EUROPEAN FIRM CONCENTRATION AND AGGREGATE PRODUCTIVITY

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Abstract
This paper derives a European Herfindahl–Hirschman concentration index from 15 micro-aggregated country datasets. In the last decade, European concentration rose due to a reallocation of economic activity toward large and concentrated industries. Over the same period, productivity gains from an increasing allocative efficiency of the European market accounted for 50% of European productivity growth while markups stayed constant. Using country-industry variation, we show that changes in concentration are positively associated with changes in productivity and allocative efficiency. This holds across most sectors and countries and supports the notion that rising concentration in Europe reflects a more efficient market environment rather than weak competition and rising market power. (JEL: D24, F15, L11, L25, O47)

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1. Introduction

Recent work has brought attention to the US phenomenon of high and rising market concentration, which has been associated with the rise of "superstar firms"; in other words, a concentration of domestic economic activity in a few large and highly productive firms (Autor et al. 2017, 2020). The economic consequences of this rise in firm concentration have been intensively debated in the past few years. Much of this debate centers on the implications of rising market concentration for market structure and competition. On the one hand, increasing concentration could signal a smoothly functioning market environment rewarding the most efficient producers with increased market share in an intense "winner-takes-all" competition (Autor et al. 2020; Van Reenen 2018). On the other hand, rising concentration could reflect a decrease in competition associated with increases in market power that are disconnected from technological advances at top firms (Covarrubias, Gutiérrez, and Philippon 2020; De Loecker, Eeckhout, and Unger 2020).

Despite its importance, surprisingly less is known on the empirical relationship between changes in concentration, productivity, and market structure. Moreover, we still lack evidence on the empirical patterns of market concentration and firm market power outside the United States and particularly for Europe. This paper provides novel evidence along these dimensions.

We use micro-aggregated panel data at the country-sector level for 15 European countries that we collected from administrative firm-level databases provided by European national statistical institutes and national banks.[1] Given their administrative nature, these databases are representative of the firm population and are free from selection biases or related issues that other publicly available European firm-level datasets face (e.g. ORBIS).

Using this data, we aggregate country-specific concentration indices to derive a European Herfindahl–Hirschman concentration index (HHI). We show that weighting country-level HHIs with squared revenue shares recovers precisely the aggregate HHI as if it were computed using a merged panel of European firms. Using our HHI aggregation, we document a 43% increase in European concentration between 2009 and 2016 that is predominantly driven by the manufacturing sector. The increase in European concentration is consistent with evidence for the United States documenting a rise in firm concentration over multiple decades (Gutiérrez and Philippon 2017; Rossi-Hansberg et al. 2021). Yet, differently from the U.S., where markups have strongly increased after 2008 (De Loecker, Eeckhout, and Unger 2020), European markups are low and have not increased since 2009.

We further use the aggregation properties of our concentration index to study how reallocation processes have affected aggregate concentration. We find that European concentration is rising due to an increase in sales shares of large and concentrated

1. Confidentiality restrictions prevent combining individual country databases at the firm-level. The data is published as part of the CompNet database. An older vintage of our database containing less detailed coverage for several countries (particularly Germany) has been used in Autor et al. (2020) and other studies.

industries. As a result, Germany has become increasingly dominant in shaping aggregate concentration patterns in past years.

As we combine individual country-level data, our concentration measures cannot account for multinational firm structures. We thus assign sales to local firms (legal units), not to headquarters of multinational companies. The preferred approach depends on the specific context. For instance, in our regression analysis described below, we explicitly want to assign sales to local firms. Yet, to provide a complete description of European concentration, we ideally want to compare concentration statistics that do and do not account for multinational firm activity.

To address this data limitation, we use additional data from the Worldscope database. Although Worldscope is not representative of the firm population, it contains complete information on consolidated firm accounts for the largest European firms. Combining Worldscope with national account data allows us to compute representative top firm concentration measures that account for multinational firm activity over 25 years. Using this data, we show that the rise in firm concentration we documented after 2009 from unconsolidated firm data is confirmed when accounting for multinational firm activity. Moreover, this long time series shows that concentration started to rise long before 2009, which is in line with U.S. evidence (Rossi-Hansberg et al. 2021).

Having established how European concentration evolved in the past decades, we ask how changes in concentration relate to changes in productivity and market power. This is our second contribution. We exploit within country-industry variation and find a strong positive association between concentration and productivity, whereas the connection between markups and concentration is statistically insignificant. These findings are consistent with models of heterogeneous firms selling differentiated goods (e.g. Melitz and Ottaviano 2008) and differ from U.S. evidence in Covarrubias, Gutiérrez, and Philippon (2020) documenting a negative (but statistically insignificant) association between concentration and productivity after 2000.

We further decompose changes in industry productivity into changes in the unweighted average productivity across firms and the covariance between firm size and productivity. Following Olley and Pakes (1996), this latter term captures changes in allocative efficiency. We show that changes in this allocative efficiency measure explain the entire association between changes in concentration and productivity. This connection between productivity, allocative efficiency, and concentration is highly robust to alternative concentration measures and holds for most European countries individually. It is also consistent with our results that (i) half of Europe's productivity growth between 2009 and 2016 results from an increase in allocative efficiency, (ii) markups did not increase in Europe after 2009, and (iii) rising European firm concentration is driven by a reallocation of sales shares toward more concentrated sectors.

Overall, our study provides strong support for a "winner-takes-all" mechanism driving rising concentration in Europe along with a more efficient market allocation. The remainder is structured as follows: Section 2 reviews the related literature. Section 3 presents the data. Section 4 derives our HHI aggregation method. Section 5 describes the evolution of European firm concentration. Section 6 studies the

connection between concentration, productivity, and allocative efficiency in Europe. Section 7 concludes.

2. Related Literature

Our study complements a large body of recent U.S. studies by providing European evidence on market concentration and its relation to market efficiency. Whereas most U.S. studies focus on a much longer time span over several decades using U.S. census or Compustat data, the European data availability limits our analysis to years after 2000, and, when defining a consistent starting year across all countries, to the post-2009 period.

Several studies have documented a rise in U.S. firm concentration over past decades that coincides with a fall of the labor share (Autor et al. 2020), a rise in firm profits (Grullon, Larkin, and Michaely 2019), and a fall in investment (Gutiérrez and Philippon 2017). Similarly, Hall (2018) and De Loecker, Eeckhout, and Unger (2020) document a rise in markups over the past decades in the United States, while Gutiérrez and Philippon (2017, 2018) and Gutiérrez, Jones, and Philippon (2019) argue that increased entry costs, lax antitrust enforcement, and lobbying caused a decline in U.S. market competition. Akcigit and Ates (2019, 2021) emphasize that a decrease in knowledge diffusion between leader and follower firms accounts for these secular trends, and Martin, Parenti, and Toubal (2020) highlight the role of corporate tax avoidance. Using data from 1990 to 2014, Rossi-Hansberg et al. (2021) show that rising concentration at the U.S. level is accompanied by a negative trend in concentration at a more disaggregated regional level. Crouzet and Eberly (2019) argue that investment in intangible assets of market leaders explains weak physical investment and rising concentration in the United States. They further show that markups and productivity are positively correlated with investment in intangible assets, whereas Ganapati (2021) reports a positive association between market concentration and productivity within U.S. industries. Covarrubias, Gutiérrez, and Philippon (2020) challenge his findings reporting negative associations between concentration and productivity after 2000.

In the European context, studies on market concentration are scarce, mostly because data limitations prevent researchers from combining administrative national data sources. Among the few European studies, Cavalleri et al. (2019) document flat concentration trends in Germany, France, Spain, and Italy since 2006 using ORBIS data. Similarly, Gutiérrez and Philippon (2018) argue that product market (de)regulations and strict antitrust enforcement created a highly competitive market environment in Europe and report flat concentration trends at the European level since 2000 using ORBIS and Compustat data. In contrast, Bajgar et al. (2019) report a steady increase in concentration in Europe since 2000 based on Multiprod data from the OECD.[2]

2. There are also studies on changes in markups in Europe. Using Worldscope data, Diez, Leigh, and Tambunlertchai (2018) and De Loecker and Eeckhout (2021) report an increase in markups between 1980 and 2016, whereas Weche and Wambach (2021) report a stable trend in markups between 2007 and 2015.

Relative to this research strand, our study makes the following contributions: First, we eschew the selection biases and cross-country comparability issues associated with ORBIS and Compustat data. Second, our decomposition allows us to evaluate the relative importance of individual countries and sectors in shaping European firm concentration. Third, we analyze the link between those concentration trends on the one hand; and changes in productivity, market power, and allocative efficiency on the other hand; finding that higher firm concentration is associated with a more efficient market environment in Europe.

Finally, our study relates to earlier discussions on whether rising concentration reflects higher market power or a more efficient market environment, dating back at least to Bain (1951). This includes work by Demsetz (1973), Martin (1988), and Clarke, Davies, and Waterson (1984). Schmalensee (1987) provides a review of this prior debate.

3. Data

We use the Competitiveness Research Network dataset (henceforth, CompNet), which contains micro-aggregated firm-level-based information at the industry-country level for 19 European countries. We built this dataset from harmonized data collection protocols, executed by European national statistical institutes and national banks on their administrative *firm-level* data. Our data collection protocols calculate firm and market performance measures, aggregated at the two-digit industry, sector, and regional levels. This includes, among others, concentration indices, labor and total factor productivity, markups, and various firm input, output, and investment information. The data covers the years 1999–2017 and the NACE rev. 2 industries 10–33 (manufacturing), 41–43 (construction), 45–47 (wholesale/retail trade and repair of motor vehicles and motorcycles), 49–53 (transportation/storage), 55–56 (accommodation/food services), 58–63 (ICT), 68 (real estate), 69–75 (professional/scientific/technical activities), and 77–82 (administrative/support service activities). Time and sector coverage differ between countries. We discuss how we define a consistent set of years and sectors for our analysis below.

Although our data is aggregated at the industry-country-year level, it contains various moments of the firm-level distributions (means, percentiles, and standard deviations). This allows us to analyze firm heterogeneity within those aggregation levels and is key to our analysis of allocative efficiency in Section 6. To ensure that the data is representative and comparable across countries, variables are weighted by firm population weights and deflated by PPP-adjusted deflators in the case of monetary variables.[3] The dataset comes in two versions. One contains firms with at least 20

3. For details on the weighting and deflation procedures, we refer to CompNet's User-Guide (CompNet 2020). For our concentration measures, we, however, rely on non-population weighted measures as the population weighted HHIs are often missing in the data (this is a result of country-specific disclosure rules). We compare population weighted and non-population weighted HHIs for a subset of countries and industries in Online Appendix C.2 and find that they are highly correlated and follow an identical trend.

employees (20e sample) and the other features firms with at least one employee. We focus on the 20e sample as it is available for more countries.[4]

Due to its richness and because combining administrative firm data from multiple European countries is impossible, CompNet offers a unique opportunity to conduct cross-country research on distributional measures across European firms. This makes CompNet perfectly suited for studying European firm concentration.

Table 1 provides an overview of the subset of countries and sectors we study (some countries and sectors lack the required information to be included). Our final dataset is a balanced set of countries and sectors for 2009–2016. We refer to these years, countries, and sectors as the "balanced sample". We use the balanced sample in our aggregation and decomposition exercises where we require a comparable set of sector-country pairs across time. We widen the set of years for specific analyses where a balanced set is not required (Section 6.2). We test the importance of omitted sectors in Section 5.1.3 and Online Appendix K, finding similar results.

Panel A shows coverage information for the firm-level data underlying CompNet using all available years for each country. Panel B displays statistics on our balanced-panel sectors using the first and last years for which all countries report (2009 and 2016). Table 1 highlights the high coverage of the raw data underlying our results by comparing it with the population of firms with at least 20 employees from Eurostat.[5] As Table 1 shows, the data underlying CompNet covers a large share of active firms in most countries and sectors. In several countries, our data covers the entire firm population; in others, the firm-level datasets underlying CompNet are stratified samples that are representative of the firm population and comparable over time.[6]

When comparing CompNet with other data sources, one can view CompNet as an aggregation of a collection of representative firm datasets. These are comparable to the census data for the U.S., but with (i) a detailed yearly data collection on firms' outputs and inputs also outside of manufacturing and (ii) not containing the full population of firms for every country. The closest publicly available alternative data source to CompNet is the ORBIS data, which, although being a firm-level database, suffers from two key drawbacks: First, as reporting to the ORBIS database is not mandatory

4. Country concentration indices for the full firm data and the data containing only firms with at least 20 employees are extremely similar (see Online Appendix C.3).

5. Eurostat is the statistical office of the European Union and provides aggregated data for all European Union countries and several other countries. The data sources of Eurostat are the national statistical institutes.

6. The country datasets do not always cover the entire firm population and sometimes miss certain sectors because data collection schemes differ between countries. Direct access to business registries was often not possible and because CompNet statistics require information on various firm inputs, the CompNet data collection focused on the structural business statistics or similar datasets. These statistics, if not covering the full population, are based on highly representative stratified sample data that is comparable over time and always include the largest firms of the economy. Particularly in Germany, these types of statistics are not available for research purposes for all sectors (e.g. wholesale/retail trade). That is why we exclude several sectors to have a comparable set of countries and sectors. As this leads to an overrepresentation of the remaining sectors, we test for the importance of omitted sectors in Section 5.1.3 and Online Appendix K. Our results hold when including the omitted sectors.

TABLE 1. Country and sector coverage.

Country	Years (1)	Number firms first year CompNet (2)	Number firms last year CompNet (3)	Population number firms first year (4)	Population number firms last year (5)
Panel A: Country coverage					
Belgium	2003–2017	4,462	7,129	8,092	8,873
Czech Republic	2005–2017	7,480	6,825	11,848	12,808
Finland	1999–2017	3,937	5,730	3,940	5,735
France	2004–2016	45,497	44,872	45,598	44,862
Germany[a]	2003–2016	D	D	70,103	104,288
Italy	2006–2016	38,127	40,563	48,866	46,493
Lithuania	2000–2016	2,537	3,531	2,539	3,550
Netherlands[b]	2007–2017	10,875	13,013	10,884	13,022
Poland	2005–2017	14,026	18,345	20,095	24,492
Portugal	2004–2017	11,006	10,531	11,033	10,561
Romania[b]	2005–2016	13,727	13,328	14,185	14,284
Slovakia	2000–2017	1,652	4,360	3,960	4,621
Spain	2008–2017	13,198	16,205	40,136	34,234
Sweden	2008–2016	8,533	8,894	8,861	10,061
Switzerland	2009–2017	4,296	4,089	8,922	10,337
Total	2009–2016	191,711	195,142	323,550	344,623

Sector	Number firms 2009 CompNet (1)	Number firms 2016 CompNet (2)	Population number firms 2009 (3)	Population number firms 2016 (4)
Panel B: Sector coverage (balanced sample)				
Manufacturing	107,850	101,129	170,719	161,915
Transportation and storage	23,679	26,063	41,780	48,399
ICT	13,641	15,684	22,505	26,890
Real estate	4,114	4,250	6,966	7,528
Professional activities	19,877	21,904	37,067	45,196
Administrative and service	22,550	26,112	44,513	54,695
Total	191,711	195,142	323,550	344,623

Note: Table 1 shows firm coverage information for the firm-level data underlying the CompNet data. Panel A displays country-level statistics using the first and last year of observation for each country. Panel B shows statistics for each sector using the balanced set of countries and sectors from 2009 to 2016. CompNet data, excluding the sectors "wholesale/retail trade and repair of motor vehicles and motorcycles", "construction", and "accommodation and food service activities".

a. Germany does not disclose sample number information for confidentiality reasons.

b. There is no information for the real estate sector for the Netherlands and Romania available.

for firms (contrary to CompNet), the ORBIS data is not representative. Second, as shown by Bajgar et al. (2020), ORBIS is unsuitable for cross-country comparisons and for analyzing firm distributions, due to not being based on a comprehensive stratified sampling method and its severe changes in the number of firms covered over time (see Online Appendix B.1). When measuring market concentration, this is particularly

problematic as changes in the firm composition affect measured concentration indices.[7] We further discuss the CompNet data and its underlying sources in Online Appendix A.1. Online Appendix B discusses alternative European data sources.

4. Deriving a European HHI from Country-Level Datasets

We measure concentration using the HHI of firm sales at different aggregation levels. We use the HHI because it can be consistently decomposed and aggregated across any partitions, such as countries and sectors. In addition, the HHI captures concentration across the entire distribution of firms, whereas sales shares of the largest firms focus on market concentration in a few selected firms. Yet, both concentration measures are highly correlated (see Online Appendix C.1).

We construct a European HHI from independently derived country HHIs. This can be achieved using the following decomposition property of the HHI. Consider that firms are partitioned into two groups according to an index $i \in \{A, B\}$. Let $r_A = \sum_{i \in A} r_i$ and $r_B = \sum_{i \in B} r_i$ denote aggregate group sales, where r_i denotes firm sales. The aggregate HHI can be written in terms of the HHI for each group:

$$\begin{aligned} HHI &= \sum_i \left(\frac{r_i}{r^A + r^B} \right)^2 = \sum_{i \in A} \frac{r_i^2}{\left(r^A + r^B\right)^2} + \sum_{i \in B} \frac{r_i^2}{\left(r^A + r^B\right)^2} \\ &= \left(\frac{r^A}{r^A + r^B} \right)^2 \sum_{i \in A} \left(\frac{r_i}{r^A} \right)^2 + \left(\frac{r^B}{r^A + r^B} \right)^2 \sum_{i \in B} \left(\frac{r_i}{r^B} \right)^2 \\ &= \left(\frac{r^A}{r^A + r^B} \right)^2 HHI^A + \left(\frac{r^B}{r^A + r^B} \right)^2 HHI^B. \end{aligned} \tag{1}$$

This decomposition can be extended to an arbitrary number of groups representing any partition of firms. Thus, we can use it to recover the exact pan-European HHI using information on countries' HHIs and sales shares (as reported in CompNet). This aggregation also shows how the contribution of large countries to European concentration is magnified as the output share weights on the countries' HHIs are squared. Throughout the remainder of this study, we report all HHIs multiplied by 100.

Our European concentration index incorporates intra-European trade flows but does not capture the impact of external trade flows to Europe. Whether one should account for imports when defining concentration measures depends on the question of interest. For instance, if researchers use HHIs to measure product market power, the relevant HHIs are a function of firms active in the relevant consumer market. For some products, this includes domestic and foreign firms (Smitkova 2021). For other products,

7. Another multi-country data source is Multiprod, which cannot be accessed outside the OECD.

this is limited to narrow local product markets (Benkard, Yurukoglu, and Zhang 2021). In our study, we do not seek to make a direct connection between HHIs and market power. Instead, we use the HHI as a measure of the shape of the firm-sales distribution, which reflects, among others, differences in production technologies across firms. We then study how this statistic of the firm distribution relates to market outcomes.[8] In our main econometric analysis in Section 6, we analyze how changes in HHIs relate to changes in productivity and market power within narrow country-industry-cells.

Finally, note that our approach treats multinational firms as independent production entities and assigns sales to local firms instead of allocating them to headquarters of multinational companies. Both approaches have their pros and cons. For instance, when studying how industry-level productivity relates to industry-level concentration (Section 6), we explicitly want to assign sales to local firms as this better reflects the sales distribution within an industry. Nevertheless, to provide a complete picture of European concentration, we ideally want to study both concentration metrics. Therefore, in Section 5.2, we combine consolidated firm data from Worldscope with national account data to derive top firm concentration measures. Using these measures, we find a similar increase in concentration as with our baseline HHI measure, suggesting that concentration *trends* are not strongly affected by ignoring multinational firm activity.

5. Firm Concentration in Europe

This section presents evidence on European firm concentration. We also show that (i) markups are low and stable in Europe, (ii) rising European concentration results from reallocation processes between country-sector pairs, and (iii) the German manufacturing sector accounts for most of the European concentration level. Because we focus on a reduced set of sectors, Online Appendix K replicates key results, including all available sectors, yielding qualitatively similar results.

5.1. European Firm Concentration

5.1.1. Aggregate Results. Figure 1 presents the evolution of firm concentration in Europe since 2009 using our HHI aggregation. We find a steady increase in concentration over those years. Aggregate concentration (left axis), as measured by the HHI, rose by 43%. When separating manufacturing and non-manufacturing, we find that manufacturing sector concentration doubled, while concentration outside of manufacturing declined by 30%. Although a general increase in European concentration is consistent with U.S. findings over multiple decades, the key role of manufacturing, with other sectors showing declining concentration, differs from U.S.

8. Another extreme example is when researchers use firm concentration to measure monopsony power. Here, only firms in the relevant local labor market should enter the computation of HHIs.

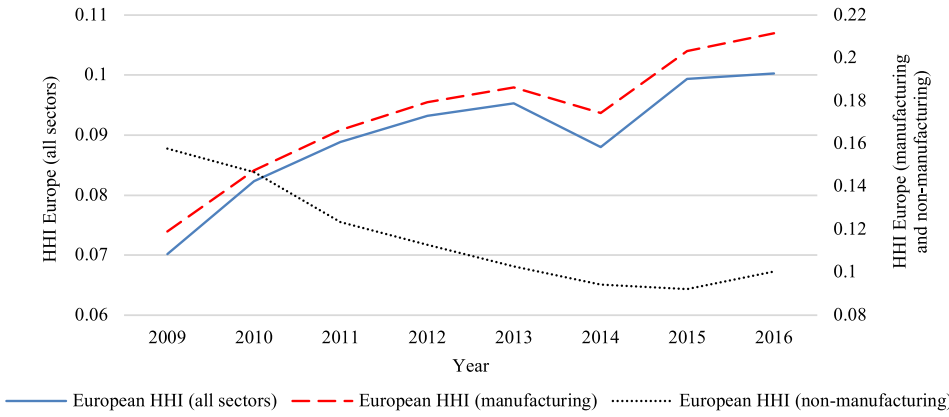

FIGURE 1. European firm concentration. The blue solid, red slashed, and black dotted lines show the European Herfindahl–Hirschman index for all sectors, the manufacturing sector and non-manufacturing sectors. Balanced sample of countries and sectors from 2009 to 2016. CompNet dataset.

evidence (e.g. Rossi-Hansberg, Sarte, and Trachter 2021). As shown in Section 5.1.3, this results from a decline in Europe's ICT sector concentration.

Table 2 reports country-specific changes in concentration and markups. Periods vary by country to display the largest possible time spans. To recover firm markups, we follow the production function approach of De Loecker and Warzynski (2012) (see Online Appendix D) using a gross output production function.[9] Our CompNet data directly includes these markup estimates at the industry, sector, and country levels as cost- and sales-weighted aggregates. To derive markups in Table 2, we start from sector-level cost-weighted markups and aggregate them to the country level using sector cost-weights. This ensures a harmonized set of sectors across countries. We focus on cost-weighted markups as these recover the true aggregate markup under standard preferences (Edmond, Midrigan, and Xu 2018). The average HHI and markup in Table 2 refer to the average aggregate values of these variables over the country-specific and European time spans. The Δ operator indicates changes between the first and last year of observation. Columns (3) and (6) report linear trends for HHIs and markups. Online Appendix G.2 provides a graphical illustration of the time series of markups and firm concentration by country.

Concentration levels and changes strongly vary across countries. This reflects differences in industry and market structure and market size. Although European firm concentration increased, 10 out of 15 countries displayed a decrease in concentration. Coinciding with the large change in European concentration, the aggregate product

9. We assume that intermediates are flexible inputs and that intermediate input prices are exogenous to firms. Therefore, our markup measures reflect "product market power". For studies separating product and input market power, see Mertens (2020a, b, 2022) and Morlacco (2019).

TABLE 2. Aggregate concentration and markups, country-level.

Country	Average HHI (1)	ΔHHI (2)	Trend HHI (3)	Average markup (4)	Δmarkup (5)	Trend markup (6)
Belgium (2003–2017)	0.45	–0.03	–0.003	1.14	0.04	0.003
Czech Republic (2005–2017)	0.80	0.37	0.033	1.14	0.08	0.006
Finland (1999–2017)	0.73	–0.35	–0.011	1.09	0.05	0.002
France (2004–2016)	0.20	0.09	0.005	1.32	0.07	0.002
Germany (2003–2016)	0.62	0.05	0.005	1.10	0.04	0.002
Italy (2006–2016)	0.13	0.02	–0.001	1.47	0.05	0.004
Lithuania (2000–2016)	0.54	–0.35	–0.023	1.12	0.06	0.001
Netherlands (2007–2017)[a]	0.78	–1.10	–0.070	1.11	0.01	0.002
Poland (2005–2017)	0.16	–0.11	–0.010	1.17	0.03	0.002
Portugal (2004–2017)[b]	0.36	–0.02	0.002	1.21	–0.01	–0.001
Romania (2005–2016)	0.40	–0.36	–0.033	1.12	0.01	0.002
Slovakia (2000–2017)	2.50	–1.34	–0.098	1.12	0.06	0.001
Spain (2008–2017)	0.56	–0.26	–0.038	1.25	0.00	0.002
Sweden (2008–2016)	0.57	–0.13	–0.021	1.24	–0.03	–0.007
Switzerland (2009–2017)	1.21	0.26	0.019	1.23	–0.02	–0.002
Europe (2009–2016)	0.09	0.03	0.004	1.18	0.01	0.001

Notes: Table 2 shows aggregate HHIs and markups for all countries in our sample. Concentration indices are aggregated from our set of sectors as described in Section 4. Markups are calculated following De Loecker and Warzynski (2012) and using gross output production function estimates based on OLS. Markups are derived from the first-order condition for intermediate inputs and aggregated using intermediate input cost weights. Averages (columns (1) and (4)) reflect the average of country-level aggregates over the entire time span. Δ indicates changes between the first and last year for each country (columns (2) and (5)). Columns (3) and (6) show linear trends. CompNet data.

a. Markup data for the Netherlands ends in 2016.

b. Markup data for Portugal starts in 2010.

markup increased by only one percentage point and displays a stable trend.[10] Changes in markups are small (but often positive) and systematically unrelated to changes in concentration. Markup levels differ across countries, from a high of 1.47 for Italy and 1.32 for France to a low of 1.09 for Finland and 1.10 for Germany.[11]

Our markup estimates and their changes for Europe are *much lower* than the evidence reported by De Loecker, Eeckhout, and Unger (2020) for the U.S. and De Loecker and Eeckhout (2021) for Europe. Both studies report a severe increase in

10. Online Appendix D.4 conducts a decomposition of the aggregate markup into the unweighted mean markup and the covariance between firms' markups and market shares. The small change in the European markup is mostly driven by the covariance term.

11. De Loecker et al. (2020) note that one cannot directly use these aggregate markups to recover aggregate profit rates using the *firm-level* identity $\pi_{it} = 1 - (1/\mu_{it})$, where π_{it} is the profit rate and μ_{it} is the markup. This is because (i) this equation assumes an average to marginal cost ratio of one and (ii) firms are heterogenous in terms of size, markups, and costs. To recover an aggregate profit rate, one would need to estimate the firm-level relationship between average and marginal costs and account for firm heterogeneity when aggregating. We cannot do this with our data, but De Loecker et al. (2020) showed that an aggregate markup of 1.61 is consistent with a profit rate of 8% for the U.S.

markups over the last four decades with a strong increase after 2008. Using Worldscope data, De Loecker and Eeckhout (2021) report an increase in the European aggregate markup from 2009 to 2016 from 1.40 to 1.60, and their individual country estimates for markups in 2016 lie far above our estimates (e.g. 2.54, 1.51, and 1.35 for Italy, France, and Germany, respectively).

We do not believe that our findings necessarily contradict results from De Loecker and Eeckhout (2021), as they rely on a restricted set of public firms. We base our results on the most representative European firm data available and also include private companies. Moreover, as De Loecker and Eeckhout (2021, p. 6) note, they use a markup measure that combines labor market imperfections and product markups. Hence, their estimates do not necessarily only capture product markups (as we do) but also firms' monopsony power and labor adjustment costs, potentially explaining differences to our estimates (Online Appendix D.2 provides further details).

Finally, we emphasize that neither we nor De Loecker and Eeckhout (2021) can report fully unbiased markup estimates. To recover truly unbiased markups, one would need to observe firm-specific price information (Bond et al. 2021; De Loecker et al. 2016). Yet, it is virtually impossible to collect economy-wide firm-specific price data for 15 (or more) countries in Europe. We emphasize that one should have this caveat in mind when interpreting markup estimates.

Nevertheless, to test for potential biases in markup estimates, we use German firm-product-level data for the manufacturing sector that we can directly access and in which we observe firm-specific output price information. The latter allows us to control for firm price variation. Online Appendix D.3 compares markups derived from this data with German manufacturing markups in CompNet, showing only small differences between both estimates. In particular, changes in markups are almost identical. Although this (i) does not provide a full test of the markup estimates in CompNet, (ii) still relies on other usually made assumptions when estimating production functions, and (iii) might be a specific result of the German manufacturing sector, where firm price variation might be relatively small, we are confident that, given the European data restrictions, we stick to the best possible approach, which is to estimate markups from a harmonized data collection protocol executed across representative European firm-level databases.

To summarize, the two take-away-messages from Table 2 are as follow: First, judging from our markup estimates, European markets have not experienced a rise in product market power in past years. Second, as firm concentration falls in 10 out of the 15 countries, the increase in European firm concentration must be driven by a few countries and/or reallocation processes between countries.[12]

12. A concern is whether the documented rise in European concentration is part of a long-run trend or whether it reflects a recovery after the great financial crisis. As long time series of firm-level data are not available for almost all countries, we address this question by using (i) additional data on consolidated firm accounts for the largest European firms from Worldscope covering several decades (Section 5.2) and (ii) highly representative firm-level data for Germany covering the years 2003 (1995 for manufacturing) to 2017 (Online Appendix I). Both databases show a positive long-run trend in firm concentration starting

5.1.2. Decomposition of Changes in Concentration. We can decompose the aggregate change of the HHI into changes within and between countries and sectors using a decomposition approach similar to Olley and Pakes (1996). Letting the square of country n's output share, $s_{nt} \equiv \left(r_{nt} / \sum_{i=1}^{T} r_{it}\right)^2$, be the weight of country n's concentration index, HHI_{nt}, the European concentration index, HHI_t, can be decomposed as

$$\begin{aligned} HHI_t &= \sum_{n=1}^{N} HHI_{nt} * s_{nt} \\ &= \sum_{n=1}^{N} \left(HHI_{nt} + \overline{HHI} - \overline{HHI}\right)\left(s_{nt} + \bar{s} - \bar{s}\right) \\ &= N * \bar{s} * \overline{HHI} + cov\left(HHI_{nt}, s_{nt}\right), \end{aligned} \tag{2}$$

where variables with a bar indicate mean values. The first term in equation (2) captures changes in the aggregate HHI due to changes in average HHIs within countries. It is rescaled by the sum of countries' average squared output shares. We interpret this first term as the "within-country change" in European concentration.[13] The second term measures the covariance between countries' squared revenue shares and HHIs. Changes in cov(HHI_{nt},s_{nt}) reflect changes in aggregate concentration due to changes in market shares between differently concentrated countries.

We apply this decomposition to the country and sector level. We expect that if a winner-takes-all mechanism drives rising concentration (i.e. if rising concentration reflects an efficient market outcome), increasing concentration should be associated with an increasing covariance term. This would reflect that market size is an important driver of concentration. Such a mechanism is also present in standard models with heterogeneous-productivity firms (e.g. Melitz 2003), where an increase in firms' market size causes an efficiency-enhancing reallocation of economic activity toward the most productive (and largest) producers leading to higher firm concentration.

Table 3 shows that increasing covariance terms explain the entire change in European firm concentration. Although more concentrated countries and sectors are on average smaller (negative covariance), these sectors gain increasingly large market shares, which drives the increase in European concentration. This explains why concentration is rising in the aggregate while declining in many countries (Table 2).

well before the financial crisis. Notably, Section 5.1.3 also shows that Germany accounts for most of the level and changes in European firm concentration. The German data is thus highly informative on patterns of European firm concentration. Consistent with that, if we exclude Germany, the European HHI *decreases* (see Online Appendix G.1).

13. One can decompose equation (2) further into $\overline{HHI} + \overline{HHI}(N\bar{s} - 1) + \text{cov}(HHI_{nt}, s_{nt})$. As the sum of squared market shares converges to unity, $\overline{HHI}(N\bar{s} - 1)$ converges to zero and our decomposition becomes identical to a classical Olley and Pakes (1996) decomposition. The term $\overline{HHI}(N\bar{s} - 1)$ scales $\overline{HHI}$ to the level of the aggregate HHI. In Online Appendix G.3, we decompose the aggregate HHI into these three components and again find that the covariance term drives most of the change in the European HHI.

TABLE 3. HHI-decomposition, within vs. between country and sector changes.

		Country decomposition		Sector decomposition	
Year	Aggregate HHI (1)	Within (2)	Between (3)	Within (4)	Between (5)
2009	0.070	0.096	–0.026	0.164	–0.094
2010	0.082	0.106	–0.024	0.160	–0.078
2011	0.089	0.105	–0.017	0.150	–0.061
2012	0.093	0.107	–0.014	0.152	–0.059
2013	0.095	0.102	–0.007	0.162	–0.067
2014	0.088	0.104	–0.016	0.157	–0.069
2015	0.099	0.100	–0.001	0.144	–0.044
2016	0.100	0.098	0.002	0.154	–0.053
Percentage contribution 2009–2016	42.87%	3.53%	39.34%	–15.07%	57.94%

Notes: Table 3 shows the HHI decomposition from equation (2) at the country (columns (2) and (3)) and sector (columns (4) and (5)) level. Column (1) shows the level of the European HHI. Columns (2–3) and (4–5) show levels of the within ($N * \bar{s} * \overline{HHI}$) and between ($\text{cov}(HHI_{nt}, s_{nt})$) components that sum-up to the aggregate HHI. The last row shows the percentage change of the aggregate HHI in column (1) over the entire time span (2009–2016). Columns (2–5) of the last row display the percentage point contribution of the within and between terms to the entire change in the HHI. Balanced samples of countries and sectors. CompNet Dataset.

Our results are consistent with the notion that changes in the market size of large and efficient producers drive changes in European concentration. We explore this in further detail in Section 6 and uncover a strong and robust association between concentration, aggregate productivity, and productivity-enhancing reallocation processes within industries.

5.1.3. The Role of Large Countries and Sectors. As our HHI aggregation is based on a weighted sum, we can separate the contribution of individual countries and sectors to European firm concentration by calculating the shares of countries and sectors in the total HHI. Using this decomposition, Table 4 shows the contribution of individual countries to the European concentration index. The picture is striking. Germany accounts for 69% (84%) of the European HHI in 2009 (2016).

The large contribution of Germany can be a result of two factors: Germany being highly concentrated and/or Germany accounting for a large sales share in Europe. Table 4 displays both components. Although the German HHI was neither particularly large nor small in 2009, Germany became one of the more concentrated countries in 2016.

What is more striking is the huge revenue share of the German economy. In 2009 (2016), Germany accounted for 32% (34%) of all sales in Europe. As these revenue shares enter the HHI with a square, they drive most of the large contribution of Germany. This can be directly calculated from Table 4: A country's HHI contribution equals its HHI times its squared revenue share in the sum of all countries' HHIs times their squared revenue shares. Even if we assume counterfactually equal HHIs across countries, the variation in sales shares alone would imply a German contribution of

TABLE 4. Country contribution to the European HHI, 2009–2016.

Country	HHI contribution 2009 (in %) (1)	HHI contribution 2016 (in %) (2)	HHI 2009 (3)	HHI 2016 (4)	Revenue share 2009 (in %) (5)	Revenue share 2016 (in %) (6)
Belgium	0.71	0.57	0.37	0.45	3.66	3.57
Czech Republic	1.15	1.63	0.57	0.99	3.76	4.07
Finland	0.31	0.10	0.95	0.54	1.52	1.38
France	5.24	3.79	0.19	0.23	13.75	12.85
Germany	69.05	84.12	0.47	0.71	31.99	34.47
Italy	4.04	1.27	0.18	0.11	12.42	10.79
Lithuania	0.01	0.01	0.50	0.31	0.36	0.49
Netherlands	2.34	1.03	0.77	0.50	4.63	4.55
Poland	0.79	0.54	0.16	0.11	5.83	6.90
Portugal	0.12	0.07	0.34	0.32	1.59	1.46
Romania	0.25	0.08	0.49	0.18	1.90	2.08
Slovakia	0.37	0.54	1.29	2.09	1.41	1.61
Spain	12.70	3.94	0.76	0.49	10.87	9.01
Sweden	0.80	0.42	0.68	0.56	2.89	2.74
Switzerland	2.10	1.89	1.26	1.17	3.42	4.03
Europe	100	100	0.07	0.10	100	100

Notes: Table 4 shows the contribution of each country to the European HHI, measured by the percentage share of the European HHI that is accounted for by each country. Columns (1) and (2) show the HHI contribution by country for 2009 and 2016. Columns (3–6) display country HHIs and revenue shares in total European revenue for 2009 and 2016. Balanced samples of countries and sectors 2009–2016. CompNet dataset.

more than 70% in 2016. Hence, the large German contribution results from the high sales shares of German firms, and the increasing European HHI is driven by Germany's increasing market share and national HHI.

Table 5 performs the same decomposition at the sector level. It shows that manufacturing, a large sector in Germany, contributes the most to the European HHI. Note that the ICT sector shows a strong decline in concentration, which drives the patterns of the European non-manufacturing HHI in Figure 1. The decline in ICT-sector concentration is a widespread phenomenon across many European countries, which is consistent with a strong increase in the number of firms within European ICT sectors in the past decades (Rossetti 2017).[14]

Taking this decomposition to the country-sector level (Online Appendix G.4), we find that, on average, 75% of European firm concentration is explained by the German manufacturing sector alone (followed by the Spanish (2.8%) and German (2.7%) ICT sectors). The German manufacturing sector also experienced the largest gain in its HHI contribution, whereas ICT sectors displayed a strong decline in their HHI contribution in many countries, resulting from the decrease in firm concentration within ICT sectors.

14. We also find a long-run decrease in ICT sector concentration from 1995 to 2016 using consolidated firm data from Worldscope (see Online Appendix G.4).

TABLE 5. Sector contribution to the European HHI 2009–2016.

Sector	HHI contribution 2009 (in %) (1)	HHI contribution 2016 (in %) (2)	HHI 2009 (3)	HHI 2016 (4)	Revenue share 2009 (in %) (5)	Revenue share 2016 (in %) (6)
Manufacturing	74.28	87.26	0.12	0.21	66.17	64.32
Transportation and storage	6.37	5.03	0.42	0.38	10.35	11.54
Information and communication	18.15	6.55	1.04	0.70	11.07	9.66
Real estate	0.09	0.12	0.27	0.54	1.55	1.49
Professional, scientific, and technical activities	0.46	0.41	0.10	0.10	5.56	6.42
Administrative and support service activities	0.66	0.63	0.16	0.15	5.31	6.59
Europe	100	100	0.07	0.10	100	100

Notes: Table 5 shows the contribution of each sector of our sample of sectors to the European HHI measured by the percentage share of the European HHI that is accounted for by each sector. Columns (1–2) show the HHI contribution by sector for 2009 and 2016. Columns (3–6) display sector HHIs and revenue shares in total European revenue for 2009 and 2016. Balanced samples of countries and sectors 2009–2016. CompNet dataset.

A natural concern is that we may overestimate Germany's contribution due to excluding sectors where other countries have particularly large firms.[15] We assess the scope of this issue using aggregated data from Eurostat. Individual countries account for a large part of the European HHI either because of its being highly concentrated or because of their large sales shares. We can thus use data on country sales shares and counterfactual assumptions on countries' HHIs to recalculate the contribution of individual countries to the European HHI.

We report this exercise in Table 6. Columns (1–3) display country's output shares for 2016. Column (1) is based on the CompNet data and focuses only on our selected set of sectors. Columns (2) and 3 use official data from Eurostat for all firms and report output shares once for the sectors we study and once for the entire economy. Note that Eurostat includes all firms, whereas our data is based on firms with at least 20 employees. Although the Eurostat data implies a slightly lower output share for Germany, our CompNet data reproduces the relative country sizes well. Column (3) shows that including the sectors we omitted from our analysis does not fundamentally change countries' output shares. Column (4) reports the HHI of each country from the

15. Whereas Germany has large manufacturing companies (e.g. Volkswagen), other countries might have particularly large firms in other sectors, like wholesale/retail trade, which is a large sector in Europe. However, Germany contains also most of the largest European retailers, for example, Schwarz Group, Aldi Einkauf GmbH & Co. oHG, Edeka Group, and Rewe Combine, which ranked #1, #2, #5, and #6 among the largest retailers in Europe in 2019, respectively (Veraart Research Group BV 2021).

TABLE 6. Counterfactual estimates of country contribution to the European HHI, 2016.

	Sales share CompNet vs. Eurostat			HHI	Counterfactual HHI contributions (in %)			
Country	Sales share CompNet, sample sectors (20e sample) (1)	Sales share Eurostat, sample sectors (all firms) (2)	Sales share Eurostat, entire economy (all firms) (3)	HHI CompNet, sample sectors (4)	HHI contribution, baseline (5)	Eurostat sales shares, sample sectors (6)	Eurostat sales shares, entire economy (7)	Column (8) + increasing the HHI of all countries but Germany by 50% (8)
Belgium	3.57	4.23	4.76	0.45	0.57	0.91	1.33	1.72
Czech Republic	4.07	2.19	1.94	0.99	1.63	0.54	0.49	0.63
Finland	1.38	1.87	1.70	0.54	0.10	0.21	0.20	0.26
France	12.85	16.44	17.03	0.23	3.79	7.00	8.69	11.24
Germany	34.47	31.40	27.11	0.71	84.12	78.88	67.99	58.61
Italy	10.79	13.06	12.55	0.11	1.27	2.11	2.26	2.92
Lithuania	0.49	0.32	0.35	0.31	0.01	0.00	0.00	0.01
Netherlands	4.55	6.13	6.65	0.50	1.03	2.12	2.88	3.73
Poland	6.90	4.08	4.12	0.11	0.54	0.21	0.24	0.31
Portugal	1.46	1.32	1.43	0.32	0.07	0.06	0.09	0.11
Romania	2.08	1.12	1.20	0.18	0.08	0.03	0.03	0.04
Slovakia	1.61	1.00	0.83	2.09	0.54	0.24	0.19	0.24
Spain	9.01	7.86	8.36	0.49	3.94	3.41	4.46	5.77
Sweden	2.74	3.99	3.82	0.56	0.42	1.00	1.06	1.38
Switzerland	4.03	4.99	8.13	1.17	1.89	3.28	10.08	13.03

Notes: Table 6 presents counterfactual estimates of the country contribution to the European HHI. Columns (1–3) show different ways of calculating country sales shares in total European sales. Columns (1), (2), and (3), respectively use (i) the CompNet data and our selected set of sectors, (ii) Eurostat data based on our selected set of sectors, and (iii) Eurostat data based on all sectors to construct sales weights. Column (4) shows the country-level HHIs based on the CompNet data and our selected set of countries. Columns (5–8) show our baseline measures of the country contribution and subsequently alternative ways of measuring the country contribution based on (i) Eurostat sales shares for the sample sectors and our baseline HHIs (column (6)), (ii) Eurostat sales shares for all sectors and our baseline HHIs (column (7)), and (iii) Eurostat sales shares for all sectors and a counterfactual HHI distribution where we increase the HHI for each country except Germany by 50% (column (8)). Eurostat data is based on all firms, whereas CompNet data is based on firms with at least 20 employees. Eurostat structural business statistics and CompNet.

CompNet data based on our chosen set of sectors for 2016. Columns (5–8) compare our baseline HHI contribution with counterfactual estimates.

The findings are reassuring. Although using Eurostat weights reduces the importance of Germany, Germany still accounts for more than 75% of the European HHI level (column (6)). Even when considering output weights based on all sectors, Germany's contribution is still 68% (column (7)). In column (8), we go one step further and increase the HHI of each country except Germany by 50%. This accounts for potential mismeasurements in the HHIs, for instance, due to omitting sectors. We view increasing the HHIs by 50% as an upper-bound counterfactual. It illustrates that even under huge measurement errors in the HHIs, Germany would still account for most of the European HHI level.

5.2. Robustness: Extending the Time Span and Accounting for Multinational Firm Groups

CompNet offers rich information for studying concentration and productivity in Europe. Yet, it cannot account for multinational corporate groups and features only a short time period. Although this does not affect our regression analysis in Section 6 and might be preferable for some analyses, it raises two questions: First, are concentration trends based on assigning sales to multinational firm groups different from our approach that assigns sales to legal units of firms? Second, do aggregate concentration patterns simply reflect recovery dynamics after the financial crisis instead of a long-run trend?

We use two additional datasets spanning several decades from Worldscope and the German Statistical Offices to address these questions. Online Appendix A.2 describes both datasets. First, we use Worldscope to calculate European concentration measures based on consolidated firm accounts for our 15 countries (using all sectors). Although Worldscope covers only a few firms, it is representative of the largest public firms. By combining Worldscope with representative population totals (Eurostat), we can thus define representative concentration measures as the sum of sales of the four (five) largest European companies in total European sales, where total European sales are taken from national account data.[16] We start our time series in 1995 because national account data is only available from 1995. Figure 2 shows the results. According to both measures, firm concentration increased by 45% between 1995 and 2019. Concentration strongly increased after the crisis, yet the recent rise in European firm concentration is part of a positive long-run trend starting well before the financial crisis. The documented rise in European concentration is thus (i) not sensitive to how we allocate sales across firms within multinational companies and (ii) part of a long-run trend starting well before the financial crisis.

As a second validation exercise, we use highly representative administrative firm-level panel data for Germany from 2003 (for manufacturing, from 1995) to 2017 to

16. We confirmed that the largest firms in Worldscope are indeed the largest firms in Europe using Fortune 500 data (Fortune Media IP Limited 2021), which includes public and non-public firms. Our top firm concentration measures based on Worldscope are thus perfectly representative.

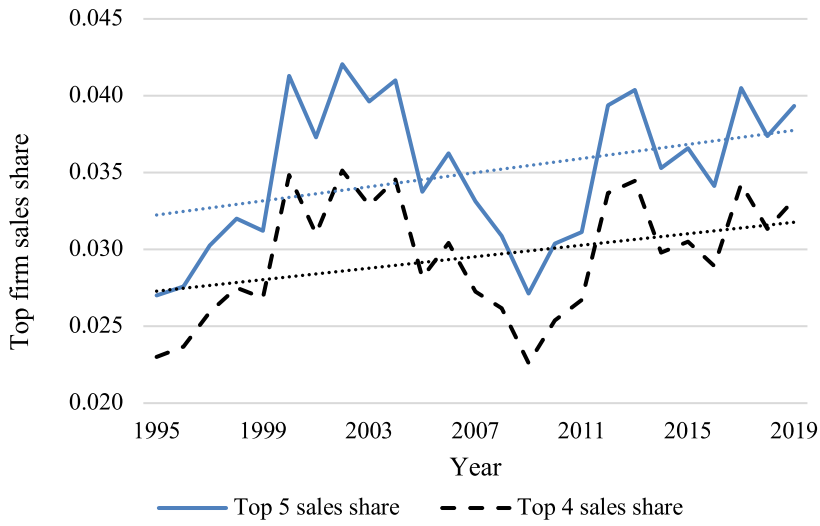

FIGURE 2. European firm concentration based on Worldscope data. European firm concentration using consolidated firm data from the Worldscope database and national account data from Eurostat. The solid (dashed) line shows the sales share of the largest four (five) firms. The dotted lines show linear trends. All economic sectors for the 15 countries in our main analysis.

study firm concentration over a longer time-series in Online Appendix I. As Germany accounts for most of the HHI, studying Germany provides another robustness check given that longer firm-level data series spanning multiple countries are not available.

We find that (i) the rise in German firm concentration is consistent with the increase in European firm concentration from the CompNet data and (ii) the rising concentration in Germany is part of a long-run trend.

6. Concentration, Productivity, and Allocative Efficiency

This section relates changes in concentration to changes in productivity and allocative efficiency. We first describe the evolution of European-level productivity. We then use variation across country-industry pairs to study how changes in concentration relate to changes in productivity, allocative efficiency, and markups. We find that increases in concentration are strongly associated with increases in industry productivity and allocative efficiency—-but not with changes in markups.

6.1. Productivity and Allocative Efficiency in Europe

As we are interested in whether higher concentration reflects a more efficient market environment or excessive market power, Table 7 provides some initial insights from a decomposition of European productivity changes using value-added per worker as a productivity measure. The advantage of using labor productivity is that it can

TABLE 7. Productivity dynamics, 2009–2016 balanced sample of firms and sectors.

Year	Aggregate productivity growth (in %) (1)	Contribution of unweighted mean (percentage points) (2)	Contribution of allocative efficiency (percentage points) (3)
2009	–	–	–
2010	5.71	3.46	2.25
2011	0.73	1.60	–0.87
2012	–0.17	–0.81	0.64
2013	–0.12	–0.01	–0.10
2014	0.32	0.59	–0.27
2015	0.11	–0.51	0.62
2016	0.84	–0.38	1.22
2009–2016	7.5	3.94	3.59

Notes: Table 7 displays European-level productivity decomposition for value-added labor productivity. Columns (1), (2), and, (3) respectively show yearly changes in aggregate productivity ($\Delta\Omega_t/\Omega_{t-1}$), the unweighted mean contribution to aggregate productivity growth ($(\Delta\bar{\omega}_t/\Delta\Omega_t)(\Delta\Omega_t/\Omega_{t-1})$), and the allocative efficiency contribution to aggregate productivity growth ($(\Delta\text{cov}_t(\omega_{it},s_{it})/\Delta\Omega_t)(\Delta\Omega_t/\Omega_{t-1})$). Balanced sample of countries and sectors. We excluded the sector "professional, scientific, and technical activities" for Romania due to missing information on aggregate productivity for several years. CompNet dataset.

be aggregated across sectors and countries and can be directly calculated from the data.[17] We decompose aggregate changes in European productivity (Ω_t) into the unweighted mean productivity across firms ($\bar{\omega}_t$) and the covariance between firms' employment share (s_{it}^L) and productivity ($\text{cov}_t(\omega_{it}, s_{it}^L)$):

$$\Delta\,\Omega_t = \Delta\bar{\omega}_t + \Delta\text{cov}_t\left(\omega_{it}, s_{it}^L\right), \tag{3}$$

where i references the firm index and Δ indicates changes (Olley and Pakes 1996).

Equation (3) describes a static Olley and Pakes (1996) decomposition. Here, productivity effects of firm entry and exit are captured in $\Delta\text{cov}_t(\omega_{it}, s_{it}^L)$ and $\Delta\bar{\omega}_{it}$. The covariance term reflects the extent to which more productive firms are larger, and we follow the literature in interpreting it as an allocative efficiency measure. $\Delta\text{cov}_t(\omega_{it}, s_{it}^L)$ includes any effect of market share reallocation between incumbent firms on aggregate productivity. A part of the reallocation effect on productivity related to firm entry and exit is, however, also captured in $\Delta\bar{\omega}_{it}$. Typically, this part is only a small contributor to aggregate productivity growth because (i) the yearly market share of entering and exiting firms is small (we study yearly changes) and (ii) $\Delta\text{cov}_t(\omega_{it}, s_{it}^L)$ already captures how entry and exit affect productivity through the covariance between firms' size and productivity. Therefore, $\Delta\text{cov}_t(\omega_{it}, s_{it}^L)$ is not only

17. Although CompNet provides production function estimates and TFP measures, the estimated production functions are not perfectly identified because, to run harmonized data collection protocols across countries, the estimation routine can only be sparsely specified. This also means that the empirical production function does not include a correction for firm-specific price variation.

an allocative efficiency measure, but also a close approximation of overall productivity gains from reallocation processes between firms.[18]

Because CompNet does not include the underlying firm-level data but contains productivity decompositions for the sector level, we can reweight country-sector-level components of equation (3) to recover European-level decomposition.[19] Table 7 shows that European labor productivity grew by 7.5% between 2009 and 2016.[20] Column (1) reports the percentage growth of productivity for each year, and columns (2) and 3 display the percentage point contribution of the unweighted mean and allocative efficiency component (column (2) plus column (3) yields column (1)). A growing unweighted mean firm productivity and an increasing allocative efficiency of the European market each account for one-half of Europe's productivity growth in past years. This finding is in line with evidence for the United States showing that half of aggregate TFP growth between 1997 and 2015 resulted from reallocation processes between firms (Baqaee and Farhi 2020).

6.2. Regression Analysis

We study how changes in concentration relate to changes in productivity and markups, using a fixed-effects regression analysis at the country (n) – two-digit industry (j) – year (t) level:

$$HHI_{njt} = \beta_{\Omega}\, \Omega_{njt} + \boldsymbol{C}'_{njt}\boldsymbol{\gamma} + \upsilon_{nj} + \upsilon_{t}. \tag{4}$$

HHI_{njt} and Ω_{njt} denote concentration and labor productivity, respectively. Industry-level productivity is the employment weighted average of firm-level labor productivity. $\boldsymbol{C}'_{njt}$ is a vector of controls, including (depending on the specification) average firm size, industry markups, and industry capital-labor ratios. Controlling for capital-labor ratios accounts for changes in labor productivity that result from changes in capital intensity. Including industry-country and year fixed effects (υ_{nj} and υ_{t}) ensures that we identify coefficients from within-industry-country variation over time. This controls country-specific industrial policies.[21]

18. Arguably a lower bound approximation because market selection will cause entering firms to be more productive than exiting firms. An alternative to our static decomposition is a dynamic decomposition as described in Melitz and Polanec (2015). We apply the static version because we focus on firms with at least 20 employees and often lack the necessary information on firm entry and exit. We discuss how the different components of the static and dynamic decomposition relate to each other in Online Appendix J.

19. We weight sector-level aggregate productivity with sector-level employment shares in European employment and sector-level unweighted mean productivity with the sector-level number of firms in the European number of firms.

20. Productivity changes are similar when using all sectors instead of our balanced set of sectors. We replicate the productivity growth patterns with Eurostat data for firms of all size classes, finding reasonably similar results. See Online Appendix K.

21. An alternative to equation (4) would be a regression in first differences. We prefer the fixed effects specification as it uses the same source of identifying variation (within-industry changes) but avoids a disproportional loss due to missing values. Such missing values result from smaller industry-year cells not passing country-specific disclosure criteria.

We include right-hand-side variables for both productivity and markups to evaluate their independent prediction power for changes in concentration. Thus, we seek to understand whether the concentration is an outcome of a more efficient market environment or higher firm market power. We run several versions of equation (4) where we also replace Ω_{njt} with alternative variables (e.g. industry-level allocative efficiency). As we no longer need to aggregate our industry-country data, we use all available years in our data.

Table 8 presents the regression results, highlighting a strong association between productivity and concentration. It is robust to include industry-level markups (column (2)) and the average firm size (column (3)).[22] Notably, there is no statistically significant association between markups when conditioning on productivity, implying no particular role for market power in creating inefficient types of market concentration. Beyond that, conditioning on markups also absorbs any changes in productivity due to firms charging higher markups. This implies that concentration is indeed associated with a higher level of production efficiency.[23]

Columns (4–6) and (7–9) apply the Olley and Pakes (1996) decomposition for Ω_{njt} into the unweighted mean productivity ($\bar{\omega}_{njt}$) and allocative efficiency ($\text{cov}_{njt}(\omega_{nijt}, s^L_{nijt})$) components. Strikingly, the entire positive relation between concentration and productivity is driven by the positive connection between allocative efficiency and concentration.[24] This strongly supports a winner-takes-all view where increasing concentration in Europe is an outcome of a more efficient market environment that features higher productivity and allocates market shares to the best performing firms (Autor et al. 2017; Van Reenen 2018).

Tables 9 and 10 report estimates for equation (4) separately by countries and sectors with all controls (as in Table 8, column (3)). Although the coefficients are not always statistically significant (partly due to low observation counts), the association between concentration and productivity is positive for almost all countries and sectors. The negative associations between concentration and productivity we document for a few countries are mostly driven by a negative coefficient on the unweighted mean

22. Given the definition of the HHI, it is difficult to interpret the size of the coefficients in Table 8. We address this in Table 11, using the share of the ten largest firms (top ten shares) in an industry as an alternative concentration measure. Top ten shares are highly correlated in terms of levels and changes with HHIs (see Online Appendix C.1).

23. Regressing markups on concentration without controlling for productivity also yields no statistically significant relationship between markups and concentration.

24. When regressing the productivity decomposition terms on concentration (reversing equation (4)), we can quantify the part of the positive association between industry productivity and concentration resulting from changes in allocative efficiency and unweighted mean productivity. We do this in Online Appendix F and find that 99% (1%) of this connection is explained by the allocative efficiency (unweighted mean) component. Decker et al. (2017) note that changes in the covariance term might also reflect within-firm changes in the upper part of the size distribution. Online Appendix F shows that the positive association between allocative efficiency and concentration is not explained by the changing average productivity of the largest firms. Hence, a market share reallocation toward more productive firms indeed explains the positive association between concentration and productivity.

TABLE 8. Concentration and productivity, two-digit-industry-level analysis.

	HHI_{njt} (1)	HHI_{njt} (2)	HHI_{njt} (3)	HHI_{njt} (4)	HHI_{njt} (5)	HHI_{njt} (6)	HHI_{njt} (7)	HHI_{njt} (8)	HHI_{njt} (9)
Aggregate producitivity$_{njt}$	0.0255***	0.0241***	0.0259***						
	(0.00563)	(0.00577)	(0.00626)						
Unweighted mean productivity$_{njt}$				–0.00755	–0.0110	–0.00831			
				(0.00706)	(0.00772)	(0.00735)			
Allocative efficiency$_{njt}$							0.0699***	0.0694***	0.0698***
							(0.0214)	(0.0217)	(0.0209)
Capital intensity$_{njt}$	–0.00311	–0.00310	–0.00275	–0.00103	–0.00109	–0.000787	–0.00283	–0.00284	–0.00241
	(0.00244)	(0.00243)	(0.00209)	(0.00135)	(0.00137)	(0.00110)	(0.00252)	(0.00253)	(0.00215)
Log(*avr. firm size*$_{njt}$)			4.493**			4.183**			4.322***
			(1.718)			(1.697)			(1.567)
Log(*aggregate markup*$_{njt}$)		1.457	0.768		4.002*	3.394		0.409	–0.123
		(1.521)	(1.496)		(2.154)	(2.097)		(1.315)	(1.327)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,364	6,364	6,364	6,364	6,364	6,364	6,364	6,364	6,364
# of industries	47	47	47	47	47	47	47	47	47
R-squared	0.791	0.791	0.799	0.785	0.786	0.793	0.805	0.805	0.812

Notes: Table 8 displays regression results from estimating equation (4) using aggregate productivity (columns (1–3)), unweighted mean productivity (columns (4–6)), and allocative efficiency (columns (7–9)) as explanatory variables. Standard errors are clustered at the industry level. All available industries and years. CompNet dataset. Significance: *10%, **5%, and ***1%.

TABLE 9. Concentration and productivity, two-digit-industry-level analysis, separately by country.

	Aggregate productivity$_{njt}$ (1)	*Unweighted mean productivity*$_{njt}$ (2)	*Allocative efficiency*$_{njt}$ (3)
Belgium	0.0084 (0.0077)	0.0011 (0.00743)	0.0511* (0.0265)
Czech Republic	0.0385 (0.0379)	–0.0206 (0.0349)	0.170** (0.0703)
Finland	0.0984** (0.0378)	0.145*** (0.0397)	0.150*** (0.0534)
France	0.0494*** (0.0102)	0.0227 (0.0149)	0.0698*** (0.00920)
Germany	0.0211** (0.0096)	–0.00344 (0.0217)	0.0494** (0.0183)
Italy	0.00944 (0.00997)	0.00411 (0.0119)	0.0130 (0.0178)
Lithuania	–0.0037 (0.0794)	–0.155*** (0.0524)	0.273** (0.110)
Netherlands	0.206** (0.0916)	–0.158* (0.0912)	0.254** (0.104)
Poland	0.0393 (0.0404)	–0.0139 (0.0333)	0.0972 (0.0585)
Portugal	0.0926** (0.0375)	–0.0643 (0.0407)	0.150*** (0.0371)
Romania	–0.0424 (0.0314)	–0.0944** (0.0350)	0.0797* (0.0413)
Slovakia	–0.0359*** (0.00554)	–0.0438*** (0.00635)	–0.0128 (0.0855)
Spain	0.0082 (0.00944)	–0.0157 (0.0179)	0.0376* (0.0215)
Sweden	0.0094 (0.0139)	–0.0264*** (0.0050)	0.0470* (0.0258)
Switzerland	0.113** (0.0481)	0.0890** (0.0335)	0.128 (0.0786)

Notes: Table 9 shows regression coefficients from estimating equation (4) separately by countries when using industry capital over labor ratios, average firm size, and industry markups as controls. Columns (1), (2), and (3), respectively show coefficients when using industry-level aggregate productivity, average productivity, and allocative efficiency as explanatory variables. Standard errors are clustered at the industry level. All available industries and years. CompNet dataset. Significance: *10%, **5%, and ***1%.

TABLE 10. Concentration and productivity, two-digit-industry-level analysis, separately by sector.

	Aggregate productivity$_{njt}$ (1)	*Unweighted mean productivity*$_{njt}$ (2)	*Allocative efficiency*$_{njt}$ (3)
Manufacturing	0.0253*** (0.009)	–0.0192** (0.0087)	0.206*** (0.0278)
Transportation and storage	0.0122 (0.0141)	–0.0172*** (0.0053)	0.0381** (0.0165)
Information and communication	0.0209** (0.0095)	–0.0144 (0.0172)	0.0575*** (0.0138)
Real estate	0.0249 (0.0183)	0.006 (0.0226)	0.0347** (0.0173)
Professional, scientific, and technical activities	0.0579*** (0.0133)	–0.0151 (0.0111)	0.117*** (0.0226)
Administrative and support service activities	0.0251** (0.0102)	–0.00431 (0.014)	0.0355*** (0.0081)
High-tech and knowledge intensive	0.0314*** (0.0107)	–0.0118* (0.0067)	0.0756*** (0.0140)
Low-tech and not knowledge intensive	0.0167*** (0.0038)	0.0055* (0.0032)	0.0447*** (0.0074)

Notes: Table 10 shows regression coefficients from estimating equation (4) separately by sectors and technology classes when using industry capital over labor ratios, average firm size, and industry markups as controls. Columns (1), (2), and (3), respectively show coefficients when using industry-level aggregate productivity, unweighted mean productivity, and allocative efficiency as explanatory variables. We do not cluster standard errors at the industry-level in Table 10 because this leads to too few clusters for several sectors. Instead, we report robust standard errors in parenthesis. All available industries and years. CompNet data. Significance: *10%, **5%, and ***1%.

component (Table 9, column (2)).[25] Strikingly, in almost every country and sector, there is a strong and often highly statistically significant association between allocative efficiency and concentration (Tables 9 and 10, column (3)).

The last two rows of Table 10 group industries into high-tech-knowledge-intensive and low-tech-non-knowledge-intensive sectors using a classification provided by Eurostat (see Online Appendix H). This speaks to the notion that the positive association between concentration and allocative efficiency/productivity could be driven by high-tech and knowledge-intensive industries where the development of modern technologies is associated with high sunk research costs and creates dominant market positions. Yet, concentration, productivity, and allocative efficiency are strongly associated in both high-tech-knowledge-intensive and low-tech-non-knowledge-intensive industries. This underlines a general connection between allocative efficiency, productivity, and concentration in Europe, independent of the industry's technological sophistication.

Finally, Table 11 uses the share of the ten largest firms within an industry as an alternative concentration measure and finds that our results are also robust to this specification.[26] A one-unit increase in industry-level productivity is associated with a five-percentage point higher revenue share of the ten largest firms—-a large effect.[27] Again, there is a particularly strong association between concentration and allocative efficiency.

Online Appendix E provides several additional robustness tests and replicates our main regression results: (i) for a total factor productivity measure derived from a production function estimation, using (ii) alternative fixed effects structures, and (iii) lagged values of our productivity variable (the latter accounts for reverse causality). Our results hold across all these additional specifications.

Overall, our results show that concentration is strongly positively associated with higher productivity and a more efficient allocation of resources in Europe. This provides strong support for the "positive view" of rising concentration in Europe and is consistent with our findings that (i) increasing European firm concentration is an outcome of more concentrated sectors and countries becoming larger and (ii) the rising allocative efficiency of the European market is a key driver of European productivity growth in past years.

25. The negative coefficients on the unweighted mean are fully consistent with our proposed mechanism, as smaller firms disproportionally drive the unweighted mean. A reallocation of market shares from small, low-productivity to large, high-productivity firms will, for instance, increase concentration and allocative efficiency and reduce unweighted average firm productivity in a model where firms' production activities require periodic fixed overhead costs or where firms face adjustment costs.

26. The sample in Table 11 is smaller than in our baseline estimates because some countries did not disclose the top ten shares.

27. Labor productivity is defined in terms of thousands of real value-added units per employee (in 2005 values).

TABLE 11. Concentration and productivity, two-digit-industry-level analysis, using the sales share of the ten largest firms as concentration measure.

	$Top10_{njt}$ (1)	$Top10_{njt}$ (2)	$Top10_{njt}$ (3)	$Top10_{njt}$ (4)	$Top10_{njt}$ (5)	$Top10_{njt}$ (6)
Aggregate producitivity$_{njt}$	0.0494***	0.0511***				
	(0.0120)	(0.0132)				
Unweighted mean productivity$_{njt}$			0.0247*	0.0259*		
			(0.0131)	(0.0144)		
Allocative efficiency$_{njt}$					0.0950***	0.0921***
					(0.0280)	(0.0271)
Capital intensity$_{njt}$	0.000518	0.00115	0.00267	0.00319	0.00179	0.00251
	(0.00221)	(0.00270)	(0.00323)	(0.00375)	(0.00230)	(0.00287)
Log(*avr. firm size*$_{njt}$)		7.973***		7.789***		7.557***
		(1.590)		(1.621)		(1.546)
Log(*aggregate markup*$_{njt}$)		0.336		3.127		1.146
		(2.541)		(2.663)		(2.407)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country-industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,820	5,820	5,820	5,820	5,820	5,820
# of industries	47	47	47	47	47	47
R-squared	0.943	0.946	0.941	0.944	0.944	0.946

Notes: Table 11 displays regression results from estimating equation (4) using the top ten shares as the dependent variable and aggregate productivity (columns (1–2)), unweighted mean productivity (columns (3–4)), and allocative efficiency (columns (5–6)) as explanatory variables. Standard errors are clustered at the industry level. All available industries and years. CompNet dataset. Significance: *10%, **5%, and ***1%.

7. Conclusion

This paper studies firm concentration and its relation to productivity, market power, and allocative efficiency in Europe. In a large data collection effort, we derive a European firm concentration index from 15 micro-aggregated country-sector-level datasets. We document a 43% increase in European firm concentration. Coinciding with the rise in concentration, we document (i) that, in contrast to recent U.S. evidence (e.g. De Loecker, Eeckhout, and Unger 2020), markups are low and stable in Europe and (ii) a strong increase in the allocative efficiency of the European market.

We test the association between changes in firm concentration, productivity, allocative efficiency, and markups using within country-industry variation. Changes in concentration are strongly and positively associated with changes in allocative efficiency and industry productivity, but statistically unrelated to changes in markups. Our findings are consistent with the aggregate patterns of concentration, allocative efficiency, and markups in Europe and support the view that higher concentration reflects a more efficient European market environment, where more productive firms are rewarded with higher market shares.

Our study has important consequences for European industrial and antitrust policy. As concentration is associated with higher market efficiency and statistically unrelated to markups, rising concentration must not be, prima facie, a cause of concern. The assessment regarding the detrimental consequences of excessive market power must thus be based on direct measures of that market power and its associated rents rather than relying on observed increases in concentration.

Building on our work, we identify two important roads for future research. First, while we study productivity, markups, and allocative efficiency, we did not analyze labor market effects of firm concentration.[28] Second, our study provides an overview of European firm concentration and its relation to productivity, but evidence on other European macroeconomic trends is still limited due to data availability. Our CompNet data provides a unique database for researchers to fill this gap. We hope that this paper and our data collection efforts will contribute to encouraging fruitful discussions on these and related topics.

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Supplementary Data

Supplementary data are available at *JEEASN* online.