Intangibles and Industry Concentration:

A Cross-Country Analysis

Abstract

This paper presents new evidence on the growing scale of large businesses in the United States, Japan, and 11 European countries. It documents a broad increase in industry concentration across the majority of countries and sectors over the period 2002 to 2017. The rising concentration is strongly linked to investment in intangibles — particularly innovative assets; and software and data — and this relationship is magnified in more globalized industries. The results are consistent with intangibles disproportionately benefiting large firms, enabling them to scale up and increase their market shares by leveraging intangibles across multiple markets.

Keywords: concentration, intangible investment, business groups

JEL: E22, L1, L25

1. Introduction

Big businesses are growing bigger. The share of industry sales from the largest firms[1] has been increasing in the United States across many sectors of the economy,[2] and studies have documented similar trends in Europe (e.g., Bajgar et al., 2023). This has led to a surge of interest in concentration among policymakers and the broader public on both sides of the Atlantic, with numerous newspaper articles discussing the growth of big business.[3] An appropriate policy response requires understanding which mechanisms have allowed the largest firms to further

[1] In most of the paper, we simply refer to "firms", irrespective of whether these are independent legal units or business groups comprised of multiple legal units. However, in the analysis, we aggregate across legal units that belong to the same groups and operate in the same country and industry (see section 2).

[2] The increase in the US has been well documented using different data sets and concentration metrics. See, e.g., Crouzet and Eberly (2019), Furman and Orszag (2015), Grullon et al. (2019), and Autor et al. (2020).

[3] See, e.g., https://www.economist.com/special-report/2018/11/15/across-the-west-powerful-firms-are-becoming-even-more-powerful, https://www.ft.com/content/489c7acc-a175-11e8-85da-eeb7a9ce36e4 and the Jackson Hole symposium 2018.

increase their shares in economic activity and, looking forward, if more concentrated economies represent a threat to competition, business dynamism, innovation, and ultimately economic growth.

Intangibles—such as business research and development (R&D), software, data, marketing, and training[4]—are an increasingly essential part of the leading firms' business models. They are much more important in today's knowledge-intensive, digital, service-intensive, and globalized economy than they were in the past (Borgo et al., 2013; Corrado et al., 2018). For some economies, aggregate intangible investment now dwarfs that in tangible assets, such as buildings and machinery (Haskel and Westlake, 2017). This change in production technology may have disproportionately benefited the largest global firms and facilitated an increase in industry concentration, as evidence from the US suggests (Kwon et al., forthcoming; Bessen, 2022; Crouzet and Eberly, 2019). A crucial property of most intangible assets, like innovation or digital investments, is that they are non-rival in nature and easily scalable; an invention or software can be applied in many different markets at low (and sometimes near zero) marginal costs. Investment in intangibles allows firms to scale up by reducing their marginal costs or developing new higher-quality varieties (De Ridder, 2024). However, intangible investments are characterized by fixed costs and require recurrent investment to cover their high depreciation rates (De Ridder, 2024). This gives an inherent advantage to large companies, which have the finance available to invest heavily in intangibles and the scale needed to recoup these fixed costs.

Our paper contributes to this growing literature in different ways. First, we use cross-country firm-level panel data for 11 European countries, plus Japan and the United States, between 2002-2017, to construct new measures of concentration at the country-industry-year level. We then link these to country-industry level measures of intangible investment,[5] distinguishing between, e.g. innovative property; data and software; and economic competencies; indicators of globalization; digitalization; and M&A activity to shed new light on the factors that have facilitated recent concentration trends. We find that the share of sales from the largest 8 business groups increased in about two thirds of country-industries in the sample, with an average

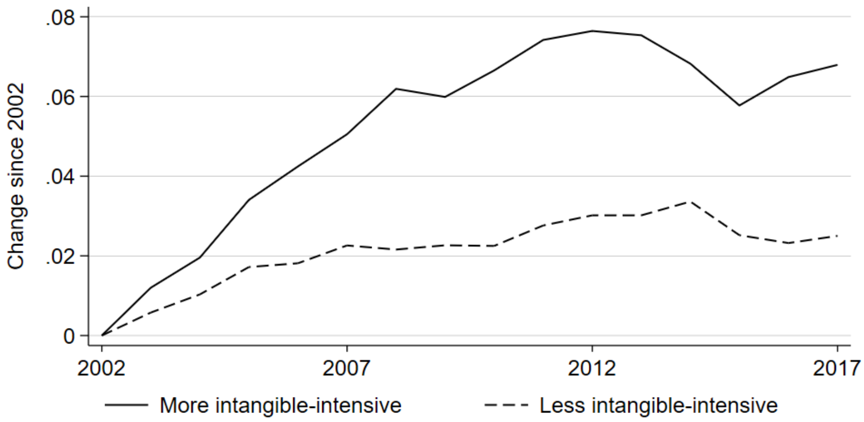
[4] For an overview of intangible capital and its rise, see Corrado and Hulten (2010) and Haskel and Westlake (2017). Demmou and Franco (2021) provide a recent summary of the literature.

[5] We rely on the INTAN-Invest database (Corrado et al., 2012).

concentration increase between 2002 and 2017 of around 5 percentage points, showing that the rising concentration trends span beyond the US.[6]

Second, we show that increasing industry concentration is strongly linked to investment in intangible assets—particularly innovative assets; software and data—with the relationship being of similar magnitude across countries, suggesting that the trends are linked to structural changes resulting from the rising importance of proprietary knowledge, data, and software.

Figure 1. Trends in top 8 concentration by intangible investment intensity – change since 2002



Notes: The figure shows changes in the (unweighted) mean concentration across country-industry pairs compared to the base year 2002. The concentration trends are shown separately for country-industries above- and below-median intensity of intangible investment (calculated as the mean value over the sample period). Countries included are BEL, DEU, DNK, ESP, FIN, FRA, GBR, GRE, FRA, JPN, PRT, SWE, and USA. Included 2-digit industries cover manufacturing, construction, and non-financial market services.

Our econometric results confirm descriptive evidence (Figure 1) indicating that changes in industry concentration are strongly related to intangible investment intensity, particularly in innovation, data and software. The estimates are relatively large: a 1-standard deviation increase in intangible investment (as a share of value added) is associated with a 1.5 percentage point increase in concentration over the next 4 years.[7] This corresponds to about a third of the observed concentration increase in the average country and industry. The relationship between concentration and intangibles appears to be similar across the US, Japan, and European

[6] The results are robust to using alternative concentration measures, as we discuss later.

[7] To avoid measuring short-term fluctuations, the analysis relates intangible investment intensity with 4-year changes in industry concentration; our results also hold for changes over longer and shorter periods.

countries. It is robust to instrumental variable (IV) estimation, with instruments based on intangible investment in other countries and changes in policy, i.e., R&D tax incentives.

Third, to further understand the mechanisms at work, we examine whether these effects are amplified by globalization and digitalization. If firms invest in intangibles to scale up through lower marginal costs, this should be amplified when these firms have access to larger global markets (e.g., Bustos, 2011). Similarly, there is extensive evidence documenting that investments in intangibles are highly complementary to digital technologies. Digital technologies can allow intangibles, like innovation or management practices, to be swiftly transmitted and embedded across borders or across locations within a country (see Bloom et al., 2012). We find that the relationship between intangibles and concentration changes is magnified in (initially) more open country-industries. Firms are better able to scale intangibles when they have access to larger foreign markets.[8]

Fourth, we also investigate the possibility that competition policy rather than structural changes were the main driver of the observed concentration increases, and that the association between intangible investment and concentration changes disappears once the rise in mergers and acquisitions (M&As) is appropriately accounted for. We decompose the total changes in concentration into (1) M&A-related changes in concentration and (2) organic changes that would be observed if firm ownership remained unchanged. We document that M&As play a smaller role in the observed concentration increase than organic changes. We also show that investment in intangibles is strongly associated with organic concentration changes but not with changes in concentration due to M&As. In further robustness exercises, we examine whether other factors, such as changes in openness, could directly explain the observed concentration trends, and we find little evidence for these alternative narratives.

Furthermore, our study presents suggestive evidence on some implications for the business environment. If increases in concentration relate to intangible investment as we posit, one would expect that the higher fixed costs and lower marginal costs would translate into lower prices but greater mark-ups and lower business dynamism (as suggested by the framework of De Ridder, 2024). We find evidence broadly in support of this. Industries with the largest concentration increases also have the fastest growth in large firm mark-ups but also lower industry prices. This is in line with the idea that concentration is linked to a greater role of fixed costs, such as those characterizing intangible investment. However, concentration also goes

[8] This result is in line with a positive relationship between market size and innovation (e.g. Acemoglu and Lynn, 2004).

hand-in-hand with the increasing persistence of top firms' market shares and increases in the number and values of M&As, potentially raising longer-term concerns regarding business dynamism.

To the best of our knowledge, this paper is the first to document a relationship between intangibles and rising industry concentration in a cross-country context, suggesting that the link is not unique to the United States. Our study is most closely related to Crouzet and Eberly (2019), who demonstrate for the United States that a higher ratio of intangible to tangible investment is associated with higher market shares and—depending on the industry—productivity or mark-ups of the largest companies. Covarrubias et al. (2019) also examine the relationship between industry concentration and intangibles and argue that increases in US industry concentration were related to intangible capital deepening (and were largely pro-competitive) in the 1990s but became associated with depressed investment, weakened competition, and increased barriers to entry after 2000. As mentioned earlier, our approach leverages the predictions of the model of De Ridder (2024), which he applies to French data, where an increase in intangible inputs generates a shift from variable to (endogenous) fixed costs, and firms better able to adopt intangibles gain a competitive edge and expand at the expense of less intangible-intensive competitors.

In addition to providing a cross-country dimension, this paper further sheds light on how the intangibles-concentration link interacts with other industry characteristics—such as openness to trade and digital intensity—hinting at the crucial role of the scalability property of intangible capital. A growing literature documents important structural changes in the business sector of OECD economies. In addition to increasing industry concentration, mounting evidence points to rising profits and mark-ups,[9] declining business dynamism,[10] a growing productivity gap between leaders and laggards,[11] falling investment rates,[12] and a decline in the labor share of

[9] For the US, see, e.g., Gutiérrez and Philippon (2017a,b) and Barkai (2019) on profits, De Loecker et al. (2020) and Hall (2018) on mark-ups, and Bessen (2016) on operating margins. For international evidence, see IMF (2019) on profits and Calligaris et al. (2018), as well as Diez et al. (2018) on mark-ups.

[10] See Decker et al. (2016) for the US and Calvino et al. (2015) for cross-country evidence.

[11] Andrews et al. (2016) document a faster productivity growth at the global productivity frontier, and Berlingieri et al. (2017) study productivity divergence within countries.

[12] See, e.g., Gutiérrez and Philippon (2017a,b) and Alexander and Eberly (2018) for the US and Lewis et al. (2014) and Bussiere et al. (2015) for international evidence.

income.[13] Autor et al. (2020) show how such reallocation can result from a globalization shock, but they also note that other forces with "winner-take-most" characteristics, such as scale-biased technological change, could have similar effects. Kwon, Ma, and Zimmermann (forthcoming) present a model with heterogenous technologies where reductions in trade barriers encourage the adoption of the scalable technology and increase the concentration of both total sales and domestic sales. Their empirical evidence also confirms that changes in trade barriers may not be the only force affecting rising concentration. In line with the model of Kwon, Ma, and Zimmerman, our results highlight the complementary roles of intangible investment, globalization, and digital technologies in enabling this reallocation across several countries.

By examining churning, defensive patenting, and M&As of top firms, we also contribute to a growing literature investigating if the structural trends observed in OECD economies represent signs of weaker competition. Gutiérrez and Philippon (2017a,b) document a link between relatively weak investment in the United States on one hand and increasing concentration and less intense competition on the other. Gutiérrez and Philippon (2019a) argue that a decline in the elasticity of business entry with respect to Tobin's Q in the US is due to lobbying and regulations. The increase in profits and mark-ups, documented both in the US and internationally, can also be seen as indicative of weakened competition. However, the hypothesis of weakened competition is at odds with findings suggesting that US industries that saw a larger increase in concentration on average experienced *stronger* growth in real output, productivity, and innovation, while their prices did not grow any faster than those of other industries (Bessen, 2017; Autor et al., 2020; Ganapati, 2021).

Finally, the paper contributes to the ongoing debate on whether the rise in industry concentration is a US-specific phenomenon or has also taken place in other OECD countries. Using Orbis data, Gutiérrez and Philippon (2019b) and Kalemli-Özcan et al. (2019) have found industry concentration in Europe to be flat or decreasing. In contrast, Bajgar et al. (2023) find a steady increase in European industry concentration between 2000 and 2014, both (i) when they focus on the largest business groups in Orbis and treat Europe as a single market, and (ii) when they calculate the sales share of 10% largest firms within each country-industry based on

[13] Karabarbounis and Neiman (2013) and ILO and OECD (2015) show that labor shares have declined in many countries. See Barkai (2019), Autor et al. (2020) and Zhu (2017) for evidence on the US.

representative national microdata in 10 countries.[14] Koltay et al. (2020) similarly find clear evidence of rising concentration amongst the 5 largest European economies between 1998 and 2017. Using novel data based on EU merger cases between 1995 and 2014, Affeldt et al. (2021) find large average increases in market concentration. De Ridder (2024) finds evidence of rising concentration using administrative data for France. Our paper builds on the measures in Bajgar et al. (2023) by showing that a similar upward trend documented while treating Europe as a single market is also observed *within* most European countries in the sample, and within Japan and the United States.

The rest of the paper is structured as follows. Section 2 explains how industry concentration is measured and describes concentration trends in the thirteen countries studied. Section 3 introduces the empirical strategy and the data used in the estimation. Section 4 presents the results. Section 5 concludes.

2. Trends in Industry Concentration

2.1. Measuring Concentration

We follow the methodology of Bajgar et al. (2023), who calculate concentration at a US and European regional (supranational) level using Orbis data, and apply this to measure country-level concentration across our sample of 13 countries. For each country-industry, we measure industry concentration as the share of the largest business groups in the total sales of that country and industry. Our preferred measure focuses on the share of 8 largest business groups (CR8) but we also test robustness to using 4 or 20 largest business groups (CR4, CR20). We calculate concentration as:

$$CR^{8}_{c,i,t} \equiv \sum_{g=1}^{8} s_{g,c,i,t} \quad (1)$$

[14] The national microdata cover the entire firm population for all countries except Germany and Austria; excluding these two countries from the sample leaves the results unchanged.

where $s_{g,c,i,t}$ denotes the share of business group g in the sales of industry i in country c, where the group is among the 8 business groups with the largest sales in year t.[15] We also examine robustness to using the Herfindahl-Hischman Index (HHI).[16]

The top 8 entities in sales are not measured at the level of individual firms but at the level of business groups, which may comprise multiple subsidiaries sharing the same ultimate owner. This is a preferable way to measure concentration. On average in our data, a top 8 group in a country and an industry comprises 3 subsidiary firms in that country and industry. It would be incorrect to consider an industry un-concentrated because industry sales are spread over a large number of firms, if all these firms are part of the same group. At the same time, it would also be inaccurate to assign *all* sales of a business group to the country and industry of the group headquarters. This could easily result in concentration levels exceeding 100% as many multinational enterprises generate more sales in foreign subsidiaries than in the home country. For this reason, we only aggregate firm sales up to the group level *within* each country and industry.[17] We calculate the industry sales shares of each business group as:

$$s_{g,c,i,t} = \frac{S_{g,c,i,t}^{ORBIS}}{S_{c,i,t}^{STAN}} \quad (2)$$

where $S_{g.c.i.t}^{ORBIS}$ marks group sales in country c and industry i and $S_{c.i.t}^{STAN}$ designates the total sales of the industry.

The primary source of firm sales data is Orbis, where we focus on a subset of countries with a good coverage of large firms over the period from 2002 to 2017. We follow the cleaning

[15] Note that our data does not allow us to separate domestic sales from exports, and it also does not contain any information on firm-specific imports. The observed concentration thus reflects the concentration of domestic production rather than of sales in the domestic markets.

[16] HHI is defined as the sum of squared shares of all business groups in the total sales of each country and industry, or

$$HHI_{c,i,t} \equiv \sum_{g} s_{g,c,i,t}^2$$

As in the case of the CR concentration measures and for the same reasons, related to the changing coverage of smaller firms in Orbis, the sales shares $s_{g,c,i,t}$ are defined using the 2-digit industry output from OECD STAN as the denominator.

[17] We primarily rely on unconsolidated financial data. In cases where unconsolidated accounts of the parent company are not available, we set sales of the parent company to the consolidated group sales minus the combined sales of all its subsidiaries.

procedures outlined by Kalemli-Ozcan et al. (2019), which we complement with additional automated checks and manual corrections based on company annual reports and other sources. For more information on the data cleaning and concentration measurement using business group data, see Bajgar et al. (2023). We complement Orbis with Worldscope to achieve a more complete coverage among publicly traded firms, mainly in the United States prior to 2006. Aggregating firm sales to the group-level requires firm ownership information, which we take from Orbis and complement with ownership changes observed in the Zephyr merger and acquisitions (M&A) database, alongside a battery of automated checks and extensive manual checks for the largest firms. Further details on these adjustments are discussed in Bajgar et al. (2023).

Using the right denominator is essential for measuring concentration correctly. Orbis offers substantially better coverage for larger firms (Bajgar et al., 2020); this, together with manually checking information for the top 8 business groups in each country industry, makes it a reliable data source for the numerator – the sales of the largest firms. However, variation in the Orbis coverage of smaller firms across countries and over time makes it problematic to construct the denominator from Orbis. Instead, the denominator uses 2-digit industry output from OECD STAN, derived from national accounts.[18,19] Our baseline measure of concentration reflects the distribution of domestic production rather than of sales in the domestic markets, since it does not include any adjustment for trade flows.

However, for US manufacturing, recent evidence suggests that rising trends in concentration of domestic production were largely offset by increasing competition from imports (Amiti and Heise, 2021). To apply the Amiti and Heise (2021) methodology fully to measure domestic market concentration, one needs to adjust both the denominator and numerator of the concentration ratio. As a robustness exercise, following Amiti and Heise (2021), we adjust our concentration denominator to add imports and subtract exports – using OECD Bilateral Trade in Goods by Industry and End-use data. The use of goods trade data means this is possible only for manufacturing, and a lack of firm-level export data means we are not able to subtract the

[18] Bajgar et al. (forthcoming) report that using a denominator based on Orbis rather than on STAN can lead to very different observed concentration trends. Using STAN-based denominators unfortunately means that we are not able to calculate concentration at a finer industry detail.

[19] To maximize country and industry coverage, some NACE Rev. 2 2-digit industries are aggregated together to match the STAN A64 classification. For information on A64, A38, and A21 classifications, see http://www.oecd.org/sti/ind/3max.pdf.

exports of the largest firms from the concentration numerator. In Figure B1 in the online Appendix, we report the baseline and trade-adjusted measures, showing that there is only a small difference.

2.2. Concentration Trends

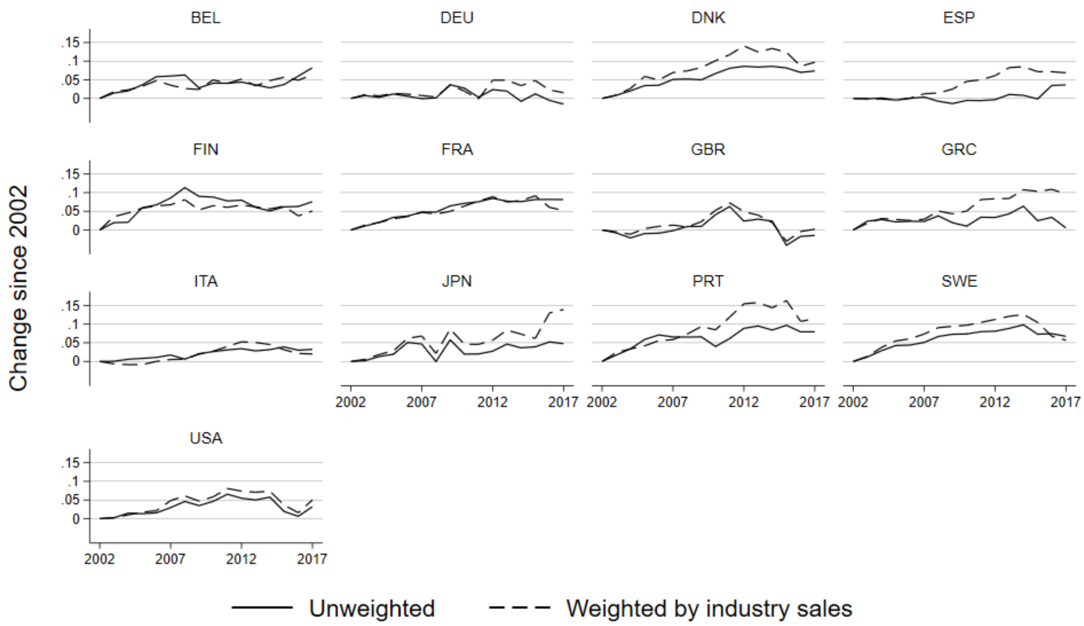
We follow the methodology of Bajgar et al. (2023) to measure country-level concentration across US, Europe, and Japan. We believe we are the first paper to document these trends across multiple countries and industries. Looking at unweighted averages across industries, all countries, except Germany and the UK, experienced an increase in concentration; when industries are weighted by their sales; concentration increased in all countries (Figure 2).[20] The trends are qualitatively similar to findings using representative country-specific firm-level data for France and the US (De Ridder, 2024; Autor et al, 2020).[21] Concentration also increased in 30 out of 37 2-digit industries. Among broad sectors, the concentration increase was particularly pronounced in "Retail", "ICT", "Transportation and Storage" and "Manufacturing", whereas concentration slightly decreased in "Administrative Services" (Figure 3). Overall, concentration increased in 66% of country-industries, which also accounted for two thirds of the total gross output in 2017. The share of the top 8 business groups in the sales of the average country-industry grew by about 5 percentage points (6 percentage points when industries are weighted by their sales).[22]

[20] Using different data, a report by Monopolkomission (2018) also finds a flat concentration in Germany in recent years.

[21] This is despite methodology differences. For instance, unlike our paper, these country-level studies do not account for firms being part of the same business group.

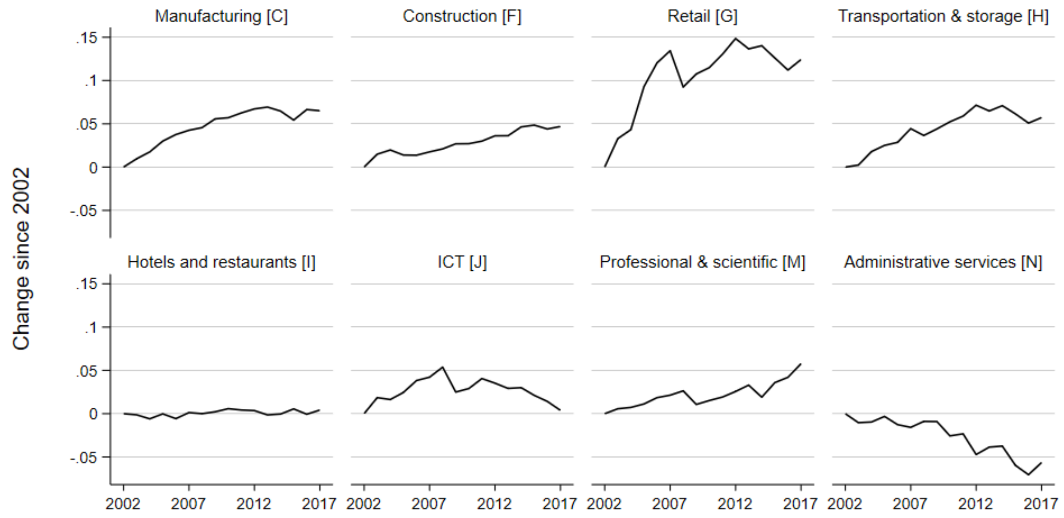
[22] Online Appendix Figure B2 shows the evolution of concentration on average across country-industry pairs, with and without weighting. Online Appendix Figure B3 shows that the proportional concentration increase was very similar for the top 4 and top 20 business groups.

Figure 2. Trends in top 8 concentration by country – change since 2002



Notes: For each country, the figure shows changes in the unweighted and weighted mean concentration across industries compared to the base year 2002. The weighted mean reweights concentration across industries within each country based on time-varying weights given by the share of each industry in the total country-level sales. Included 2-digit industries cover manufacturing, construction, and non-financial market services.

Figure 3. Trends in top 8 concentration by industry – change since 2002



Notes: For each A21 industry, the figure shows changes in the (unweighted) mean concentration across countries compared to the base year 2002. Countries included are BEL, DEU, DNK, ESP, FIN, FRA, GBR, GRE, FRA, JPN, PRT, SWE, and USA. Included 2-digit industries cover manufacturing, construction, and non-financial market services.

We also investigate the sources of business group growth that led to the observed increase in concentration, distinguishing between "organic" growth (firms within a business group getting larger) and "M&A-related" growth (business groups acquiring new firms via M&As). To measure organic concentration, we use firm ownership data (i.e. the business group structure) in the initial year and recalculate concentration each year, keeping this ownership structure fixed. M&A-related concentration changes reflect the differences between total concentration changes and those attributable to organic growth. The online Appendix Figure B4 shows that, while M&As played an important role, they accounted for only about one third of the observed increase in industry concentration, with the remaining two thirds attributable to organic growth within the top business groups.

3. Empirical Approach and Data

3.1. Empirical Approach

3.1.1. Industry Concentration and Intangible Investment

The first part of our analysis examines the relationship between intangible investment intensity and changes in industry concentration. If firms incur intangible fixed costs to reduce their marginal costs (as in De Ridder, 2024), then intangibles are expected to lead to increasing concentration. We estimate this in the following baseline specification:

$$\begin{aligned}(3)\quad & \Delta Concentration^{8}_{c,i,t+k,t} \\ & = \alpha_1 Intangibles_{c,i,t-1} + \alpha_2 \Delta \log Sales_{c,i,t+k-1,t-1} + \alpha_3 Tangibles_{c,i,t-1} + Z_{c,i,t-1}\alpha_4 \\ & + \delta_{ct} + \delta_{it} + \varepsilon_{c,i,t}\end{aligned}$$

where $\Delta Concentration^{8}_{c,i,t+k,t}$ designates the change in the top 8 industry concentration (as defined in section 2.1) in country *c* and industry *i* between years *t* and *t+k*. Our baseline examines 4-year changes in concentration ($k = 4$), and we test robustness to using shorter and longer concentration changes. $Intangibles_{c,i,t-1}$ denotes the intensity of intangible investment in *t-1*, measured at the industry-level as intangible investment divided by value added. An alternative approach would be to use changes in intangible capital stocks over the 4-year period, but stock data are not available for many countries.

To control for country- and industry-specific business cycle dynamics, the specification controls for 4-year growth of real output in country *c* and industry *i*, lagged by one year compared to the period over which concentration is measured ($\Delta \log Sales_{c,i,t+k-1,t-1}$). The baseline specification further controls for the intensity of tangible investment ($Tangibles_{c,i,t-1}$), also measured as a share in value added and at the industry level. This is important given that intangible and tangible investment intensities are strongly and positively correlated.[23] The specification also allows including other factors that may be related to the observed changes in industry concentration ($Z_{c,i,t-1}$) such as the occurrence of mergers and acquisitions or changes in trade openness.[24] Country-year and industry-year fixed effects ($\delta_{c,t}, \delta_{i,t}$) ensure that the observed correlations are not driven by general country-specific or industry-specific characteristics and time variation. Robust standard errors are clustered for each country-A21 industry pair, reflecting the variation in the intangible measure.

Whilst we examine *changes* in industry concentration, which removes time-invariant factors affecting concentration levels, endogeneity concerns remain. A positive correlation between the changes in industry concentration and intangible investment could mean that when the largest firms increase their market shares, they stand to gain more from investing in intangibles, or it could reflect omitted factors that both help firms grow their market shares and lead to a more intensive intangible investment. We construct two instruments for current intangible investment: the first uses intangible investment growth in other countries and the second uses changes in the home country's R&D tax incentives, both interacted with pre-sample investment levels in the home country.[25] The growth of investment abroad is assumed to be driven by factors that are plausibly exogenous to changes in industry concentration in the home country and industry. R&D tax policy changes are commonly used to predict R&D expenditure (e.g. Boler et al., 2015) and, in our case, identification assumes that changes in R&D tax incentives only affect concentration through changes in intangible investment (which includes R&D).[26]

The first instrumental variable combines the (time-invariant) pre-sample (and thus pre-determined) investment with time variation in other countries. It is constructed by multiplying the home country's pre-sample intangible intensity by an index of intangible investment

[23] As these controls could be subject to the post-treatment bias, we also report results without these controls.

[24] Occurrence of large M&As is calculated using Zephyr and is a dummy equal to 1 if at least one company in a given country and industry has been a target of an acquisition with value above the 95th percentile among all acquisitions in a given country.

[25] We measure pre-sample intangible intensities in the earliest year for which we observe intangibles in our data, 1995 (i.e. $t_0=1995$).

[26] Bloom et al. (2013) use R&D tax incentives as an instrument for R&D investment when estimating spillovers from R&D.

intensity in the same industry on average across all other countries in the sample. Formally, the instrument is defined as:

$$(4) \qquad IVOther\ Countries_{c,i,t-1} = Intangibles_{c,i,t_0} * \frac{1}{n-1} \sum_{d \in C, d \neq c} \frac{Intangibles_{d,i,t-1}}{Intangibles_{d,i,t_0}}$$

where C is the set of 13 countries in our sample.

The second instrumental variable instead combines the same pre-sample intangible intensity with time variation in tax incentives for research and development (R&D). While R&D represents only one type of intangible investment, it is the largest individual component of intangibles in our data (see section 3.2 below). The instrument multiplies the pre-sample investment with the change in the implied marginal tax subsidy rate for R&D reported in the OECD R&D Tax Incentives Database relative to year 2000:[27]

$$(5) \qquad IVRDSubsidies_{c,i,t-1} = Intangibles_{c,i,t=0} * \left(RDTax_{c,t-1} - RDTax_{c,2000}\right)$$

To further understand the mechanisms at work, we examine whether these effects are amplified by globalization and digitalization. If intangibles are inherently complementary with scale, they can be expected to give a greater advantage when the leading firms have big markets in which to grow and/or in industries where digitalization facilitates fast expansion. We therefore include an interaction between intangible investment and each of these potential complementary factors, measured at the start of our sample period. Trade openness is defined as the average of industry imports and exports, divided by industry value added, measured by OECD STAN. We consider industries digital-intensive if they were classified by Calvino et al. (2018) as medium-high or high digital intensive for the period 2001-2003.[28] We also examine robustness to alternative interactions such as the intensity of product-market regulations, initial concentration or investment in tangible capital. Product-market regulations are measured by the OECD Product Market Regulation (PMR) Index, with a higher value of the index corresponding to more regulated product markets.

[27] See oe.cd/rdtax. Year 2000 is the first year for which the tax subsidy data are available.

[28] The measure of industry digital intensity is based on the taxonomy developed by Calvino et al. (2018), which classifies A38 industries as more or less digital intensive based on multiple criteria including ICT investment, purchases of intermediate ICT goods and services, robots use, number of ICT specialists, and turnover from online sales.

3.1.2. Industry Concentration and Measures of Business Dynamics and Competition

To better understand the potential implications of concentration for business dynamics and competition, the final part of our analysis examines the extent to which concentration has gone hand-in-hand with other changes in the business environment. If increases in concentration relate to intangible investment as we posit, one would expect that the higher fixed costs and lower marginal costs would translate into lower prices but greater mark-ups and lower business dynamism (as suggested by the framework of De Ridder, 2024).

We consider indicators of top firm mark-ups, churning of the top firms, defensive patenting, and merger and acquisition activity, and estimate equation:

$$(6) \qquad \Delta Comp^{8}_{c,i,t+k,t} = \alpha_1 \Delta Concentration^{8}_{c,i,t+k,t} + \alpha_2 \Delta \log Sales_{c,i,t+k,t} + \delta_{ct} + \delta_{it} + \varepsilon_{cit}$$

where $\Delta Comp^{8}_{c,i,t+k,t}$ denotes the change in the particular competition or business dynamism indicator between *t and t+k*. The equation is estimated with linear regression, clustering at the level of country-A64 industry pairs.

The increasing share of top firms in industry sales could reflect an increase in their market power. The first indicator is the average mark-up of the largest 8 companies within each country and industry, with mark-ups calculated following the methodology developed by De Loecker and Warzynski (2012).[29] However, higher mark-ups do not necessarily imply higher prices. We thus complement mark-ups with a direct measure of prices. As firm-level prices are not available in Orbis, we rely on country-industry price indices from the OECD STAN database.

The fact that the largest firms represent a greater share of industry output need not indicate weaker competition, as long as the top firms continue to be contested by new rising stars. We explore three different measures of the churning of top firms. The first measure serves as a proxy for the top firms being displaced by initially smaller rivals – the share of firms in the top 8 in year *t* that were not in the top 8 in year *t-1*.[30] The second measure captures mobility among firms that remain in the top 8. It is defined as a rank correlation between the market shares of the top 8 firms in *t* and in *t-1* (Joskow, 1960).[31] Where the first two measures focus on the relative ranking of firms, the third measure—market share instability (Sakakibara and Porter, 2001)—

[29] We use labor as a flexible input and estimate industry-specific output elasticities from Orbis data following Wooldridge (2009). The estimation sample contains firms with 20 or more employees.

[30] For studies examining turnover among the leading firms see, e.g., Kato and Honjo (2006) and Honjo et al. (2018).

[31] Only firms that are in the top 8 in both years are used in the calculation.

captures the variability in firms' market shares. Market share instability (MSI) is defined as the mean absolute value of market share changes between t and t-1 across the 8 largest firms in each country and industry, where the market shares are calculated as each firm's sales divided by the total sales of the 8 largest firms:[32]

(7) $$MSI_{c.i.t} = \frac{1}{8}\sum_{f=1}^{8}\left|\frac{S_{f.c.i.t}^{ORBIS}}{\sum_{f=1}^{8} S_{f.c.i.t}^{ORBIS}} - \frac{S_{f.c.i.t-1}^{ORBIS}}{\sum_{f=1}^{8} S_{f.c.i.t-1}^{ORBIS}}\right|$$

One mechanism through which leading firms could try to entrench their position at the top is using intellectual property in a defensive way to prevent their competitors from contesting. Following Akcigit and Ates (2019a), we construct a measure of defensive patenting, using the prevalence of self-citations in patents held by the 8 largest firms in each country and industry. For each firm amongst the top 8 in an industry-country-year, we calculate stocks of patent self-citations and non-self-citations, where self-citations are defined as citations citing patents held by the same firm as the citing patent. The data reflect European Patent Office patents from OECD-PATSTAT, which matches patent applicants to Orbis data using harmonized firm-name matching procedures.[33]

M&As represent another way in which leading firms could reduce pressure from competitors. In the context of digital-intensive industries, in particular, a hot debate is under way about "killer acquisitions", where established firms are suspected of strategically buying start-ups that have a potential to grow into serious competitors for the acquiring firms.[34] We compute the number of M&A investments by the largest 8 companies in each country and industry, sourcing information from the Zephyr database. We separate these into digital and non-digital acquisitions using the industry of the acquiring firm and the digital intensity indicator of Calvino et al. (2018).

[32] The total sales of the 8 largest firms, rather than the total industry sales, are used as a denominator to avoid building in a mechanical relationship between changes in industry concentration and the market share instability measure.

[33] "Patents" here represent unique patent families filed with the European Patent Office (EPO) from 1980 onwards. All applications referring to the same priority patent are defined as a patent family. This avoids double counting of patents filed with multiple patent offices. We focus on EPO patents since data on self-citations is not available to us for other patent offices, and our sample of firms largely reflects European countries. Note that we aggregate patents belonging to subsidiaries of the firm, using our detailed subsidiary ownership data. Stocks are constructed using a 15% depreciation rate following Hall et al. (2005).

[34] See Cunningham et al. (2018), Gauthier and Lamesh (2020), and Motta and Peitz (2020).

The increasing dominance of leading firms could also be associated with weaker general business dynamism, which has been documented in many countries and industries.[35] To investigate this, we use the industry-level firm entry rate, firm exit rate, and job churning rate[36] from the OECD Dynemp database (Desnoyers-James et al., 2019).

3.2. Data

The CR concentration measures are calculated from the matched Orbis-Worldscope-Zephyr database for each country, A64 industry, and year as discussed in section 2.1.

Table 1. Categories of intangible investment in Intan-Invest

	Share in total intangible investment	Components
Innovative Property	40%	R&D (scientific); Mineral exploration; Entertainment and artistic originals; New products/systems in financial services; Design and other new products/systems
Computerized Information	15%	Software; Databases
Economic Competencies	45%	Advertising; Market research; Employer-provided training; Organizational structure

Source: Corrado et al. (2012) and the authors' calculations of shares in the estimation sample.

Industry-level data on intangible and tangible investment comes from the INTAN-Invest database described by Corrado et al. (2012). It contains harmonized information by country, A21 industry, and year for 15 European countries and the United States for the period 1995-2015. We complement it with information on intangible investment in Japan from the Japan Industrial Productivity Database. The intangible investment consists of three broad categories: innovative property, computerized information, and economic competencies. Table 1 summarizes the components of these categories and the average share of each of them in the total intangible investment for our sample. For the analysis, intangible investment intensity is constructed by dividing investment by industry value added, also coming from INTAN-Invest.

Figure 4 documents how the composition of intangibles has changed over time. It shows that between 1995 and 2015, the share of investment in innovative property and in computerized information in total intangible investment increased, respectively, by 7 p.p. and 5 p.p., while the share of economic competencies declined. The shift in the composition of intangible

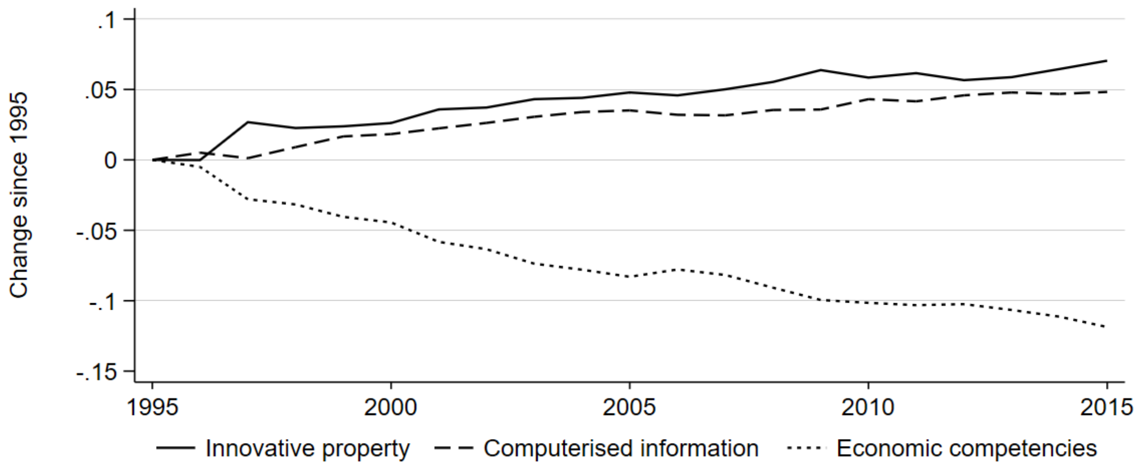
[35] See Decker et al. (2016) for the US and Calvino et al. (2015) for cross-country evidence.

[36] The job churning rate is defined as the number of jobs created plus the number of jobs destroyed, relative to the total number of jobs in the industry. The indicator is calculated from firm-level data, capturing only *net* job creation/destruction within each firm.

investment mirrors the literature documenting dramatic falls in (quality-adjusted) prices of ICT investment observed over recent decades, for instance with 9.9% annual falls between 2004 and 2014 (Byrne and Corrado, 2017).

To complement these industry-level changes, we also examine in our data whether top firms' expenditures on fixed cost intangibles have risen over time more than other firms within the same country-industry.[37] Using R&D reported in firm financial statements, we calculate R&D expenditure at the business-group level (consistent with our measure of sales concentration) by aggregating reported R&D expenditure in their individual underlying subsidiaries and expressing this as a share of (aggregated) sales. We find increases in R&D intensity within the largest 8 firms over time, in contrast to a slight downward trend for the largest 100 firms (see online Appendix Figure B5).

Figure 4. Trends in the share of individual components of intangible investment



Notes: The figure shows changes in the mean share (across country-industry pairs) of each component of intangible investment (Innovation Property, Computerized Information, and Economic Competencies) in the total intangible investment, compared to the base year 1995. Countries included are BEL, DEU, DNK, ESP, FIN, FRA, GBR, GRE, FRA, JPN, PRT, SWE, and USA. Included 2-digit industries cover manufacturing, construction, and non-financial market services.

The final sample spans years 2002-2017 and includes 13 countries: Belgium, Denmark, Finland, France, Germany, Greece, Italy, Japan, Portugal, Spain, Sweden, the United Kingdom,

[37] De Ridder (2024) shows a strong relationship between firm fixed costs and the firm-level intensity of R&D expenditure as a share of sales.

and the United States. The analysis focuses on 2-digit sectors comprising manufacturing, construction, and non-financial market services.[38]

Table 2. Summary Statistics

	N	Mean	SD
CR8 Concentration	4,824	0.40	0.27
CR4 Concentration	4,824	0.31	0.24
CR20 Concentration	4,824	0.50	0.30
Herfindahl-Hirschman Index	4,824	0.07	0.13
Intangible Investment Intensity (t-1)	4,824	0.15	0.08
Innovative Property Investment Intensity (t-1)	4,824	0.07	0.05
Computer and Software Investment Intensity (t-1)	4,660	0.02	0.02
Economic Competencies Investment Intensity (t-1)	4,807	0.06	0.03
Tangible Investment Intensity (t-1)	4,824	0.21	0.08
Industry Real Gross Output (bil. of 2005 PPP $, t-1)	4,824	44.06	91.43
Trade Openness (t-1)	4,800	0.68	0.65
Product Market Regulation Index (t-1)	4,824	1.59	0.29
Large M&A Dummy	4,824	0.12	0.33
Value of M&As / Value Added	4,824	0.04	0.37
Number of M&As	4,824	16.18	46.70
Digital Intensive Dummy	4,824	0.58	0.49
Top 8 mark-up (log)	4,066	0.08	0.54
Industry price index	4,824	1.04	0.18
Share of new firms in the top 8	4,433	0.16	0.12
Rank correlation of top 8 firm sales in t and t-1	4,433	0.89	0.15
Market share instability	4,433	0.02	0.01
Share of self-citations	3,098	0.05	0.06
M&A deals of the largest 8 companies	4,824	2.19	3.98
Industry job churning rate	2,516	0.18	0.07
Industry firm entry rate	2,519	0.05	0.03
Industry firm exit rate	2,529	0.06	0.03

Notes: The number of observations reflects the country-industry-year level. The control variables of industry real gross output and tangible investment intensity come from the OECD STAN database. Real output has been converted to 2005 PPP dollars using exchange rates from the World Bank Development Indicators. Tangible

[38] Due to data differences in measuring output, we exclude wholesale trade (industries 45 and 46) for all countries, and, due to changes in coverage, we exclude industry 41-43 for Belgium and industries 19, 21, 47, 50, 51, 52, 58 and 61 for Germany. We further exclude highly heterogeneous "residual" A64 industries 74-75 and 80-82. Finally, we exclude industry 68, for which INTAN-Invest data are only available for Japan.

investment intensity is measured as Gross Fixed Capital Formation divided by industry value added, from the OECD STAN database. All other variables are defined in the previous section.

Summary statistics of key variables are presented in Table 2. In the baseline regression sample, the average CR4, CR8, and CR20 industry concentration ratios are, respectively, 31%, 40%, and 50%. Industries on average invest around 15% of value added in intangibles, compared to a share of 21% for tangible investment. Our sample of developed economies are relatively open, with trade representing around 70% of value-added for the mean country-industry and with comparatively low levels of product market regulation. 12% of country-industry-year observations experienced at least one large M&A with the value of M&As amounting to, on average, 4% of industry value added, and there were 16 M&As in an average industry, country and year. 58% of observations are in industries classified as digital intensive. On average, 15% of firms that are among the top 8 in a given country and industry in a particular year were not in the top 8 in the previous year. The rank correlation between the market shares of the top 8 firms in years t and t-1 is 0.89, and the market share instability is about 2 percentage points. About 5% of patent citations by top 8 firms, on average, cite patents held by the same firm, and in an average country, industry, and year about 2 acquisitions and minority investments by top 8 firms take place.

In online Appendix Figures B6 and B7, we present heatmaps by country-industry of both a long-difference of concentration changes (between 2002 and 2017) and intangible investment intensity (our key treatment variable). There are large differences in intangible investment across industries, with particularly salient investment in IT and professional services, and some countries with higher (lower) overall investment such as Sweden (Greece).

In online Appendix Table B1, we examine how intangibles and concentration trends differ across a range of initial country characteristics (measured in 2002 to minimize possible reverse causality). We examine two measures of financial market development from the IMF and the World Bank. We include a measure of domestic market size (industry sales) given the potential link between market size and investment in intangibles. Country IT intensity is measured by the investment in IT as a share of total capital investment, and we include two measures of country-level skill endowments – high-skill workers (the share of tertiary education enrollment) and researchers (R&D employment as a share of total employment). We find that IT intensity is correlated with intangibles, but only skills is correlated with both intangibles and concentration changes. The relationship with skills is particularly salient for R&D employment, which also motivates our use of R&D tax incentives as an instrumental variable.

4. Results

4.1. Industry Concentration and Intangible Investment

The results show that changes in country-industry concentration (see Table 3) are strongly correlated with intangible investment. The simplest specification that only includes country-year and industry-year fixed effects (to control for broad characteristics and other developments in particular countries or particular industries) shows a positive and highly statistically significant association between intangible investment intensity and 4-year changes in concentration (column 1). Controlling for real growth in industry output has little impact on the results (column 2). Importantly, the result is not driven by investment intensity in general – intensity of tangible gross capital formation is not significantly associated with concentration, and including it as a control leads to a further slight increase in the coefficient on intangibles (column 3). Thus, in our sample, we do not find evidence of a link between increasing concentration and tangible investment, contrary to what has been suggested for the US by Gutiérrez and Philippon (2017b).

Table 3. Industry Concentration Changes and Intangible Investment

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome Variable:	4-Year Change in CR8 Concentration					
Estimation Method:	OLS	OLS	OLS	IV	IV	IV
Instrumental Variables:				Other countries	Tax incentives	Both
Intangible Investment Intensity	0.174***	0.169***	0.198***	0.192**	0.245	0.195**
	(0.060)	(0.059)	(0.070)	(0.093)	(0.188)	(0.093)
4-Year Growth in Real Output		-0.071***	-0.071***	-0.071***	-0.071***	-0.071***
		(0.012)	(0.013)	(0.012)	(0.013)	(0.013)
Tangible Investment Intensity			-0.043	-0.041	-0.060	-0.042
			(0.053)	(0.055)	(0.076)	(0.055)
Country-Year FE	Y	Y	Y	Y	Y	Y
Industry-Year FE	Y	Y	Y	Y	Y	Y
N	4812	4812	4812	4812	4812	4812
First-Stage F-Statistic	n/a	n/a	n/a	97.5	21.2	60.2
Hansen J-Test P-Value	n/a	n/a	n/a	n/a	n/a	0.75

Notes: *** 1%, ** 5%, * 10%. The table shows results of regressions at the country–A64 industry–year level. Columns 1 to 3 present OLS regressions and columns 4 to 6 present second stage IV estimates (the first stage estimates are reported in online Appendix Table B2). The reported first-stage F-statistic is the Kleibergen-Paap cluster-robust weak instrument statistic. Robust standard errors clustered at the country–A21 industry level (the level of aggregation of the intangible data) are in parentheses.

The instrumental-variable results (columns 4-6) mirror the findings from the OLS regressions. In column 4, we use an instrument for intangible investment based on changes in intangibles in other countries. In column 5, we use an instrument based on changes in R&D tax credits at home. In column 6, we use both instruments jointly. First-stage estimates (see online Appendix Table B2) reveal that both instruments are strongly significant predictors of intangible investment intensity, with F-statistics of around 100 with the first instrument, 20 with the second instrument, and 60 when we use both instruments jointly. The second stage estimates in columns 4-6 are close to the corresponding OLS estimates (column 3). We also obtain similar point estimates using either of the instruments separately or both instruments jointly, and the Hansen J-test of over-identifying restrictions does not reject the null hypothesis of exogenous instruments, with a p-value of 0.75. One difference is that the results obtained using only the instrument based on changes in R&D tax incentives are less precisely estimated. Consequently, our second stage estimates remain statistically significant at conventional levels when we use the instrument based on intangible investment in other countries or both instruments jointly.[39]

The association between changes in concentration and intangible intensity is economically meaningful. According to our preferred specification (column 6), a 1-standard-deviation increase in the intensity of intangible investment corresponds to a 1.5-percentage-point greater change in industry concentration over the next four years. This corresponds to about a third of the observed concentration increase in the average country-industry.

[39] Our first instrument—the average of changes in intangibles in other countries—belongs to the Bartik shift-share class. Borusyak et al. (2022) decompose such instruments into shocks and exposure share weights. In reference to equation 4 in the main paper, the shocks are given by $\frac{Intangibles_{d,i,t-1}}{Intangibles_{d,i,t_0}}$ and the exposure share weights are given by $Intangibles_{c,i,t_0} * \frac{1}{n-1}$. The instrument is plausibly exogenous if the shocks—the growth of foreign intangibles—are randomly assigned. To test this, we examine correlations between foreign intangible growth and initial country-industry characteristics that could be correlated with concentration changes. We conduct these regressions at the foreign country-industry level (i.e. the "shock level"), using their average exposure as weights. We also perform regressions at the bilateral domestic-foreign country-industry level using the exposure weights without averaging.

We find no systematic correlations with a host of characteristics like concentration ratios, industry output, trade openness, or digital intensity (see online Appendix Table B3), except for some cases of tangible investment. We follow Borusyak et al. (2022) and assess the potential magnitude of omitted variables, by repeating our baseline regressions with and without the tangible investment control. Our baseline results are virtually unchanged (available upon request), supporting the random assignment of foreign shocks and the validity of the Bartik instrument.

We discuss the robustness and alternative explanations of our results in section A of the online Appendix. We show that the results are robust to (1) measuring concentration with CR4, CR8 or the Herfindahl-Hirschman index, rather than CR8 (Table A1); (2) using 2-year or 6-year changes in concentration, rather than 4-year changes (Table A2); (3) dropping any one country (Table A3); (4) dropping any one industry (Table A4); (5) calculating intangible investment intensity using a time-invariant denominator (Table A5); and (6) controlling for other commonly cited factors that might be related to concentration trends, such as changes in trade openness and in regulatory strictness (Tables A7 and A8).

Weak antitrust enforcement of mergers and acquisitions has been proposed as an alternative explanation for divergent concentration trends, with the acquisition of innovative start-ups by incumbent firms potentially weakening future competition (e.g., Cunningham et al., 2018; Gutiérrez and Philippon, 2019a). A particular concern is that, if intangible investment is correlated with M&As, M&As could be an omitted variable biasing our results for intangibles. However, as discussed in section 2.2 above, M&As accounted for only a smaller part of the observed increase in industry concentration over the sample period. Additionally, in section A of the online Appendix Table A6, we show that the estimated relationship between concentration changes and intangible investment intensity is robust to controlling for the occurrence of M&As in a number of different ways and that intangible investment intensity is strongly correlated with organic concentration changes but not with M&A-related concentration changes. Together, these results indicate that our main findings are not driven by M&A activity.

Our data also allows us to compare whether the observed relationship between concentration and intangibles differs between countries in Europe and the US or Japan. In online Appendix Table B4, we replicate the baseline OLS and IV estimations, adding interactions between intangible investment and the US or the US and Japan, with the baseline group being Europe. We do not find any evidence that the link between intangibles and concentration is quantitively different across these regions.

Although our results are consistent with investments in intangible assets disproportionately benefiting large firms and leading to increased concentration, one could potentially argue that the causality runs in the opposite direction, as firms in more concentrated industries invest more in intangibles. Throughout the paper, we attempt to mitigate this concern by lagging the main explanatory variable and, most importantly, by relying on our IV strategy. As an additional check, we estimate a specification where we include the lagged, contemporaneous, and lead intangible investment intensity.[40] If the coefficient on the lead industry investment intensity is statistically significant, one should be seriously concerned about the risk of reverse causality. We report the results in online Appendix Table B5. Given the limited variation of the intangible investment intensity over time, it appears challenging to accurately pin down the timing of the relationship between the intangible investment intensity and the concentration changes, with all coefficients' estimates being insignificant. Importantly, we do not find any indication of a positive relationship between lead values of the intangible investment intensity and industry concentration changes.

The analysis so far has used total intangible investment, but intangibles encompass a broad range of investments that may have different characteristics. Table 4 decomposes intangible investment into three subcategories outlined in section 3.2: innovative property (R&D, design…); computerized information (data and software); and economic competencies (advertising, marketing, training...).

Table 4. Decomposing Total Intangible Investment

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome Variable:	4-Year Change in CR8 Concentration					
Estimation Method:	OLS	IV	OLS	IV	OLS	IV
Innovative Property	0.274***	0.423***				
	(0.088)	(0.116)				
Computerized Information			0.647**	0.985		
			(0.295)	(0.683)		
Economic Competencies					0.043	-0.094
					(0.194)	(0.221)
Country-year FE	Y	Y	Y	Y	Y	Y
Industry-year FE	Y	Y	Y	Y	Y	Y
N	4615	4615	4615	4615	4615	4615

Notes: *** 1%, ** 5%, * 10%. The table shows results of OLS and IV regressions at the country–A64 industry–year level. All regressions include (4 year) growth in industry sales and tangible investment intensity as control variables, which are omitted for parsimony. Robust standard errors clustered at the country–A21 industry level (the level of aggregation of the intangible data) are in parentheses.

The results for total intangible investment appear to be mostly driven by investments in innovative property and computerized information. The coefficients for investment in

[40] As our outcome variable is defined as a concentration change between *t* and *t+4*, and to keep the number of explanatory variables somewhat limited, we calculate the lagged intangible investment intensity as the average of the investment intensities in *t-2*, *t-1* and *t*, the contemporaneous intensity as average across years *t+1*, *t+2* and *t+3* and the lead intangible investment intensity as the average across years *t+4*, *t+5* and *t+6*.

innovative property are positive and statistically significant using both OLS (column 1) and IV (column 2) estimations. The OLS coefficients for investment in computerized information (column 3) is also positive and more than twice as large as the estimates for innovative property, although the IV estimate is much smaller (column 4) and only the OLS estimate is statistically significant at conventional levels.[41] Using the IV estimates, a 1-standard-deviation increase in the intensities of investment in innovative property and computerized information correspond, respectively, to 2.1-percentage-point and 1.7-percentage-point increases in industry concentration over the next four years. In contrast, investment in economic competencies is not significantly linked to concentration changes (columns 5 and 6).

These contrasting results are consistent with the idea that the relationship between changes in concentration and investments in intangibles are driven by the scalability property of intangibles. Software, data, and inventions are much more easily scalable than economic competencies, often embedded in people. It is also interesting to note that the high coefficients for computerized information are consistent with the key role of digital technology in some related models (e.g., De Ridder, 2024).[42] In this context, it is also worth noting the increasing importance of investment in innovative property and computerized information as a share of the total intangible investment (see Figure 4). Similarly, Lashkari et al. (2019) find that declines in IT prices in France can explain most of the observed increases in industry concentration, since the demand for IT inputs increases with firm size.

To further analyze the mechanisms at work, we examine whether these effects are amplified by globalization and digitalization. If intangible investments allow large firms to further scale up and increase their market shares, this should be easier when these firms have access to larger markets to grow into. Intangible investment is indeed more strongly correlated with concentration growth in country-industries that are (initially) more open to international trade (columns 1 and 2 of Table 5). A one standard deviation higher trade openness corresponds to roughly 50% stronger association between intangible investment and concentration, in line with

[41] This could reflect that, in most industries, firms invest relatively less in this type of intangibles, or it could be related to measurement challenges for intangibles of this type (e.g., the value of data).

[42] Note that in the model by De Ridder (2024), digital technologies (or intangibles more generally) and R&D play rather different roles. The former represent fixed cost investments that reduce marginal costs, while the latter drive growth through product quality improvements. In practice, however, R&D likely plays both aforementioned roles. While some R&D involves product innovation along the quality ladder, other R&D is aimed at process innovation that lowers marginal costs. This is true especially in the case of large firms, which invest relatively more in process innovation (e.g., Cohen and Klepper, 1996).

the idea that access to larger markets enables the scale-up potential of intangible capital. As discussed above, the relationship between intangibles and concentration changes should also be stronger in industries where intensive use of digital technologies facilitates further scaling up of large firms. The point estimates indeed suggest the relationship between changes in concentration and intangible investment to be about 50% stronger in the more digital intensive industries, but the interaction term is not statistically significant (columns 3 and 4 of Table 5).

Table 5. Intangible Investment Complementarities with Globalization and Digitalization

	(1)	(2)	(3)	(4)
Outcome Variable:	4-Year Change in CR8 Concentration			
Exposure Variable:	Initial Trade Openness		High Digital Intensity	
	OLS	IV	OLS	IV
Intangible Investment	0.211***	0.198**	0.148**	0.139*
	(0.073)	(0.086)	(0.069)	(0.083)
Exposure variable	-0.009	-0.007		
	(0.006)	(0.007)		
Intangible Investment * Exposure variable	0.101***	0.088*	0.076	0.077
	(0.034)	(0.048)	(0.069)	(0.094)
Country-year FE	Y	Y	Y	Y
Industry-year FE	Y	Y	Y	Y
N	4776	4776	4776	4776

Notes: *** 1%, ** 5%, * 10%. The table shows results of OLS and IV regressions at the country–A64 industry–year level. All regressions include (4 year) growth in industry sales and tangible investment intensity as control variables, which are omitted for parsimony. All exposure variables reflect 2002 demeaned values (the start of our sample period), with the exception of the digital intensity indicator which uses 2001-2003 data. Robust standard errors clustered at the country–A21 industry level are in parentheses.

We also examine whether the relationship between intangibles and concentration—which was shown to be magnified by globalization and digitalization—is complementary to other factors (online Appendix Table B6). Intangible investment could be more strongly associated with increasing concentration when accompanied with investment in tangibles. For example, intangible data often requires IT hardware, and new machinery may necessitate worker training (Bisztray et al., 2020; Kaus et al., 2020; McGrattan and Prescott, 2014). Our results indeed suggest this is the case, with a one standard deviation greater initial intensity of tangible investment corresponding to a 50% stronger association between intangible investment and concentration (columns 1 and 2). We do not find any evidence of the association between intangibles and concentration changes being different in countries with stronger product market regulations (columns 3 and 4). Finally, we find some indication of the association being somewhat stronger for industries with a higher initial level of industry concentration (columns 4 and 6).

4.2. Industry Concentration and Measures of Business Dynamics and Competition

The analysis so far indicates that the observed rise in industry concentration is strongly predicted by investment in intangible assets, which allows large business groups to further scale up. An important question that follows is what the concentration increases imply for business dynamism and competition, and whether they simply reflect new large-firm biased intangible business models or whether they might also be a sign of a worsening competitive environment.

Greater shares in industry sales held by the largest firms could be associated with stronger market power of these firms. To examine this, we regress 4-year changes in the average mark-up of the 8 largest groups in each country and industry on the 4-year changes in industry concentration (column 1 of Table 6).[43] The results indicate a positive association between concentration and mark-ups, with a 10-percentage-point increase in concentration corresponding to 1.2% higher mark-ups of the largest firms. However, rising mark-ups by themselves do not indicate rising market power. If increasing concentration is a symptom of weak competition, it should be positively correlated with prices (Berry et al., 2019). We explore this in column 2 of Table 6. As information on firm-level prices is not available, we use 4-year growth in industry price indices. We find a strong negative correlation, implying that a 10-percentage-point increase in concentration corresponds to a 2.1% reduction in industry prices. Taken together, the results for mark-ups and industry prices are consistent with models where large business groups incur the fixed costs of investing in intangible assets and are rewarded by reduced marginal costs (De Ridder, 2024). Prices decline but marginal costs decline even more, leading to an increase in mark-ups.

[43] Bond et al. (2021) have recently highlighted identification challenges that arise when researchers attempt to estimate mark-ups from the production function using accounting data that do not contain information on prices, as is the case here. However, De Ridder et al. (2022) show in simulations and using real-world data that mark-ups estimated in the absence of price data are still highly informative of the dispersion of mark-ups in a cross-section and over time, although not the absolute level of mark-ups. As we are not interested in the absolute level of mark-ups, but rather in the dispersion of top firm mark-ups across different countries and industries, the findings of De Ridder et al. (2022) suggest that mark-ups estimated from accounting data are informative in our context.

Table 6. Industry Concentration and Measures of Business Dynamics and Competition

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome variable:	Mark-ups of Top 8 Groups	Industry Price Index	Share of New Top 8 Groups	Size Rank Persistence	Market Share Instability	Share of Int. Citations
4-year Change in CR8	0.123*	-0.205***	-0.077**	0.117***	-0.009**	0.028
	(0.065)	(0.040)	(0.030)	(0.035)	(0.005)	(0.018)
4-year Growth in Real Output	0.054	-0.578***	-0.017	0.022	-0.004*	0.018**
	(0.034)	(0.042)	(0.013)	(0.015)	(0.002)	(0.008)
Country-Year FE	Y	Y	Y	Y	Y	Y
Industry-Year FE	Y	Y	Y	Y	Y	Y
N	2948	2948	4491	4491	4491	2221

	(7)	(8)	(9)	(10)	(11)
Outcome variable:	More Digital M&As	Less Digital M&As	Firm Entry Rate	Firm Exit Rate	Job Churning Rate
4-year Change in CR8	1.549***	-1.258	0.002	-0.001	-0.005
	(0.568)	(0.826)	(0.004)	(0.005)	(0.015)
4-year Growth in Real Output	0.439	-0.199	0.000	-0.001	-0.031***
	(0.267)	(0.268)	(0.002)	(0.002)	(0.008)
Country-Year FE	Y	Y	Y	Y	Y
Industry-Year FE	Y	Y	Y	Y	Y
N	2099	1526	1912	1912	1912

Notes: *** 1%, ** 5%, * 10%. The table shows results of OLS regressions at the country–A64 industry–year level. Robust standard errors clustered at the country–A64 industry level in parentheses.

The growing market shares of the largest firms may be consistent with intense competition, provided that the top firms continue to be contested by initially smaller competitors and by each other. We measure such competitive activity by exploring churning amongst the largest firms in each country and industry. We investigate how concentration changes are related to three measures of firm mobility at the top: the share of top 8 firms that were not in the top 8 a year earlier, the correlation of top 8 firm relative ranking with its rank a year earlier, and the market share instability measure (capturing the annual variability in firms' market shares).

The results for all three measures consistently indicate that increased concentration is associated with reduced churning at the top (columns 3-5 of Table 6). Specifically, a 10-percentage-point increase in industry concentration corresponds to a 0.8-percentage-point reduction in the share of new firms among the top 8 (a 5% reduction compared to the mean share), a 1.2-percentage-point increase in the year-on-year rank correlation of the top 8 firms' market shares (a 1.3% increase compared to the mean value), and a 0.1-percentage point reduction in the market share instability (a 6% reduction compared to the mean value). These results are in line with evidence found for the US (Bessen et al., 2020) showing that the displacement of industry-leading firms has declined sharply since 2000 and that the greater persistence at the top is closely linked to investments in proprietary software by dominant firms.

The results above suggest that increases in industry concentration have been associated with reduced churning amongst top firms. We now turn to two examples of mechanisms that might be helping the leading firms to stay at the top. Firstly, leading firms could increasingly use intellectual property in a defensive way to prevent their competitors from contesting them (Akcigit and Ates, 2019a,b). To see if this is the case, we regress 4-year changes in the share of self-citations among all citations by patents of the top 8 firms against 4-year changes in concentration. Although we find a positive coefficient, it is not statistically significant at conventional levels (column 6 of Table 6).[44]

Leading firms can also bolster their position through mergers and acquisitions. The role of M&As is hotly debated, especially in the context of digital-intensive industries where established firms are suspected of strategically acquiring start-ups that have a potential to grow into serious competitors (e.g., Argentesi et al., 2019). In columns 7 and 8 of Table 6, we test if changes in industry concentration are associated also with changes in the number of M&As

[44] The estimate implies that a 10-percentage-point increase in concentration is associated with a 0.26% increase in the share of self-citations, which represents a 5% increase relative to the mean value.

(acquisitions and minority investments) by the top 8 firms in each industry. For M&As in digital intensive industries, we find evidence of a positive relationship with concentration. A 10-percentage-point increase in industry concentration is associated with 0.16 additional M&As by the top 8 firms per year, which corresponds to a 7% increase relative to the mean (column 7). In contrast, we find no evidence of a relationship between changes in concentration and in M&A activity in less digital-intensive industries (column 8).

Finally, we examine whether the increasing dominance of leading firms is associated with the decline in general business dynamism that has been documented in many countries (Decker et al., 2016; Calvino et al., 2015). To this end, we test if changes in industry concentration are correlated with changes in the rates at which firms enter and exit industries and with which workers are reallocated across firms. We do not find any evidence of an association between changes in top concentration and changes in the broad business dynamism using these measures (columns 9-11 of Table 6).

5. Conclusion

This paper finds that industry concentration has increased in a number of OECD economies and in many industries since the early 2000s. Using panel data at the country-industry level for 13 countries and years 2002-2017, the analysis indicates that intangibles have played a significant role in this increase, and this is amplified in more globalized industries and countries. In contrast, M&As seem to have played only a smaller role in the concentration increase. Firms incur the fixed costs of intangibles, like innovation and data, in order to reduce their marginal costs of doing business (De Ridder, 2024). The results are consistent with intangibles disproportionately benefiting large firms that can afford these fixed costs, enabling them to scale up by leveraging intangibles across multiple digital and foreign markets.

In terms of implications for competition and business dynamism, the finding that the increasing concentration is associated with investment rather than with M&As or stricter regulations can be seen as good news. The finding that concentrating industries also see rising mark-ups of largest firms need not indicate the presence of particular anti-competitive forces, but may instead be a result of the largest firms making fixed investments in intangible assets to reduce their marginal costs (De Ridder, 2024); indeed, industry prices seem to increase less, not more, in country-industries with stronger concentration increases.

This does not, however, mean that the recent rise in industry concentration does not represent a threat to competition and business dynamism. The finding that increasing concentration is consistently associated with reduced churning among the largest firms may indeed indicate a weakening of the competitive process. The largest firms in the increasingly concentrated industries are also acquiring potential competitors through M&As in digital-intensive industries. These trends may therefore represent a threat to future competition and to consumers if the position of dominant firms acts as a barrier to entry for new firms, or slows knowledge diffusion to competitors and their growth.

References

Acemoglu, D., and J. Linn. 2004. "Market Size in Innovation: Theory and and Evidence from the Pharmaceutical Industry, The Quarterly Journal of Economics, 119:3, 1049–1090.

Akcigit, U., and S. Ates. 2019a. "What Happened to U.S. Business Dynamism?" NBER Working Paper 25756.

Akcigit, U., and S. Ates. 2019b. "Ten Facts on Declining Business Dynamism and Lessons from Endogenous Growth Theory," NBER Working Paper 25755.

Affeldt, P., T. Duso, K. Gugler, and J. Piechucka. 2021. "Market Concentration in Europe: Evidence from Antitrust Markets," DIW Berlin Discussion Paper 1930.

Alexander, L., and J. Eberly. 2018. "Investment Hollowing Out," IMF Economic Review, 66:1, 5–30.

Amiti, M. and Heise, S. (2021). " U.S. Market Concentration and Import Competition". Staff Reports 968, Federal Reserve Bank of New York.

Andrews, D., C. Criscuolo, and P. N. Gal. 2016. "The Best versus the Rest: The Global Productivity Slowdown, Divergence across Firms and the Role of Public Policy," OECD Productivity Working Paper 5.

Antoniades, A. 2015. "Heterogeneous Firms, Quality, and Trade." Journal of International Economics, 95:2, 263-273.

Argentesi, E., P. Buccirossi, E. Calvano, T. Duso, A. Marrazzo, and S. Nava. 2019. "Merger Policy in Digital Markets: An Ex-Post Assessment," CEPR Discussion Paper 14166.

Autor, D., D. Dorn, L. Katz, C. Patterson, and J. Van Reenen. 2020. "The Fall of the Labor Share and the Rise of Superstar Firms," Quarterly Journal of Economics 135:2, 645-709.

Ayyagari, M., A. Demirguc-Kunt, and V. Maksimovic. 2019. "The Rise of Star Firms: Intangible Capital and Competition," World Bank Policy Research Paper 8832.

Bajgar, M., G. Berlingieri, S. Calligaris, C. Criscuolo, and J. Timmis. 2020. "Coverage and Representativeness of Orbis Data," OECD Science, Technology and Industry Working Paper 6.

Bajgar, M., G. Berlingieri, S. Calligaris, C. Criscuolo, and J. Timmis. 2023. "Industry Concentration in Europe and North America," Industrial and Corporate Change dtac059.

Barkai, S. 2019. "Declining Labor and Capital Shares," Journal of Finance 75:5, 2421-2463.

Bessen, J. 2016. "Accounting for Rising Corporate Profits: Intangibles or Regulatory Rents?" Boston University School of Law, Law and Economics Paper 16-18.

Bessen, J. 2017. "Information Technology and Industry Concentration," Boston University School of Law, Law and Economics Paper 17-41.

Bessen, J., E. Denk, J. Kim and C. Righi. 2020. "Declining Industrial Disruption," Boston University School of Law and Economics Paper 20-28.

Berlingieri, G., P. Blanchenay, and C. Criscuolo. 2017. "The Great Divergence(s)," OECD Science, Technology and Industry Policy Paper 39.

Bisztray, M., B. Murakozy, and D. Vonnak. 2020. "Analysis of the Importance of Intangible Capital and Knowledge for Productivity Measurement," mimeo.

Bloom, N., R. Sadun, and J. Van Reenen. 2012. "Americans Do IT Better: US Multinationals and the Productivity Miracle." American Economic Review, 102 (1): 167–201.

Bloom, N., M. Schankerman, and J. Van Reenen. 2013. "Identifying Technology Spillovers and Product Market Rivalry," Econometrica, 81:4, 1347-1393.

Boler, E. A., A. Moxnes, and K. H. Ulltveit-Moe. 2015. "R&D, International Sourcing, and the Joint Impact on Firm Performance," American Economic Review, 105:12, 3704-39.

Bond, S., A. Hashemi, G. Kaplan, and P. Zoch. 2021. "Some unpleasant markup arithmetic: Production function elasticities and their estimation from production data," Journal of Monetary Economics, 121, 1-14.

Borgo, M., P. Goodridge, J. Haskel, and A. Pesole. 2013. "Productivity and Growth in UK Industries: An Intangible Investment Approach," Oxford Bulletin of Economics and Statistics 75:6, 806-834.

Bussière, M, L. Ferrara and J. Milovich. 2015. "Explaining the Recent Slump in Investment: the Role of Expected Demand and Uncertainty," Banque de France Working Paper 571.

Bustos, P. 2011. "Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms", American Economic Review. 101(1), 304-340.

Byrne, D. and C. Corrado. 2017. "ICT Prices and ICT Services: What Do They Tell Us About Productivity and Technology," International Productivity Monitor, 33, 150-181.

Calligaris, S., C. Criscuolo, and L. Marcolin. 2018. "Mark-Ups in the Digital Era," OECD Science, Technology and Industry Working Paper 10.

Calvino, F., C. Criscuolo, and C. Menon. 2015. "Cross-Country Evidence on Start-Up Dynamics," OECD Science, Technology and Industry Working Paper 6.

Calvino, F., C. Criscuolo, L. Marcolin, and M. Squicciarini. 2018. "A Taxonomy of Digital Intensive Sectors," OECD Science, Technology and Industry Working Paper 14.

Cohen, W. M., and S. Klepper. 1996. "Firm size and the nature of innovation within industries: The case of process and product R&D," The Review of Economics and Statistics, 78:2, 232–43.

Corrado, C., and C. Hulten. 2010. "How Do You Measure a "Technological Revolution"?" American Economic Review, 100:2, pp.99-104.

Corrado, C., J. Haskel, C. Jona-Lasinio, and M. Iommi. 2012. "Intangible Capital and Growth in Advanced Economies: Measurement Methods and Comparative Results," The Conference Board Economics Program Working Papers 12-03.

Corrado, C., J. Haskel, C. Jona-Lasinio, and M. Iommi. 2018. "Intangible Investment in the EU and US Before and Since the Great Recession and Its Contribution to Productivity Growth," Journal of Infrastructure, Policy and Development, 2(1), 11-36.

Covarrubias, M., G. Gutiérrez, and T. Philippon. 2019. "From Good to Bad Concentration? U.S. Industries over the past 30 years," NBER Working Paper 25983.

Crouzet, N., and J. Eberly. 2019. "Understanding Weak Capital Investment: the Role of Market Concentration and Intangibles," NBER Working Paper 25869.

Cunningham, C., F. Ederer, and S. Ma. 2018. "Killer Acquistions," Academy of Management Proceedings 1.

Decker, R., J. Haltiwanger, R. Jarmin, and J. Miranda. 2016. "Where Has All the Skewness Gone? The Decline in High-Growth (Young) Firms in the U.S.?" European Economic Review 86, 4-23.

De Loecker, J., J. Eeckhout, and G. Unger. 2020. "The Rise of Market Power and the Macroeconomic Implications," Quarterly Journal of Economics, 135:2, 561-644.

De Loecker, J., and F. Warzynski. 2012. "Markups and Firm-Level Export Status," American Economic Review, 102:6, 2437-2471.

Desnoyers-James, I., S. Calligaris and F. Calvino. 2019. "Dynemp and Multiprod: Metadata," OECD Science, Technology and Industry Working Paper 13.

De Ridder, M. 2024. “Market Power and Innovation in the Intangible Economy”, American Economic Review, 114(1), 199-251.

De Ridder, M., B. Grassi, and G. Morzenti. 2022. “The Hitchhiker’s Guide to Markup Estimation,” CEPR Discussion Paper 17532.

Diez, F., D. Leigh, and S. Tambunlertchai. 2018. “Global Market Power and its Macroeconomic Implications,” IMF Working Paper 137.

Furman, J., and P. Orszag. 2015. “A Firm-Level Perspective on the Role of Rents in the Rise in Inequality,” paper presented at “A Just Society” Centennial Event in Honor of Joseph Stiglitz.

Ganapati, S. 2021. “Growing Oligopolies, Prices, Output, and Productivity”, American Economic Journal: Microeconomics, 13(3), 309-327.

Grullon, G., Y. Larkin, and R. Michaely. 2019. “Are US Industries Becoming More Concentrated?” Review of Finance, 23:4, 697–743.

Gutiérrez, G., and T. Philippon. 2017a. “Investment-less Growth: An Empirical Investigation,” Brookings Papers on Economic Activity.

Gutiérrez, G., and T. Philippon. 2017b. “Declining Competition and Investment in the U.S.,” NBER Working Paper 23583.

Gutiérrez, G., and T. Philippon. 2019a. “The Failure of Free Entry,” NBER Working Paper 26001.

Gutiérrez, G., and T. Philippon. 2019b. “How EU Markets Became More Competitive than US Markets: A Study of Institutional Drift,” NBER Working Paper 24700.

Hall, B. H., A. B. Jaffe, and M. Trajtenberg. 2005. “Market Value and Patent Citations,” Rand Journal of Economics, 36:1, 16–38.

Hall, R. 2018. “New Evidence on the Markup of Prices over Marginal Costs and the Role of Mega-Firms in the US Economy,” NBER Working Paper 24574.

Haskel, J., and S. Westlake. 2017. “Capitalism Without Capital: The Rise of the Intangible Economy,” Princeton: Princeton University Press.

Honjo, Y., N. Doi, and Y. Kudo. 2018. “The Turnover of Market Leaders in Growing and Declining Industries: Evidence from Japan,” Journal of Industry, Competition and Trade, 18, 123-138.

IMF. 2019. “The Rise of Corporate Market Power and Its Macroeconomic Effects,” in World Economic Outlook.

ILO, and OECD. 2015. “The Labour Share in G20 Economies”, report prepared for the G20 Employment Working Group.

Joskow, J. 1960. "Rank-shift analysis as a supplement to concentration ratios." Review of Economics and Statistics, 42(1): 113–116.

Kalemli-Özcan, S., B. Sørensen, C. Villegas-Sanchez, V. Volosovych, and S. Yeşiltaş. 2019. "How to Construct Nationally Representative Firm Level Data from the ORBIS Global Database," NBER Working Paper 21558.

Kato, M. and Y. Honjo. 2006. "Market Share Instability and the Dynamics of Competition: A Panel Data Analysis of Japanese Manufacturing Industries" Review of Industrial Organization, 28, 165–182.

Kaus, W., V. Slavtchev, and M. Zimmermann. 2020. "Intangible Capital and Productivity: Firm-Level Evidence from German Manufacturing," IWH Discussion Paper 1.

Karabarbounis, L., and B. Neiman. 2013. "The Global Decline of the Labor Share," Quarterly Journal of Economics, 129:1, 61-103.

Koltay, G., S. Lorincz, and T. Valletti. 2020. "Concentration and Competition: Evidence from Europe and Implications for Policy," mimeo.

Kwon, S. Y. and Y. Ma and K. Zimmermann *(forthcoming)* "100 Years of Rising Corporate Concentration", American Economic Review.

Lashkari, D., A. Bauer and J. Boussard. 2019. "Information Technology and Returns to Scale," Boston College Working Paper in Economics 984.

Lewis, C., N. Pain, J. Stráský, and F. Menkyna. 2014. "Investment Gaps after the Crisis," OECD Economics Department Working Paper 1168.

McGrattan, E., and E. Prescott. 2014. "Theory and Measurement of Intangible Capital: A Reassessment of Real Business Cycle Theory," American Economic Review: Papers & Proceedings, 104:5, 177–182.

Monopolkomission. 2018. "Trends in Indicators of Market Power in Germany and Europe," report.

Motta M. and M. Peitz. 2020. "Big Tech Mergers," CRC TR 224 Discussion Paper Series, University of Bonn and University of Mannheim, Germany.

Rajan, R. G., and Zingales, L. 1998. "Financial Dependence and Growth," American Economic Review, 88(3), 559-586.

Sakakibara, M. and M. E. Porter. 2001. "Competing at Home to Win Abroad: Evidence from Japanese Industry." Review of Economics and Statistics. 83:2, 310-322.

Shaked, A., and J. Sutton. 1987. "Product Differentiation and Industrial Structure," Journal of Industrial Economics. 36:2, 131-146.

Wooldridge, J. M. 2009. "On estimating firm-level production functions using proxy variables to control for unobservables," Economics Letters, 104, 112-114.

Zhu, L. 2017. "Firm Size, Concentration and the Labor Share," Society for Economic Dynamics Meeting Paper 1591.