. In this paper, we refer to the expanded sources of growth framework accounting for intangibles, including constant returns to scale, cost minimization, and marginal cost pricing (Corrado et al, 2017; Crouzet and Eberly, 2021).

Adopting this framework, allows us to make some theoretical assumptions that will be critical for our empirical analysis:

Assumption 1 (A1, constant returns to scale) implies that $F(\cdot)$ is homogeneous of degree 1, i.e. elasticities sum to 1, i.e., $\epsilon_L + \epsilon_K + \epsilon_R = 1$. Therefore, the production function in intensive form can be written as:

$$q = Ak^{\epsilon_K}r^{\epsilon_R} \tag{2}$$

where all variables are in per hour terms. If A1 holds, labour productivity growth can be expressed as:

$$\Delta \ln q = \Delta \ln A + \epsilon_K \Delta \ln k + \epsilon_R \Delta \ln r \tag{3}$$

Assumption 2 (A2, cost minimization) firms set variable inputs for minimizing costs (De Loecker at al., 2020; Crouzet-Eberly, 2021; Bond et al, 2021), thus implying:

$$\frac{p_X X}{MC \cdot Q} = \epsilon_X \tag{4}$$

where X denotes the relevant decision inputs, p_X is the price of factor services, and MC is marginal cost.

Note that in a long run perspective where all factors are variable, A1 and A2 imply that $wL + p_K K + p_R R = MC \cdot Q$, where w denotes the wage, p_K the price of physical capital services, and p_R the price of intangibles capital services.

Assumption 3 (A3, marginal cost pricing) there are zero (extra) profits and gross markup is equal to one, $\mu \equiv P/MC = 1$. Denoting with P the value-added price (i.e. the price of gross output net of intermediate costs[7]), A3 is consistent with the standard national accounting definition of value-added augmented to include intangibles, $VA \equiv PQ$:

$$VA = wL + p_K K + p_R R \tag{5}$$

Therefore, A3 implies that factor shares of value-added are equal to factor output elasticities:

$$\sigma_X \equiv \frac{p_X X}{VA} = \epsilon_X \tag{6}$$

which, in turn, entails that $\sigma_L + \sigma_K + \sigma_R = 1$.

In this paper, we depart from assumption A3 (Hall, 1988; Stiroh, 2002; Corrado et al., 2017; Crouzet-Eberly, 2021), considering that under increasing market power, A3 fails, and markup is greater than one, thus breaking the equality between factor shares and output elasticities:

$$\mu\sigma_X = \epsilon_X \tag{7}$$

If this is the case, then the sum of factor shares of value-added must be lower than one, $\sigma_L + \sigma_K + \sigma_R < 1$ (and there are positive profits). This is a key point for our empirical analysis, as the estimates of equation (3) would no longer capture factor shares, but rather a combination of factor shares and markup.[8] Also, as prices would be above marginal costs, then the system would be not efficient, resulting in lower factor shares and possibly suboptimal use of factor inputs, which in turn would yield output and labour productivity below what could theoretically be obtained in a perfectly competitive framework with marginal cost pricing. As a

[7] The value-added price is the price of output minus the cost of intermediate goods, $P = p - p_M/m$, where p is the price of gross output, p_M is the price of intermediate goods and m is a technical coefficient (units of output per unit of intermediate good) so that the last term, p_M/m, represents the cost of intermediate inputs per unit of output; see the appendix for detail.

[8] In the tradition of Hall (1988) and Roeger (1996), this fact has been used in the literature as the basis for markup estimation. In this work, instead, we take a different approach as we look at measured (i.e. not estimated) markup as directly computed by national accounts. Further detail are provided below.

consequence, despite markups being an outcome of firms' decisions and market structure, they would indirectly play a role in the production function and in explaining labour productivity dynamics through their interaction with factor shares and capital deepening. The investigation of this characteristic of markup is a primary focus of this study.[9]

2.5 Research hypotheses

Based on the available literature and the above discussion, our research hypotheses and expected empirical results can be listed as follows.

As for the production of intangibles and their possible effects on output and productivity, the main hypothesis to be tested is:

> ***Hypothesis (H1):*** *Intangible capital positively affects labour productivity by increasing the amount of total capital available in the economy.*
>
> ***Corollary (C1):*** *The higher intangible intensity*[10] *of the US industries relative to Europe suggests that intangibles are a larger productivity driver in the US than in European economies.*

H1 is not new. Consistently to the literature, once intangibles are considered as a production factor in an accounting framework as in Corrado et al (2005, 2009), we expect them to positively contribute to labour productivity growth, i.e. the output elasticity to intangibles is expected to be positive. An extension of H1 would also include the impact of intangibles on total factor productivity via spillovers and knowledge diffusion (Corrado et al, 2017); while this is a very relevant issue, an in-depth analysis of these aspects is beyond the scope of this paper. Thus, in our analysis below we will focus exclusively on labour productivity.

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[9] Market power and markups may also be linked with total factor productivity (TFP) in complex ways, as briefly discussed in previous subsections. The relationship between markup and TFP raises conceptually different issues – left for future research – whose deeper investigation requires further assumptions and more theoretical structure on market forms, competition, and knowledge spillovers.

[10] Intangible intensity is defined as the intangible share of value added.

Intangibles may also impact competition and affect markup. Countries and sectors characterized by higher intangible intensity are expected to show higher markups, and those that have been investing more in intangibles are expected to show markup growing at a faster pace. Thus, the second research hypothesis is:

> ***Hypothesis (H2):*** *Intangible capital can provide a competitive advantage and it often involves sunk costs, so it can create barriers to entry, thus potentially being a source of market power and increasing markups.*
>
> ***Corollary (C2):*** *The larger intangible intensity of the US might partly account for the different markup dynamics between Europe and the US.*

Considering hypotheses 1 and 2 together suggests that we should identify in the data a positive correlation between markup and labour productivity growth likely driven by intangibles. Moreover, H1 and H2 imply that the estimated elasticities cannot be interpreted as factor shares because of markups. Thus, we assume that the production function elasticities, factor shares, and markup are all connected. Higher intangible-intensive industries are likely to display a higher intangible elasticity as well as faster labour productivity growth and higher markups. Then, if we consider also the stylized facts about intangibles, we can introduce our third hypothesis:

> ***Hypothesis (H3):*** *High intangible intensive and high markup industries tend to overlap and display larger intangible elasticities and faster productivity growth.*
>
> ***Corollary (C3):*** *Relative to Europe, the US industries display higher intangible intensities (and higher markups) thus contributing to explain the faster productivity growth in the US. This effect is expected to be stronger in highly intangible-intensive sectors.*

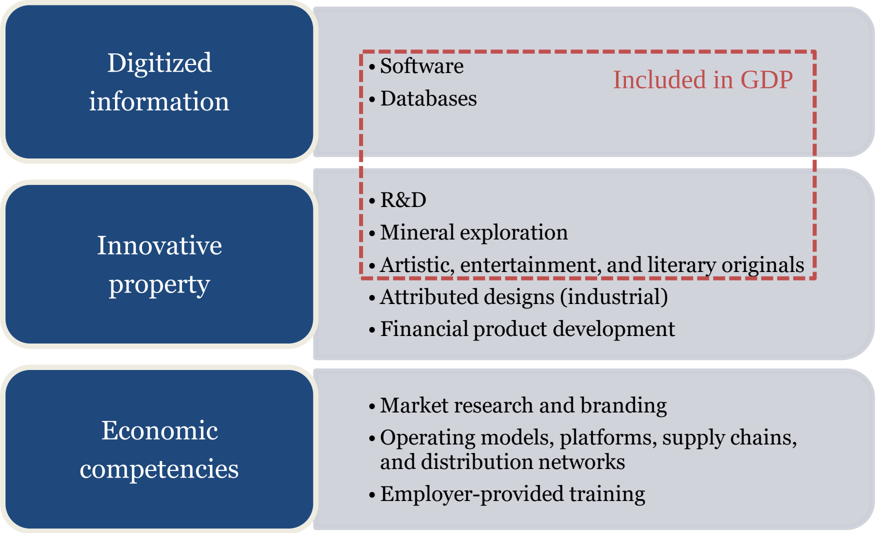
This hypothesis adds a cross-sectoral dimension whereby sectors characterized by a more intensive use of intangible assets, and higher markups, are not only expected to display larger intangible elasticities but also faster in terms of labour productivity growth. Available data suggest that this is the case for the US characterized by a dated process of intangible capital accumulation compared to Europe.

3 Data and measurement issues

3.1 Intangibles

The main source for our empirical analysis is the EUKLEMS&INTANProd database providing comprehensive and up-to-date estimates of intangibles for 26 European economies, the UK, the US and Japan. The asset classes of intangibles are based on the taxonomy by Corrado et al 2005 (CHS from now onwards) illustrated in Figure 2 below, including three broad categories of intangible assets: i) digitized information; ii) innovative property; iii) economic competencies. As it is shown in Figure 2, not all the assets included in these categories are considered investments in National Accounts. Besides R&D, Software, Mineral Explorations and Artistic Originals, the others are not included in the boundaries of GDP. The CHS approach applies a fundamental
economic criterion that defines investment, namely, that business (or public) investments are outlays expected to yield a return in a future period. EUKLEMS&INTAProd generates estimates of all CHS intangible assets consistently with national accounts as described in Corrado et al (2024).

Figure 2 – Intangible capital: broad categories and types of investment.



Source: Corrado et al. (2022).

3.2 Markup

Markups are a measure of market power. Other existing measures include the number of firms, concentration, and profits. Despite being commonly used in applied economics, the number of firms, concentration, and profits have limitations in capturing the extent of market power; while markup is considered a better indicator from a theoretical point of view but difficult to measure (Syverson, 2019). In this paper, we generate a measure of market power considering country-sector markups as suggested by standard national accounting practices. Gross markups are defined as the price-cost ratio, and are related to the Lerner index (Lerner, 1934) as follows:

$$\mu_{cst} = \frac{1}{1 - Lerner_{cst}} = \frac{Y_{cst}}{IC_{cst} + LC_{cst}} \tag{8}$$

where Y_{cst} is gross output of sector s of country c in the year t, IC_{cst} is intermediate cost, and LC_{cst} is total labour cost (hours worked based, self-employed included). Note that the above markups are computed rather than estimated and that this measure of markups is not new in the literature (Antràs et al., 2017; Autor et al., 2020; Ciapanna et al., 2022). The advantage of (8) is that: i) it is time-variant; ii) it can be easily computed consistently both at the micro and the macro-level, i.e., from firm-level data as well as from national accounts; moreover, it enhances iii) economy-wide representativeness; iv) cross-country comparability. In our analysis, country-sector markups are computed from EUKLEMS&INTANProd data following this approach.

The country-level aggregation of equation (8) is based on a weighted average of sectoral markups (weights are based on sectoral gross output shares, similar results hold using sectoral value-added shares):

$$\mu_{ct} = \sum_{s} \mu_{cst} \frac{y_{cst}}{\sum_s y_{cst}} \quad (9)$$

μ_{ct} in equation (9) has pros and cons. Empirical measures of markup are based on specific data requirements, measurement methods, and assumptions. For instance, in a Dixit-Stiglitz monopolistic competition model with constant returns to scale and barriers to entry, market power can be captured by the CES elasticity parameter, in turn determining markup, so that market power, markups, and profits are all directly connected (Eggertsson et al., 2021).[11] These assumptions allow retrieving aggregate markups from profit shares (Barkai, 2020) as follows:

$$\mu_{ct} = \frac{1}{1 - \pi_{ct}} \quad (10)$$

where the profit share π can be obtained from macroeconomic data using the residual share of output minus labour and capital income. Comparing (10) with other measures adopted in the literature suggests that they are relatively coherent (Eggertsson et al., 2021, Table 1). Also, note that changes in labour bargaining power and unmeasured intangible capital may affect gross profits, and hence markup in equation (10).

Another approach for estimating markups considers that under imperfect competition, the Solow residuals are a weighted average of technological change and output-capital ratio changes, where the weights are determined by markup (Roeger, 1995). In this case, markups can be estimated by using the difference between the quantity-based and the price-based Solow residuals:

[11] Note that, in a monopolistic competition equilibrium, the positive price-cost margin is needed to pay for the fixed cost, even with zero (extra) profits and low concentration. So, if intangible investments have a relevant (sunk) fixed cost component, they may lead to high markups (in this case also the firms' scale is larger). Also, note that markups and prices are not necessarily correlated because higher markups can stem either from more rigid demand (higher prices) or from lower marginal cost (lower prices).

$$\mu_c = \frac{1}{1 - \beta_c} \tag{11}$$

where β is the coefficient from a regression of the difference in the quantity- and price-based Solow residuals (y) on the difference between output growth and capital cost growth (x) (all in nominal terms), $y = \beta x + \varepsilon$. This approach has the advantage of being implemented both at micro and macro levels. In the latter, using national account data, however, it produces time-invariant markups (adding time trends to the regression partially addresses this issue) and crucially relies on the assumption of constant returns to scale and Hicks's neutral technological change.[12]

Other research efforts, using previous releases of EUKLEMS (2007) for the years 1981-2004 show that markups are heterogeneous across EU countries, that they are relatively higher in services, and they have been fairly stable over the sample period (Christopoulou & Vermeulen, 2012).

A direct micro-level estimate of markups instead requires data on prices and marginal costs at the firm or plant level, which are hardly available. The production approach to markup estimation builds on the assumption that, under cost minimization, firm-level markup, μ_{it}, is equal to the ratio between the elasticity of output to the variable input v, $\beta_{it,v}$, and the input share of revenues, $s_{i,v}$ (Hall, 1988):[13]

$$\mu_{it} = \frac{\beta_{it,v}}{s_{it,v}} \tag{12}$$

This approach has been recently used in several empirical analyses (De Loecker et al., 2020; De Loecker & Warzynski, 2012). This type of markup requires firm-

[12] Also, note that if one is willing to further assume the absence of any measurement error (specifically no error term in the regression, $\varepsilon = 0$, and no measurement error in x), then it is not necessary to use regression to obtain β, since it can be calculated directly as the ratio between the dependent and the independent variables, $\beta = y/x$, i.e., as the difference in the quantity- and price-based Solow residuals divided by the difference between output growth and capital cost growth.

[13] Both our theoretical framework and this firm-level approach to markup estimation are based on the same intuition from Hall (1988). Equation (12) closely resembles our equation (7). However, rather than using the relation between elasticity and factor share as the basis to estimate markup, we look at measured markup from the national accounts as evidence of a wedge between estimated elasticities and factors shares.

level data on input and output, the assumption of cost minimization, and the ability to distinguish between variable and fixed inputs[14].

The national-accounts-based markup measure used in this paper is theoretically related to the production approach as in equation (12). However, rather than estimating markups using the estimated output elasticities and factor shares, obtained under the assumptions mentioned above, we start from the measured national-accounts-based markup and test whether this simple and standard measure is informative and whether the observed dynamics are consistent with the estimated elasticities. In the appendix, we discuss further theoretical issues of this approach.

3.3 Productivity

Data on productivity are gathered from EUKLEMS-INTANProd. We use country-industry labour productivity, computed as value added per hours worked, and total factor productivity as provided by the database. Compared to standard productivity indicators, both measures are adjusted and consistent with the capitalization of intangible assets currently excluded from national accounts.

As in the new accounting framework, intangibles expenses are not treated as costs but as investments and/or service payments required to augment value-added consistently, and thus to adjust measures of capital services and capital compensations, and capital and labour shares.

3.4 Other variables

Other variables from EUKLEMS-INTANprod data include value-added, tangible capital, hours worked, and different categories of intangible assets. The country coverage embraces Austria, France, Finland, Germany, Italy, Netherlands, Spain, Sweden, and the US. The industry coverage refers to the market sector (i.e., we exclude agriculture, mining, and the public sector) including the NACE industries: C, F, G, H, I, J, K, M, N, R (see Table B.1). In the analysis, sectors are

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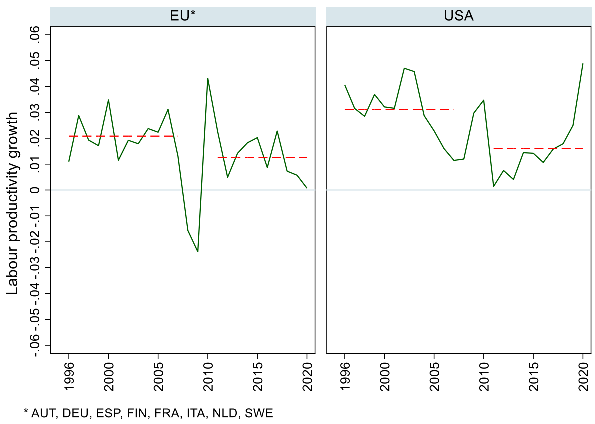
[14] This measure of markup might be particularly problematic even if one has good firm-level balance sheet data because, for instance, the Cost of Goods Sold (COGS), commonly used in the applied works, is likely to include some fixed cost components as well as to exclude some variable costs (Syverson, 2019). Moreover, the estimation would also require firm-level deflators, often proxied by industry deflators, or the assumption of common technology across firms.

grouped into manufacturing (C) vs. services (the rest); high vs. low-digital sectors (Calligaris, Marcolin, et al., 2018); high vs low-intangible sectors, based on our descriptive statistics, to investigate heterogeneous trends and effects.

4 Stylized facts

Productivity trends over the last decades reveal a prolonged productivity slowdown especially in most advanced economies such as the US and especially in the EU[15] (Figure 3). The horizontal lines in the charts represent the average values before (1995-2007) and after (2011-20) the global financial crisis (i.e. the years of the crisis and the rebound, 2008-2010, are excluded). Labour productivity growth in the EU sample economies dropped during the global financial crisis but bounced back and averaged a tad below pre-crisis rates in the most recent years. US labour productivity dropped during the Great Financial Crisis (GFC) but after the crisis went back to a striking positive trend, converging towards pre-crisis rates and above. However, the productivity growth gap between the EU and the US started well in advance of the GFC and was persistently there in the following decade.

Figure 3 – Labour productivity growth: EU vs US

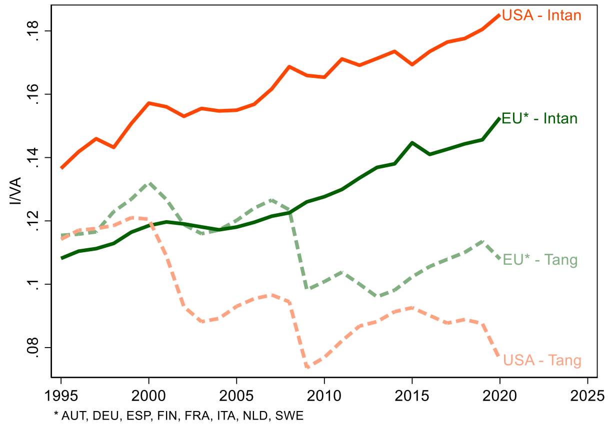


During the same period, intangible capital gained a predominant role as a source of economic growth outpacing tangible capital. Figure 4 shows the intangible and

[15] EU refers to AT, DE, ES, FR, FI, IT, NL, SE

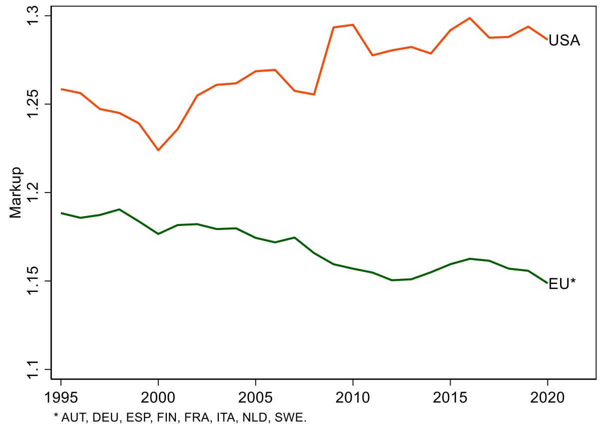
tangible investment shares of value-added in both the EU and the US. The US sets itself apart as a leader in investment in intangibles, while Europe follows a growing trend in investment in intangible assets, although at lower levels. Conversely, tangible investment slowed down relatively more in the EU thus suggesting a widening gap between tangible and intangibles over the sample period even if to a different extent between the two areas.

Figure 4 – Trends in the intangible investment share of value-added.



At the same time, markup trends (Figure 5) differed substantially. The US is characterized by a larger aggregate markup, increasing over time, while markup in the EU is lower and slightly decreasing. Of course, the EU aggregate is driven also by some between-country heterogeneity: among the selected EU countries, in the Netherlands aggregate markup trends are increasing, while in Sweden markup levels are relatively higher than the average of the sample countries (see the appendix); note also that Sweden is the most intangible-intensive EU economy.

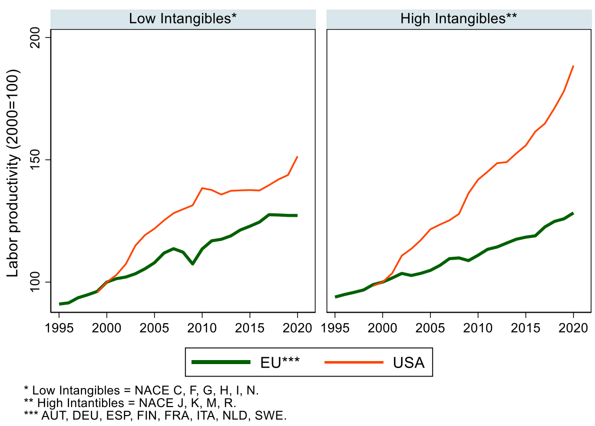
Figure 5 – Markup trends



At the industry level, we group sectors according to intangible intensity, by looking at both intangible investment and capital (Table B.1).[16] Information and communications (J), finance (K), and professional, scientific and technical activities (M) are among the most intangible-intensive sectors.

Considering low vs. high-intangible sectors also reveals relevant differences in productivity trends (Figure 4). The high-intangible sectors largely drive the EU-US gap in productivity growth.

Figure 4 – Productivity trends by industry group.

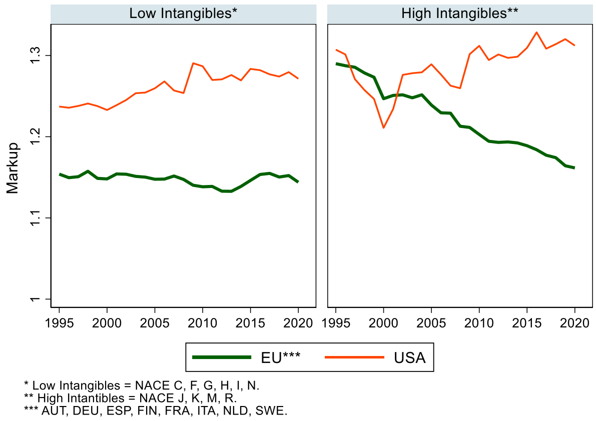


Looking at the two classes of intangible intensity suggests also that diverging markup trends are likely related to the extent of intangible industry intensity. The

[16] Our high-intangible sectors largely overlap with the high-digital sectors (Calvino et al., 2018).

same sectors show both high markup and high intangible intensity. High-intangible sector markups have been decreasing rapidly in the EU, while they have increased in the US. In the low-intangible sectors, the American markups were already higher than in the EU (Figure 5) since the beginning of the period. Similar results, but slightly less striking, hold if we compare manufacturing and services (see the figure in the appendix).[17]

Figure 5 – Markups by industry group.



As for markup and productivity growth, they are positively correlated both in the EU and in the US. Overall, the data show a strong correlation between markup and productivity growth as well as a positive correlation between intangible capital and productivity growth[18] (Figure 6). The correlation between intangible capital per hour worked and productivity growth is also positive. For intangibles, the correlation is stronger in the US (ρ=0.25, β=0.24) than in the EU (ρ=0.20, β=0.19), but the explained variance is generally smaller than for markups (Figure 7).

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[17] Our markup decompositions help us understand why we observe these trends. First, markup variations are largely determined by output growth and intermediate cost growth, while the contribution of the labour cost component tends to be small because of its smaller cost share (28% in the EU, and 33% in the US). Second, essentially all of the markup variation is due to within-sector markup changes, while the between-sector effect and the combined effect are very small; that is aggregate markup changes are not driven by the expansion of high-markup industries (see tables in the appendix).

[18] Pearson's correlation coefficient between markup and labour productivity growth (ρ) is about 0.37 and is statistically significant. The simple linear regression slope coefficient (β) is 0.9 for the EU and 0.73 for the US, and the linear model explains about 14% of the total variance (R^2=0.14).

Figure 6 – Pooled country-sector correlations between markup and productivity growth.

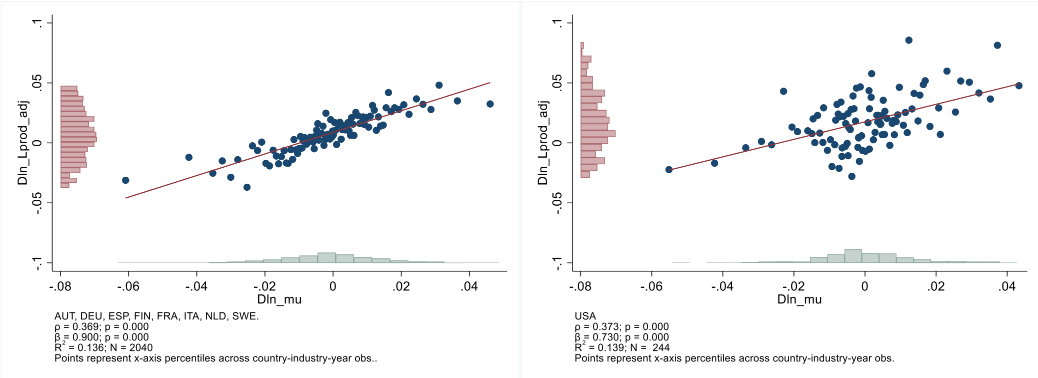
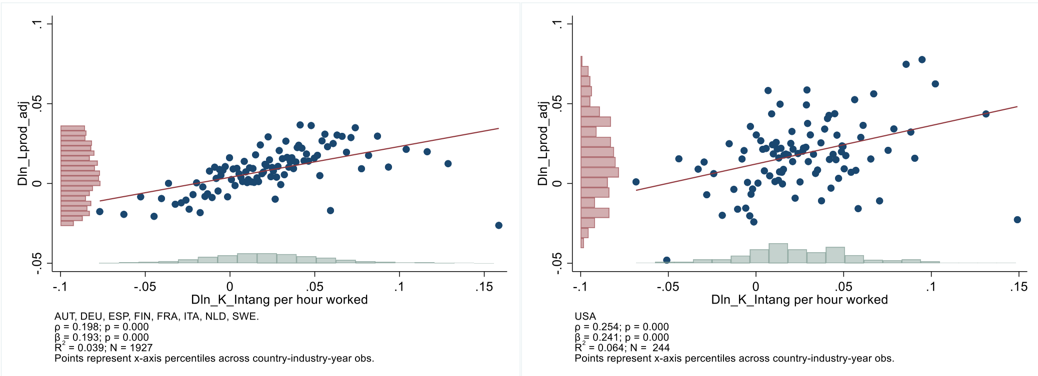


Figure 7 – Pooled country-sector correlations between intangibles and productivity growth.



5 Econometric analysis

In this section, we illustrate our econometric strategy to further explore the relationship between intangibles, markups and productivity. Our empirical approach is structured into three steps: first, we estimate a standard production function with intangibles to econometrically identify the contribution of intangibles to the productivity growth differential between the EU and the US; then, we explore the linkages between intangible and markups evaluating the impact of intangibles on markup dynamics, also considering the different patterns between the EU and the US; finally, we explore the extent to which intangible intensities (likely reflecting different markup levels) between the EU and the US may be of help to better characterise the differentiated role of intangibles as a driver of labour productivity growth in the two areas also considering some sectoral characteristics.

5.1 Intangibles and productivity growth

To test the contribution of intangibles to labour productivity in the EU and the US, we start estimating the empirical counterpart of the equation (3), a standard production function estimation with tangible and intangible capital:

$$\Delta \ln q_{cst} = \alpha + \beta_R \Delta \ln r_{cst} + \beta_K \Delta \ln k_{cst} + \gamma_s + \delta_t + \varepsilon_{cst} \qquad (13)$$

where $\Delta \ln q_{cst}$ is the delta-log of labour productivity measured as output per hour worked varying across countries, industries, and time; $\Delta \ln r_{cst}$, refers to intangible capital as described in section 2, while $\Delta \ln k_{cst}$ is tangible capital (non-residential), both in per hour worked terms; estimates include sector and time fixed effects.

The linkages between intangibles and productivity highlighted in the literature review, and summarized in Figure 1, suggest that there might be several simultaneous effects possibly affecting the relationship between intangibles and productivity (and markup). To address these concerns: first, we test the empirical model using log-differences, to rule out possible time-invariant confounding factors; second, we include a set of fixed effects to absorb time-trends at the country and sector level or common yearly shocks; third, we use a Generalized Least Square (GLS) estimator which allows for heteroskedasticity and autocorrelation in the error terms; fourth, we also check our results using a Generalized Method of Moments (GMM) estimator in which lagged variables (in log-difference and level) as used as instruments to control for possible endogenenity of the factor inputs.

Results from the baseline specification[19] show that the estimated coefficients are statistically significant and coherent with previous findings in the literature (Corrado et al 2017). Starting from these results, we check for possible different contributions of intangibles in the EU and the US augmenting the baseline model in equation (13) with a dummy for the US data ($D_{US} = 1$ for the US) and with its interactions with capital assets. Table 1 shows the results.

[19] Results are provided in the appendix.

Table 1 – Labour Productivity growth: EU vs. US.

VARIABLES	(1) GLS		(2) GLS	(3) GMM		(4) GMM
$\Delta \ln r_{cst}$	0.081***		0.081***	0.132*		0.132*
	(0.014)		(0.014)	(0.076)		(0.076)
$\Delta \ln r_{cst}\, D_{US}$	0.261***	**Δ** =	0.180***	0.428***	**Δ** =	0.296***
	(0.055)		(0.056)	(0.067)		(0.108)
$\Delta \ln k_{cst}$	0.184***		0.184***	0.186**		0.186**
	(0.020)		(0.020)	(0.088)		(0.088)
$\Delta \ln k_{cst}\, D_{US}$	0.112*	**Δ** =	-0.072	0.264***	**Δ** =	0.079
	(0.058)		(0.060)	(0.088)		(0.125)
D_{US}	0.004		0.004	-0.005		-0.005
	(0.003)		(0.003)	(0.004)		(0.004)
Observations	2,215		2,215	1,829		1,829
Year FE	Yes		Yes	Yes		Yes
Industry FE	Yes		Yes	Yes		Yes
S.E.	het-psAR1		het-psAR1	cluster		cluster

Standard errors in parentheses; columns 1 and 2: heteroskedastic s.e. with country-sector AR(1) autocorrelation; columns 3 and 4: s.e. clustered at the country-sector level.
Columns 1 and 3 display the marginal effects, i.e. the EU and US elasticities. The **Δ**s in columns 2 and 4 indicate the estimated differences between the US and the EU coefficients from the previous columns.
*** p<0.01, ** p<0.05, * p<0.1

Column (1) reports the EU and the US coefficients for tangible and intangible capital estimated by Generalized Least Squares; while column (2), shows the same model, but isolates the US dummy interactions capturing the differential effect for the US vis-à-vis the EU (denoted with **Δ** in the table) and its statistical significance[20]. The US intangibles coefficient is much larger than for the EU (column 1) and their difference is statistically significant (column 2). Columns (3) and (4) test the estimations using the Generalized Method of Moments estimator to consider the possible endogeneity of the factor inputs.[21] Results are consistent across models. These findings, not only confirm the relevance of intangibles as a

[20] If the **Δ** is statistically significant then the US elasticity from column 1 is statistically different from the EU elasticity.

[21] The number of observations is smaller because we instrument tangible and intangible capital with their lagged growth rates and levels. See the appendix for detail.

driver of labour productivity growth, but they also suggest a larger contribution in the US compared to the EU. Therefore, our first hypothesis (H1) is supported by the evidence that intangibles are a larger driver of productivity growth in the US compared to the EU.

5.2 Intangibles and markups

The second step of our empirical strategy aims to investigate the possible correlation between intangible capital accumulation and markup dynamics. The intuition is that intangibles can be a source of market power and higher markups (De Ridder, 2020; Morlacco and Zeke, 2021). Equation (14) below is the reference specification, where $\Delta \ln \mu_{cst}$ is the delta-log of markup as measured by equation (8) and the other explanatory variables are the same as in equation (13). The benchmark specification can be written as:

$$\Delta \ln \mu_{cst} = a + b_R \Delta \ln r_{cs,t-1} + b_K \Delta \ln k_{cs,t-1} + g_s + d_t + \varepsilon_{cst} \tag{14}$$

The estimated model includes sector and year fixed effects to rule out specific trends and common time shocks; moreover, dependent variables are lagged to avoid simultaneity biases. Moving from the benchmark specification, we check for possible different contributions of intangibles in the EU and the US augmenting the model with a dummy for the US data ($D_{US} = 1$ for the US) and with its interactions with capital assets.

Table 2 –Markup regressions: EU vs. US.

VARIABLES	(1) GLS		(2) GLS	(3) GMM		(4) GMM
$\Delta \ln r_{cs,t-1}$	0.015**		0.015**	0.061*		0.061*
	(0.007)		(0.007)	(0.032)		(0.032)
$\Delta \ln r_{cs,t-1} D_{US}$	0.045*	**Δ** =	0.029	0.076	**Δ** =	0.015
	(0.027)		(0.028)	(0.061)		(0.072)
$\Delta \ln k_{cs,t-1}$	0.004		0.004	0.020		0.020
	(0.010)		(0.010)	(0.029)		(0.029)
$\Delta \ln k_{cs,t-1} D_{US}$	0.023	**Δ** =	0.019	-0.001	**Δ** =	-0.021
	(0.030)		(0.031)	(0.034)		(0.040)
D_{US}	0.001		0.001	0.002		0.002
	(0.001)		(0.001)	(0.002)		(0.002)
Observations	2,195		2,195	1,809		1,809

Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
S.E.	het-psAR1	het-psAR1	cluster	cluster

Standard errors in parentheses; columns 1 and 2: heteroskedastic s.e. with country-sector AR(1) autocorrelation; columns 3 and 4: s.e. clustered at the country-sector level.
Columns 1 and 3 display the marginal effects, i.e. the EU and US elasticities. The **Δ**s in columns 2 and 4 indicate the estimated differences between the US and the EU coefficients from the previous columns.
*** p<0.01, ** p<0.05, * p<0.1

The estimates show that intangibles are generally positively associated with markups. The aim at this stage is to check whether the relationship between markup and capital assets somehow differs between the EU and the US. As in equation (13), to capture this effect we introduce a US dummy and its interactions with both tangible and intangible capital.

Table 2 shows a positive and statistically robust relationship between intangibles and markup. Considering the GLS estimations, the coefficient is rather larger for the US (column 1), but there is no evidence of a statistically meaningful differential effect between the EU and the US (column 2). The GMM estimations show an even stronger association between intangibles and markups, but again the difference between the EU and the US is not statistically significant.

Overall, as expected, we find that intangible assets are a source of competitive advantage and market power; however, data do not support show a US-specific effect. Therefore, we partly find evidence in support of the second research hypothesis (H2).

Possibly, the different markup dynamics between Europe and the US mainly reflect the different dynamics of intangible capital investment and the cross-sectoral structures of economies.

Alternatively, while intangibles are a source of market power, markups, as measured by official national accounts, might not entirely capture the possible differential effects between countries.

To further investigate the issue, we make an additional empirical step checking the linkages between markup, intangibles, and labour productivity dynamics, considering the intangible intensity across different sectors, which as we have seen in the descriptive sections seems closely related to markup. This is illustrated in the next subsection.

5.3 Intangible intensity across sectors

The third step of our empirical strategy evaluates to what extent the synergy between markup and intangible intensity of the different sectors contributes to the different labour productivity trends between the EU and the US.

To investigate this issue we start considering equation (7) above suggesting that if there is no market power and markup is equal to 1 (i.e. under assumptions A1-A3), then the measured factor shares are just equal to the estimated elasticities in equation (13); if instead there is market power, factor shares and elasticities will differ by the extent of markup μ, that is: $\beta_K = \epsilon_K = \mu\sigma_K$ and $\beta_R = \epsilon_R = \mu\sigma_R$. Considering this equality might be helpful to complement the interpretation of the econometric results. From the stylized facts, we have observed that in low intangible intensity sectors, markups are relatively lower (especially in the EU), and that the labour productivity differential between the EU and the US is higher for high intangible intensive (high markup) sectors. An (estimated) output elasticity to intangibles larger in high intangible intensive industries is consistent with these industries displaying a combination of higher markups and higher intangible factor shares (i.e. higher μ and higher σ_R imply higher ϵ_R). Considering that in the US intangible capital accumulation is faster, and markup is high and increasing mainly in high intangible intensive sectors, we might expect that a higher level of intangible capital per hour worked, while generally contributing to labour productivity growth also in Europe, provides an additional contribution to the US.

To empirically capture this mechanism, we augment the baseline model with the (lagged) level of intangible capital per hour worked. The level of intangible capital per hour worked captures the stock of intangible assets, that is the degree of intangible intensity of the sector (which is also associated with the markup). Moreover, we also interact it with a US dummy; and split the sample between low and high-intangible intensity industries:

$$\begin{gathered}\Delta \ln q_{cst} = \alpha + \beta_R \Delta \ln r_{cst} + \beta_K \Delta \ln k_{cst} \\ +\gamma_R \ln r_{cs,t-1} + \gamma_{US} \ln r_{cs,t-1} D_{US} + \delta_{US} D_{US} \\ +\delta_t + \varepsilon_{cst}\end{gathered} \tag{15}$$

Table 3 reports the estimated results. The level of intangible capital (per hour worked) is positively correlated with labour productivity growth and there is a statistically significant US effect (column 1). This evidence suggests that the US somehow benefit more than European economies from their intangible capital stock. Considering the possible heterogeneity between low and high intangible intensity sectors (columns 2 and 3) adds further detail: first, the intangible capital elasticity is relatively larger in high intangible intensity sectors, second the US intangible capital productivity premium is larger in these sectors. The GMM estimations (columns 4 to 6) support this evidence, especially the additional positive effect of the level of the US intangible capital per hour worked.

Table 3 – Productivity and intangible intensity: EU vs. US.

VARIABLES	(1) GLS Pooled	(2) GLS Low	(3) GLS High	(4) GMM Pooled	(5) GMM Low	(6) GMM High
$\Delta \ln r_{cst}$	0.124***	0.081***	0.243***	0.397***	0.382***	0.243***
	(0.015)	(0.016)	(0.028)	(0.074)	(0.096)	(0.069)
$\Delta \ln k_{cst}$	0.158***	0.217***	0.062*	0.095	0.209***	-0.077
	(0.019)	(0.024)	(0.032)	(0.079)	(0.077)	(0.135)
$\ln r_{cs,t-1}$	0.005***	0.006***	0.006***	0.006***	0.008***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$\ln r_{cs,t-1} D_{US}$	0.008**	0.012**	0.023***	0.007**	0.007**	0.026***
	(0.003)	(0.006)	(0.007)	(0.003)	(0.003)	(0.003)
D_{US}	0.033**	0.051**	0.076***	0.024*	0.025*	0.083***
	(0.013)	(0.025)	(0.024)	(0.013)	(0.014)	(0.011)
Observations	2,215	1,344	871	1,912	1,134	778
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
S.E.	het-psAR1	het-psAR1	het-psAR1	cluster	cluster	cluster

Standard errors in parentheses; columns 1 to 3: heteroskedastic s.e. with country-sector AR(1) autocorrelation; columns 4 to 5: s.e. clustered at the country-sector level. Low: low intangible intensity sectors. High: high intangible intensity sectors.
*** p<0.01, ** p<0.05, * p<0.1

In Table 3, to consider the overall effect of intangible capital intensity also due to sectoral differences, we do not include the industry fixed effects. The US dummy, capturing the labour productivity growth premium of the US, is positive and larger for the high intangible-intensive (high markup) sectors. This result fits our interpretation that intangibles are a driver of both productivity and markups, particularly in the US. A significant part of US labour productivity growth premium is due to sectoral differences; in fact, adding the sectoral fixed effects largely reduces the size of the US dummy coefficient. But in a baseline regression like equation (13), which includes industry fixed effects, the US dummy coefficient, although low, is still highly statistically significant, signalling that sectoral differences per se cannot explain the whole productivity differential. It is when the role of intangibles is explicitly considered through interactions that the US dummy coefficient becomes insignificant (as in Table 1), suggesting that intangibles contribute explaining the US-EU productivity growth differential.[22] To further investigate this evidence and how it relates to sectoral differences, we add to the benchmark model also a dummy for the high intangible intensive (high markup) industries, D_H, as well as the US dummy, D_{US}. Results indicate that the dummies' coefficients are both positive and significant, meaning that a productivity growth premium applies both to the US and to the high intangibles (high markup) sectors; these productivity differences are not explained by capital accumulation alone. Next, we augment the model with interactions. The key results are displayed in Table 4.[23] In column 1, we see that physical capital does not help to explain the productivity differentials. Instead, column 2 shows that the higher productivity growth of the high intangibles intensive (high markup) sectors can be attributed to intangible capital growth since the D_H coefficient turns insignificant. Note that in columns 1 and 2, the D_{US} coefficient remains positive; and it is still positive in column 3, where we consider a US-specific effect of physical capital growth. Finally, results from column 4 suggest that both labour productivity growth premia are explained by intangible capital growth as both coefficients of D_H and D_{US} turn insignificant: labour productivity in the high intangible intensive (high markup) sectors seems to grow faster because of

[22] See detail provided in the Appendix.

[23] Results in Table 4 are based on GLS estimations; therefore, while the evidence is suggestive and in consistent with previous results, they must be understood as conditional correlations as the causal interpretation is not warranted.

intangibles, and similarly, the faster US labour productivity growth seems due to intangible assets.

Overall, our results support our third research hypothesis (H3) that high intangible intensive and high markup industries display larger intangible elasticities and faster productivity growth, which, in turn, contributes to explaining the faster productivity growth in the US.

Table 4 – Intangibles and the US labour productivity growth premium.

VARIABLES	(1) GLS	(2) GLS	(3) GLS	(4) GLS
D_{US}	0.005*	0.005*	0.005*	0.001
	(0.003)	(0.003)	(0.003)	(0.003)
D_H	0.004***	0.001	0.004***	0.001
	(0.002)	(0.002)	(0.002)	(0.002)
$\Delta \ln k_{cst}$	0.178***	0.161***	0.176***	0.159***
	(0.022)	(0.019)	(0.023)	(0.019)
$\Delta \ln r_{cst}$	0.111***	0.085***	0.112***	0.076***
	(0.014)	(0.015)	(0.014)	(0.015)
$\Delta \ln k_{cst}\, D_H$	-0.036		-0.032	
	(0.034)		(0.034)	
$\Delta \ln r_{cst}\, D_H$		0.123***		0.126***
		(0.030)		(0.030)
$\Delta \ln k_{cst}\, D_{US}$			0.014	
			(0.050)	
$\Delta \ln r_{cst}\, D_{US}$				0.145***
				(0.047)
Observations	2,215	2,215	2,215	2,215
Year FE	Yes	Yes	Yes	Yes
S.E.	het-psAR1	het-psAR1	het-psAR1	het-psAR1

Heteroskedastic standard errors with country-sector AR(1) autocorrelation in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

6 Concluding remarks

Using a new dataset, we find evidence of heterogeneous trends of intangibles, markups, and labour productivity across sectors and between the EU and the US. In general, the contribution of intangible capital accumulation to productivity dynamics is larger where markups are higher. EU economies are characterized by slightly declining markups, whereas the opposite is true of the US where markups are increasing. Similar diverging trends can be observed for productivity, especially if we consider the intangible-intensive sectors. In these industries, we observe a reduction in markups in EU economies and a widening gap vis-à-vis the US in terms of labour productivity. Despite both economies experienced a prolonged productivity slowdown, and despite concerns regarding rising market power, especially in the US, labour productivity growth remains higher in the US. Our findings suggest that intangibles may contribute explaining these patterns. We show that the faster intangible investment and higher intangible intensity of US industries may have provided a larger contribution to productivity growth, also raising markups. The faster US productivity growth can be partly thus explained by larger intangible investment, especially in the intangible-intensive industries, also fostering increasing markups.

It is worth noting that our findings need not weaken market power concerns. In our production function approach, a structural change resulting in higher intangible elasticity, while consistent with higher markups and larger factor shares of value-added, would require even larger factor shares under marginal cost pricing. That is, markups can still hinder economic efficiency, causing suboptimal capital accumulation. Two mechanisms can occur at the same time: intangibles contribute to productivity and raise markups, and this partly explains the better performance of the US, and the increasing market power is keeping capital accumulation and productivity growth below their potential.

The US are especially strong in high intangible-intensive sectors, where the role of "super-firms" is often part of the picture. Economies of scale related to platform effects can be responsible for the emergence of these huge companies, which maintain a high degree of market power and high sectoral markup levels.

At the same time, these companies are among the main investors in intangible assets. The combination of immaterial capital formation and high markup levels is associated with stronger productivity growth at the sectoral and macro level, driven by intangible capital accumulation.

In principle, this evidence may lead to policy dilemmas as intangibles raise productivity at the firm level but high fixed costs and internal returns from intangible capital accumulation might reduce the diffusion of productivity gains. Intangible-intensive companies with a very large scale may exert opposite effects on aggregate productivity, fostering it through a direct effect but hindering it via negative diffusion effects. Moreover, the nature of these "super-firms" is often such that they exploit large-scale operations and platform/network advantages to "capture" their customers, offering them lower prices and access to a whole system of connected goods and services. This reminds of the classical debate on competition where static vs. dynamic advantages, as well as the drawbacks of concentration and diffusion, are compared to offer policy insights for regulation and industrial policy. Large firm dimension and market concentration call for anti-monopolistic measures to favour diffusion, while productivity and consumer welfare could statically benefit from the existence of such "super-firms". A well-designed taxation scheme, associated with industrial policy measures to enhance technology diffusion and R&D in catching-up firms, might in some cases prove a better policy mix than usual antitrust tools.

The quest for a centralised EU industrial policy also stems from this paper: incentives to foster intangible capital accumulation as well as the investment in human capital that can be often a complementary factor of production, can be better designed and implemented at the EU level. First, because the dimension and scope of the intangible assets that are required in Europe call for an integrated approach involving EU fiscal resources (i.e., a new sort of Next-Gen EU Plan), a revised version of the Stability and Growth Pact oriented towards intangibles, and a common approach to the mobilizing of private financial resources through the Capital Market Union. Second, a centralised EU policy reduces the risks of opportunistic behaviour by national authorities and points to a plain-field approach to intangible asset accumulation in Europe.

Financial constraints, namely the complex issue of collateralizing intangibles, is another issue that needs to be tackled at the EU level: the US capital market, with larger and smoother access to equity and venture capital, appears to be more conducive to sustained rates of capital accumulation and productivity growth. While the nature of these links between capital markets and immaterial asset investment must be better analysed and left for further research, the relevance of this policy issue is quite clear.

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Appendix (available upon request)