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Determinants of Industry Concentration and Dispersion

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Determinants of industry concentration and dispersion

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November 6, 2024

Abstract

Given the political and public interest in rising industry concentration in developed economies, researchers have been working on uncovering underlying mechanisms and implications. Various causes of concentration have been proposed, although rarely tested in a comprehensive model. We study five distinct phenomena and their association with industry concentration: 1) Industry regulation, 2) mergers, 3) information technology use, 4) imports, and 5) productivity. We find that greater concentration within an industry is related to higher productivity, more regulation, and more merger activity. On the other hand, it is lower with more imports and seemingly unrelated to the extent of information technology use. The most economically significant relationship is between concentration and industry productivity.

Keywords: Industry concentration, regulation, information technology, mergers

JEL codes: L11, L16, L51

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1. Introduction

The causes and consequences of the concentration of industry output across a few firms have interested economists, policy makers, and the public for many years. The American public's concerns can be traced to the late 19th century when citizens suffered through financial panics, recessions, and depressions, while also witnessing the seemingly unprecedented rise of wealthy industrialists, such as John D. Rockefeller, Jay Gould, J. P. Morgan, and Cornelius Vanderbilt, sometimes labeled as “robber barons.” The concerns helped motivate passage of America's three foundational antitrust acts, the Sherman Act of 1890 and the Federal Trade Commission Act and Clayton Act in 1914 (Stigler, 1985; Winerman, 2003; Orbach & Rebling, 2012). Economists' interests began earlier: Smith (1776) and Mill (1848) provided early thinking on concentration, highlighting economies of scale, government protections, control of essential resources, and possibly collusion. A federal government investigation in the early 20th century provided similar reasoning (Stigler, 1942).

Interest in industry concentration has endured over the years, but the reasons for the focus have evolved. An early public figure on the topic, Louis Brandeis (1911), argued that large enterprises lack legitimacy because they are inherently inefficient, and can use their economic resources to damage democratic processes, a theme picked up by Simon (1934), who was concerned that the large firms of his day would become permanent fixtures in the economy. Bain (1949, 1952, 1956, 1968) further developed economic views on how firms might have economies of scale, create barriers to entry, and engage in monopoly pricing. Following Smith and Mill, Tullock (1967), Demsetz (1974), Peltzman (1976), and Posner (1974) expanded on firms seeking government-created barriers to competition to the harm of buyers.

Worries about concentration have risen to the presidential level in the U.S., including a 2016 Council of Economic Advisers (CEA) report and a 2021 Executive Order on problems and remedies (CEA, 2016; Exec. Order No. 14,036, 2021). These actions and persons involved expressed concern that rising concentration is reducing product quality, raising barriers to entrepreneurship, decreasing dynamism (i.e., churn) in businesses and labor, decreasing

innovation, lowering production efficiency, and increasing firms' political power (CEA, 2016; Exec. Order No. 14,036, 2021; Furman, 2016; Teachout and Khan, 2014; Wu, 2018). These views often mesh ideas of industry concentration and market concentration, something scholars are generally quick to point out are not the same thing as industries and markets generally have different frontiers and implications (Stigler, 1942; Shapiro, 2018).

Given these worries, researchers have sought to better understand the determinants of which firms supply output. Several explanations of output concentration and dispersion have been examined, such as use of information technologies (IT), merger enforcement, regulation, globalization and international trade, and the emergence of "superstar firms." Unfortunately, these possible causes have not been studied jointly.

This study addresses this gap in the literature by studying multiple factors possibly driving industry concentration within a single framework. From an antitrust perspective, one might want to investigate not industry, but market concentration and its determinants as courts sometimes use market share to determine whether a firm should be considered a monopoly. However, broad studies of market concentration are generally infeasible as such studies would require dissecting the economy into a cross-section of markets, which is too demanding from an information standpoint (Bresnahan, 1989). Also, some concerns and some possible drivers relate to industries rather than markets (Furman, 2016). Therefore, we focus our investigation on industry concentration.

We examine in a single model how regulation, IT use, merger & acquisition (M&A) activity, trade, and productivity correlate with industry concentration. Regulation might affect industry concentration in at least three ways. Regulatory compliance costs might sometimes be largely unrelated to production volume, thus providing economies of scale and exacerbating asymmetries between large and small firms. Also, regulation might raise entry costs for new firms, perhaps because regulations were drawn according to larger firms' existing products and production methods, thereby disadvantaging disruptive rivals. Finally, some regulations increase

industry concentration by limiting product differentiation and prices, forcing industry dynamics resembling Bertrand competition that favors technical efficiency over other dimensions of rivalry.

IT may create scale economies if its adoption replaces less-efficient methods, but only at scale, making larger firms relatively more efficient than their smaller rivals.

In the case of M&A activity, absent entry, a merger decreases the number of firms in an industry and possibly increases concentration of output. Also, some argue that merger oversight has become laxer over time, leading to higher industry concentration (Baker & Shapiro, 2008). More recent studies have refuted this claim, finding merger enforcement rising since the 1980s (Macher, et al., 2024).

Imports, representing an alternative to domestic production, decrease industry concentration at least mathematically by increasing the denominator in an industry concentration ratio. However, imports might impact domestic production by providing productive inputs that might otherwise be unavailable for domestic firms. The impact is ambiguous as such inputs might increase or decrease economies of scale.

Finally, the productivity of labor could be linked to industry concentration if larger firms are more efficient than their smaller rivals, perhaps through greater labor specialization or utilizing more labor-saving methods of production (Autor et al., 2020).

Our research finds that increases in regulation, labor productivity, and M&A activity are positively correlated with rising industry concentration, while imports are negatively correlated. Labor productivity is the most economically significant variable, implying that concentration increases efficiency, results from efficiency, or both. M&A activity has the weakest relationship. In contrast to prior studies, we find the relationship between IT intensity of an industry and its concentration not to be statistically significant.

We develop our findings by examining a model using four-firm concentration ratios at the NAICS-6 level from the U.S. Census Bureau's Economic Census as our measure of industry concentration. Starting in 1967, the census has been conducted regularly every 5 years (data collection was more

irregular before that). We utilize data from three census waves: 2002, 2007, 2012, to match the availability of our IT data. Using ordinary least squares, we regress the four-firm concentration ratios on regulation, IT use, M&A activity, imports, and labor productivity. We measure industry regulation as the number of regulatory restrictions included in the Code of Federal Regulations (CFR). Our measure of IT use by industry is derived from Bessen (2020), which relies upon data from the Census Bureau's American Community Survey. We measure M&A using LSEG's Securities Data Company Platinum (SDC) databases and measure labor productivity using payroll and revenue data from the Economic Census. We incorporate imports in two ways: We include imports in the denominator for our industry concentration ratio for some analyses and include imports as an explanatory variable in other analyses.

We find that labor productivity and regulation have the strongest positive correlations with industry concentration. M&A activity has the least economically significant correlation, but it is positive. It also seems reasonable to believe that IT use affects labor productivity. More imports are associated with lower industry concentration. IT use is neither economically nor statistically significant in our model. Data limitations prohibit us from examining causation.

The remainder of this paper proceeds as follows. The next section reviews relevant literature. Section 3 discusses data and its sources, while section 4 details the econometric approach. Section 5 presents our results. Section 6 concludes.

2. Literature

2.1. Industry concentration trends

Numerous studies find growing industry concentration. Shields (2010) observes that the number of farms in the U.S. has steadily declined for decades while production has increased. Focusing on dairy farms, he finds that the loss was in smaller farms – those with fewer than 500 cows – and that the numbers of larger farms increased. Fuglie et al. (2012) finds that global concentration ratios for agricultural supply industries rose from 1994 through 2009. Corbae & D'Erasmus (2011) examine the financial services industry and find that the number of commercial banks declined by an average of 360 per year from 1980 through 2008 and that government

restrictions on branch banking led to less competition. CEA (2016) finds increasing concentration in all American NAICS sectors from 1997 through 2012, except for “Other Services, Non-Public Admin,” “Arts, Entertainment and Recreation,” and “Health Care and Assistance.” “Transportation and Warehousing” and “Retail Trade” showed the greatest percentage-point increases in concentration with 11.4 and 11.2 respectively.

More recently, Kwon et al. (2023) documents the rise of U.S. industry concentration over the past century. Using Orbis-Worldscope-Zephyr data covering both privately held and publicly traded companies, Bajgar et al. (2019) find a 2-3-percentage-point increase in the share of industry sales for the 10% largest companies in 10 European economies between 2001 and 2012 and a 4-8 percentage point increase in Europe and North America between 2000 and 2014, with 3 out of 4 industries showing increases. Using Compustat data on publicly traded companies in the U.S., Grullon et al. (2019) find that most industries experienced an increase in concentration between 1972 and 2014. Rossi-Hansberg et al. (2021) find that although concentration has been increasing at the national level in the US, this has generally not been the case when considering lower levels of geographical aggregation.

Kulick & Card (2023) challenge the validity of industry concentration studies. They argue that the measurement of industry concentration is sensitive to industry definition and sample selection bias. Adjusting for these issues, they find that increases in industry concentration over time are rather modest or even nonexistent, depending on the timeframe.¹

Some studies relate industry concentration to market power, using price-cost margins as their indicator. Grullon et al. (2019) hold that they find rising concentration to be accompanied by increasing market power but there are two problems. One is miscalculating the Lerner Index, which is their market power indicator.² Also, they find the positive relationship only in the years

¹ Our data also suggest a modest increase in concentration over the period 1997-2017. See Section 3.2 and Figure 1 for details.

² They erroneously hold that they estimate a Lerner Index, which is properly measured as one minus the ratio of marginal cost to price at the margin. The ratio declines as a firm increasingly exploits market power by restricting output, resulting in higher prices at the margin. What Grullon et al. actually measure is one minus the ratio of

2001-2014. The relationship was negative for the years 1972-1986 and there was no relationship in 1987-2000.

De Loecker et al. (2020) also find a positive relationship between industry concentration and market power for publicly traded U.S. firms from 1950-2016. They use the ratio of price and marginal cost as their measure of market power but approximate it through estimations of the productivity of each firms' inputs. Döpper et al. (2022) uses a demand approach to derive price-cost margins across more than 100 U.S. consumer product categories for 2006-2019. They find that margins rise during the period due to decreases in consumer responsiveness to price changes brought on by consumers using fewer coupons and spending less time shopping. Industry concentration did not affect price-cost margins. Alvarez et al. (2024) study markups and prices along the supply chain for a large global manufacturer from 2018 through 2023. Using detailed cost and price data, they found that retail prices increased with inflation, but total markups did not, with manufacturer and retail markups moving in opposite directions.

2.2. Regulation and industry concentration

Regulatory restrictions often limit firms' abilities to compete, but the effects on industry concentration can be ambiguous. Corbae & D'Erasmus (2011) attributed the decline in number of commercial banks from 1980 through 2008 to declines in regulation. More specifically, deposit deregulation in the early 1980's increased competitive pressure by allowing banks to compete for deposits based on interest rates. Furthermore, the relaxation of bank branching restrictions in the 1990s enabled more capable banks to grow relative to their less able rivals.

operating expenses (not including depreciation) and revenue. De Loecker et al. (2020) explains that this assumes marginal and average costs are equal, which is true only in limited circumstances. The Grullon et al. approach also confuses revenue and price and omits asset costs. Revenue might rise or fall for various reasons without changes in marginal prices. Marginal cost includes asset costs, so the omission of depreciation would tend to understate marginal cost, and the amount of error would change over time as the relative productivity of the numerous inputs change. For example, the use of information technologies grew in the late 1990s as the value of their productivity increased relative to other inputs (Basu et al., 2001).

Most studies find a positive relationship between regulation and industry concentration. Fuglie et al.'s (2012) study of agricultural supply industries holds that stricter environmental and safety regulations contributed to increasing global concentration in agricultural chemicals. Using data similar to ours, Gutiérrez & Philippon (2017) find a positive correlation between changes in regulation and changes in concentration. In contrast to our work, they consider industries at the less granular NAICS-3 level, rather than NAICS-6. Moreover, they estimate an unconditional correlation (i.e., not accounting for other covariates). In a U.S. state-level analysis, Febrizio (2018) examines the impact of government regulation at the two-digit NAICS level in a cross-sectional setting. He finds that stricter state-level industry regulation is associated with subsequent declines in the numbers of establishments. Also examining state regulation, Law & McLaughlin (2022) finds a positive and statistically significant relationship between industry size and the extent of state-level regulation.

Some studies examine whether regulation exacerbates asymmetries between large and small firms. Singla (2023) finds evidence of such an effect in an economy-wide assessment of regulation and industry concentration. In contrast to Gutiérrez & Philippon (2017) and to our approach, which rely on counts of regulatory restrictions, Singla estimates costs of regulatory compliance. Such a measure may better capture the burden of regulation, as different regulations are likely to have different compliance costs. On the other hand, the study relies on an employment-based measure of industry concentration, which is not necessarily a good proxy for concentration in the product space. Bailey & Thomas (2017) confirm that regulation contributes to firm asymmetry within industries by stifling entry and disparately affecting the propensity to exit of small and large firms. Chambers et al. (2022) arrive at the same conclusion, namely that large firms benefit from regulations at the expense of smaller businesses. Similarly, Gutiérrez & Philippon (2019) find lobbying and regulation impede entry.

2.3. Information technology and industry concentration

Two recent studies examine causal effects of IT use on industry concentration. Bessen (2020) finds that the use of proprietary IT by firms accounts for most increases in industry concentration.

Similarly, Brynjolfsson et al. (2023) using detailed firm-level census data find that IT intensity has a positive effect on firm size, on industry concentration, and on employment concentration. In contrast to those studies, Ferschli et al. (2021) find no relationship between digitization and industry concentration in Germany.

2.4. Mergers and industry concentration

Academic work on mergers and industry concentration is limited and often dated. For example, Fuglie et al. (2012) find that mergers played a role in growing industry concentration in global agricultural supply industries, but often as a complement to internal growth of larger firms.

Research has been conducted on the effects of mergers on post-merger prices or market power. In this case economic theory suggests a trade-off between additional efficiencies perhaps derived from scale economies, and increased market power due to reduced competitive pressure brought about by higher market concentration. Some research is case-by-case, but on a more aggregate level, there is a growing literature on the link between antitrust enforcement of mergers and the resulting market structure. Mellsop et al. (2023) review the literature and conclude that the evidence for increased concentration and market power is ambiguous.

Affeldt et al. (2021a) simulates mergers in Europe from 1990 to 2018 to estimate the gain in efficiencies that would be necessary to compensate for the unilateral price effects of a merger. They conclude that the European regulators should have rejected more mergers than they did. Affeldt et al. (2021b) examines European mergers from 1995 to 2014 and finds that market concentration (as opposed to industry concentration) increased in the markets affected by the mergers. Larger concentration increases were found for worldwide markets, as opposed to national markets, and for service industries. Merger enforcement was negatively correlated with concentration and the relationship was stronger prior to 2004 than since. Nocke & Whinston (2022) suggest that horizontal merger guidelines should emphasize the merger-induced change in the Herfindahl–Hirschman index, rather than the absolute post-merger level.

2.5. Productivity, labor share, and industry concentration

Research tends to find that productivity and scale economies lead to greater concentration. Peltzman (1977) reports that profits are higher in concentrated industries not because prices are higher, but because they do not decline as much as costs do as efficient firms expand their scales of operation. Analyses by Yale Brozen (1982), Harold Demsetz (1974), and others have found that the positive relation between industrial concentration and profits disappears altogether when firm size is considered. These results are consistent with the hypothesis that some industries are more concentrated than others because larger firms have cost advantages over smaller firms.

More recently, Shields (2010) finds a negative correlation between dairy productivity and the number of dairy farms, with the declining number of farms concentrated on smaller farms, implying economies of scale. Fuglie et al. (2012) finds that economies of scale and convergence of related industries played roles in growing industry concentration in global agricultural supply industries. Ganapati (2021) concludes that industry concentration is positively correlated with productivity, and negatively related to the labor share of income.

3. Data

For our analysis, we rely on several data sources which we describe below in more detail.

3.1. Imports

We obtain import data by industry from the Census Bureau's USA Trade Online database.³ There are two concerns with the data. One concern is that data appears to be missing for some industries. Another concern is that some imports might be inputs for domestic firms rather than substitutes for domestic output. Because of these concerns, we develop our results with and without imports, and we incorporate imports in two ways. In some estimates, we consider imports as substitutes for domestic production and calculate concentration ratios with imports

³ <https://usatrade.census.gov/>

in the denominator. In another set, we consider whether imports impact concentration for domestic production by including imports as an explanatory variable.⁴ Section 3.2 shows how imports are incorporated into concentration ratios.

3.2. Industry concentration

For concentration, we rely on the Economic Census aggregate industry-level measures that include concentration ratios based on industry revenue of the top 4, 8, 20, or 50 firms in the industry, at NAICS levels up to NAICS-6. The top- K concentration ratio, $K \in \{4, 8, 20, 50\}$, is the revenue of largest K firms in the industry, divided by the revenue of the whole industry, and expressed as a percentage so that its value is between 0 and 100. Concentration ratios are calculated both for domestic production only and for domestic production plus imports, as explained in section 3.1. More formally:

$$CRK_{it}^d = \frac{\sum_{k=1}^K Y_{kit}}{\sum_{k=1}^{N_{it}} Y_{kit}} \cdot 100 \quad (1a)$$

for domestic only, and

$$CRK_{it} = \frac{\sum_{k=1}^K Y_{kit}}{I_{it} + \sum_{k=1}^{N_{it}} Y_{kit}} \cdot 100 \quad (1b)$$

for domestic and imports, where Y_{kit} is revenue for firm k in industry i for year t , N_{it} is the number of firms ordered 1, 2, ..., N_{it} in descending total revenue, I_{it} is imports, CRK_{it}^d is the concentration ratio considering only domestic production, and CRK_{it} is the concentration ratio considering imports.

The Economic Census is conducted every 5 years. For our regression analysis, we rely on the 2002, 2007 and 2012 census waves. The restriction to only three census waves is dictated by the availability of the IT variable, which is given for the period 2002-2012. Since 1997, the Economic

⁴ Because imports are sometimes zero and we use logarithms, we add one to the import amounts.

Census is based on the NAICS industry classification standard. The NAICS definitions are fluid over the years and therefore need to be harmonized. For this, we used data provided by Bessen (2020).

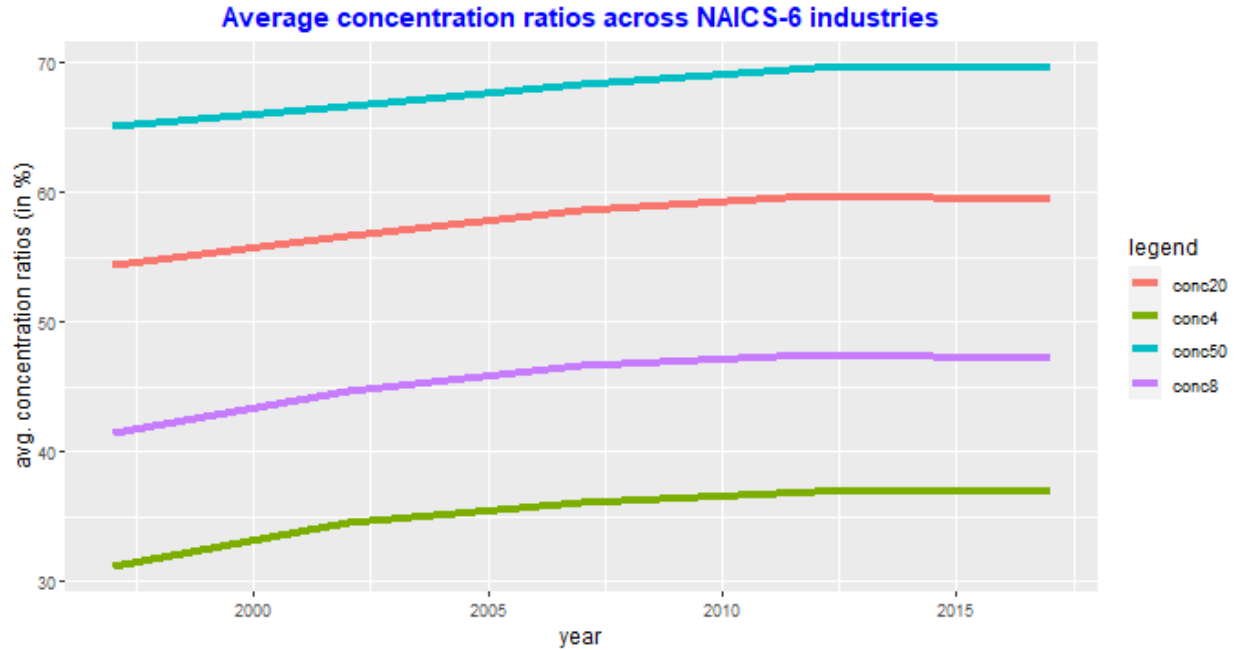
The source of industry concentration data matters. Recent studies on industry concentration in the U.S. predominantly rely either on the Economic Census or on Compustat for concentration measures. There are meaningful trade-offs between the two. Benefits of the census data include its being publicly accessible, offering concentration measures at the NAICS-6 level, and providing the most extensive data related to business activity, covering nearly 4 million business of various sizes and legal structures. The main disadvantage of the census data, and at the same time a reason why many researchers resort to the proprietary Compustat dataset, is that the Economic Census is collected only every 5 years and each wave's results are published with significant delay. In contrast, Compustat data is available yearly or even quarterly. However, its coverage is limited, containing only publicly traded companies.⁵ This limitation introduces a selection bias. Decker & Williams (2023) and Ali et al. (2009) demonstrate that this bias is substantial, finding the correlation between concentration measures using the Economic Census and Compustat is very low, about 0.1 – 0.2.⁶ Considering this we conclude that the Economic Census better represents business and industry realities in the U.S.

Figure 1 shows that industry concentration has been increasing over time at the NAICS-6 level. To ensure consistency, Figure 1 includes only those industries for which we have concentration data from each of the five census waves. The four lines represent the 50-, 20-, 8-, and 4-firm concentration ratios respectively. These measures exhibit parallel behavior, indicating that the choice of a specific ratio is of minor importance. Also, each ratio modestly increases until about the time of the Great Recession and then flattens.

⁵ This is an important distinction, as more than 99% of US businesses are privately held (See <https://www.chicagobooth.edu/review/is-us-economy-going-dark>), and they accounted for 86.4% of U.S. firms with 500 or more employees in 2010 (<https://www.forbes.com/sites/sageworks/2013/05/26/4-things-you-dont-know-about-private-companies/?sh=1515824a291a>).

⁶ Bessen (2020) also finds a correlation close to 0.2.

Figure 1: Industry concentration trends 1997-2017



3.3. Regulation

Industry regulations can take many forms. At the federal level, these include statutes, agency advisory letters, executive orders, court decisions, and department and agency regulations. We focus on agency regulations and obtain regulation data from the Mercatus Center’s *Quantgov* database.⁷ More specifically, we use the RegData U.S. 4.1 dataset, the most recent stable iteration of department and agency regulation counts at the federal level. The dataset contains an annual count of regulatory restrictions included in the CFR from 1970 to 2020, at the CFR Part level.⁸ Restrictions are identified as those sentences containing any of the following expressions: “shall,” “must,” “may not,” “prohibited,” or “required”. The dataset also contains estimated probabilities that a specific part of CFR applies to a certain industry. These probabilities are obtained by the dataset authors using machine learning models (McLaughlin & Sherouse, 2018).

⁷ <https://www.quantgov.org/>

⁸ The CFR provides the general and permanent rules of executive departments and agencies of the federal government. It is divided into 50 titles that represent broad subject areas. Each title is divided into chapters, generally according to departments and agencies, and each chapter is further subdivided into parts and subparts.

Given those data, one can construct an estimate of regulatory restrictions by industry, at up to NAICS-6 level of granularity as described in Al-Ubaydli & McLaughlin (2017).⁹

By following that method, we obtain a yearly regulation count for 1035 NAICS-6 industries over the period 1970-2020. Let P denote the set of parts of the CFR and let p denote a specific part. Then R_{it} , the number of restrictions can be expressed as:

$$R_{it} = \sum_{p \in P} q_{pi} R_{pt} \quad (2)$$

Under the summation symbol we have the product of the number of restrictions in part p in year t (R_{pt}) and the probability that restrictions in part p apply to industry i (q_{pi}). The sum of these products over all parts included in CFRs yield our industry-year measure of regulation.¹⁰

Figure 2 shows the trend for regulatory restrictions from 1970 through 2020. The vertical axis is the average number of regulatory restrictions by industry at the NAICS-6 level. The number of restrictions climbs upward throughout the period with a slowing during the early years of the Reagan presidency, a small dip in the middle of Clinton's presidency, and a flattening during the Trump administration.

⁹ RegData uses the 2007 version of the NAICS industry classification.

¹⁰ We noticed that some of the regulations included in the dataset are associated with federal agencies that are unlikely to be regulating agencies (e.g. *Presidio Trust*, *Millenium Challenge Corporation*, *Harry S. Truman Scholarship Foundation*). Thus, we created an alternative measure of regulation, which excluded regulations associated with these agencies. Since the resulting new restriction measure turned out to be nearly perfectly correlated with the original one, in what follows we use the original metric.

Figure 2: Regulatory restriction trends (1970-2020)

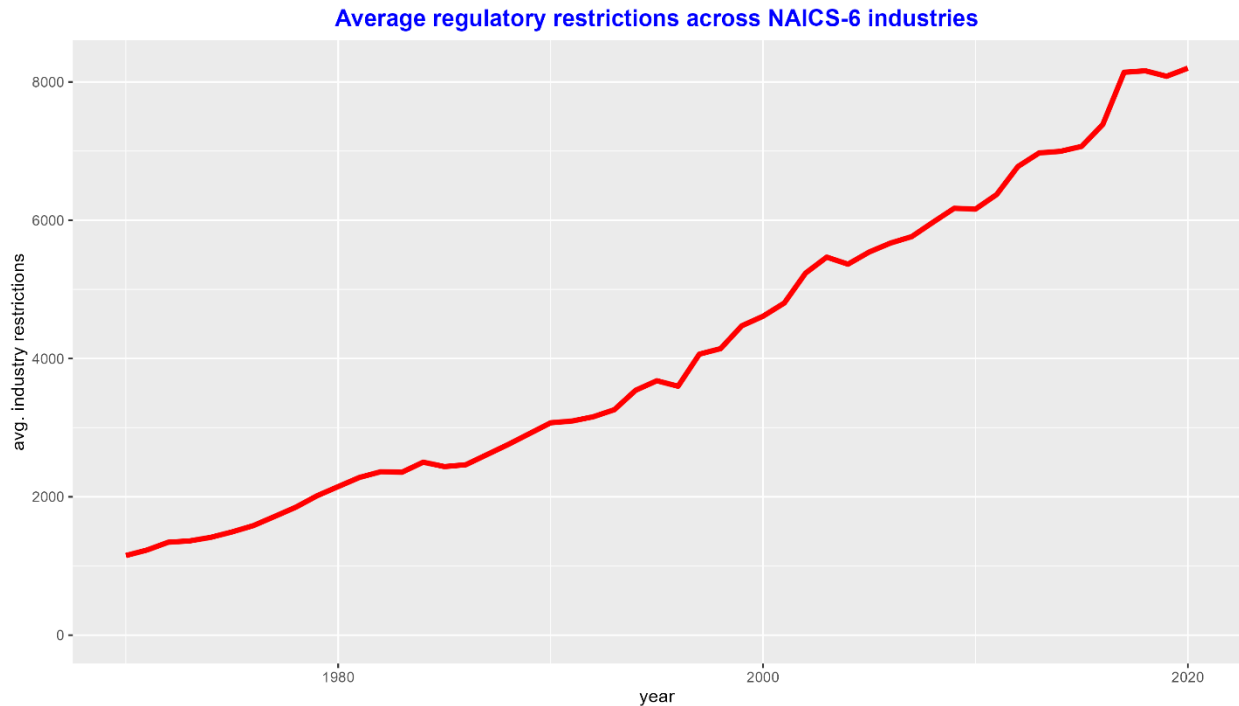
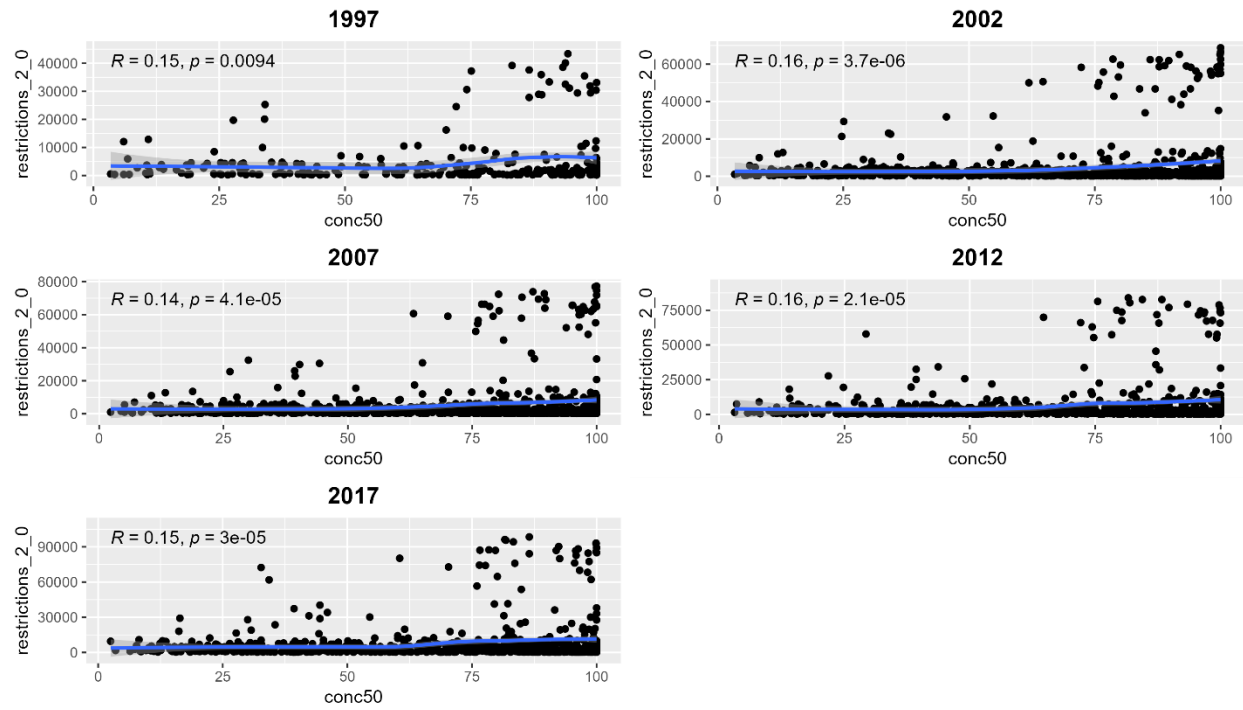


Figure 3 shows cross-sectional relationships between regulatory restrictions and industry concentration for 1997, 2002, 2007, 2012, 2017. The vertical axes are the numbers of regulations, and the horizontal axes are the percent of industry revenue for the 50 largest firms. Each dot represents an industry, and the solid line is a fitted trend line using locally estimated scatterplot smoothing. The scatterplots reveal a modest positive correlation of about 0.15. The correlation coefficient only informs us of a linear relationship, or lack thereof. Each graph shows a cluster of points in its upper-right corner, meaning that high-restriction industries tend to be also highly concentrated. This leads us to the question whether more restrictions are associated with higher concentration even within the same industry. We address the question in the following sections.

Figure 3: Cross-sectional correlations between regulatory restrictions and industry concentration



3.4. IT

There are no convenient measures of IT use by industry which would be available at our desired level of granularity, NAICS-6 classification. So we rely on measures constructed by Bessen (2020), which in turn are based on raw data from the American Community Survey (ACS). The measure is a proxy for share of IT-work hours within an industry and is derived from ACS via a back-of-the-envelope calculation. Its main limitation is that it is not consistently available at the same level of industry classification (e.g., some observations are at the NAICS-3 level, some at NAICS-4 level, etc.). Another limitation of this data is that it is only available for 2002, 2007 and 2012. Data for 2017 can be likely reconstructed from ACS, by following the author's procedure. Brynjolfsson et al. (2023) use data from Annual Capital Expenditures Survey/Information and Communication Technology Survey (Census Bureau). It contains spending towards IT equipment and computer software by industry. The problem with this source is that firm-level data is restricted and requires a lengthy clearance process to access, while aggregate industry-level data from this survey is at an unsatisfactory level of detail: Measures are available at NAICS-2 level, or at NAICS-3 level for some years only.

3.5. Mergers & Acquisitions

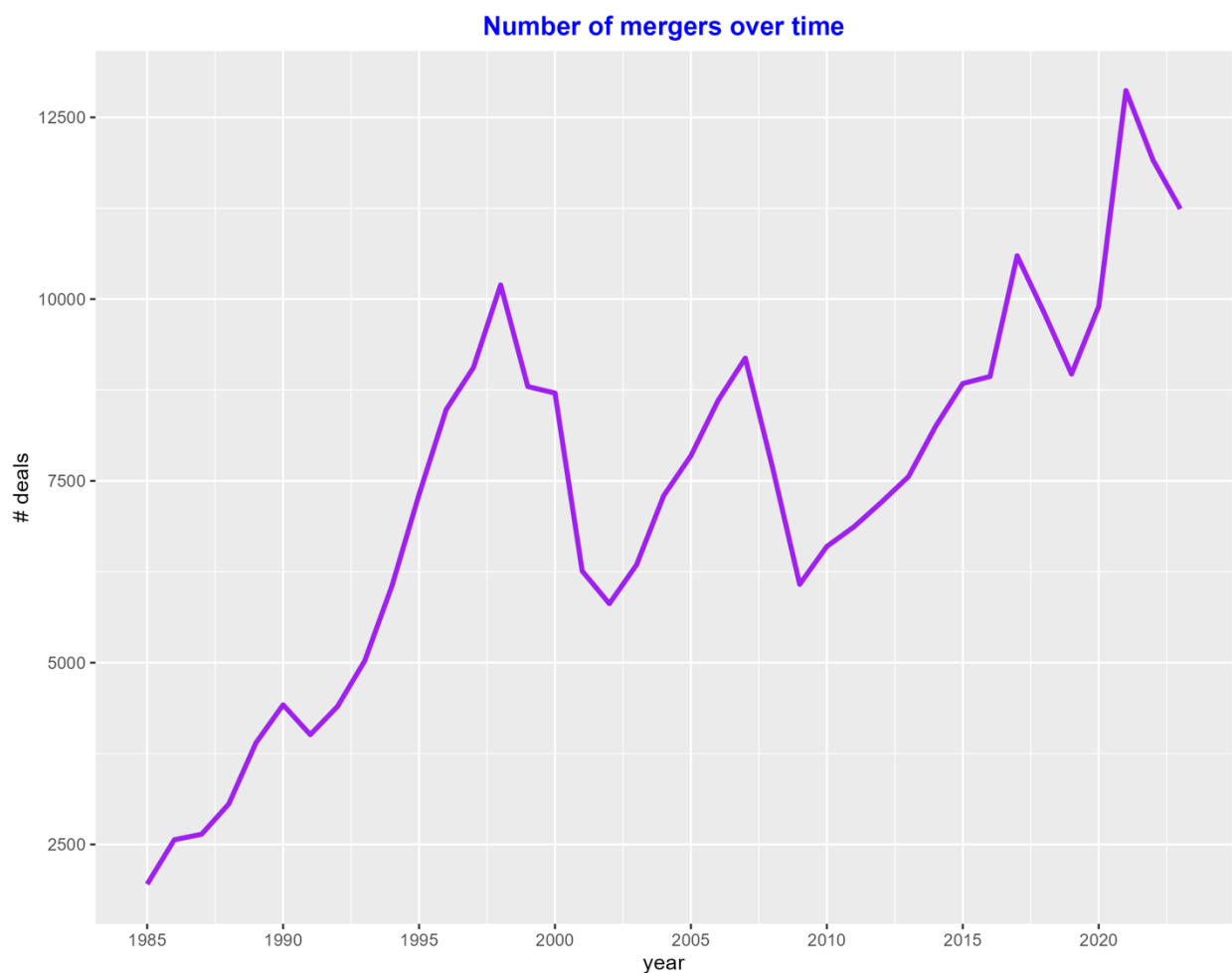
M&A data is available from LSEG/SDC at the NAICS-6 industry level.¹¹ Data is available starting from 1962; however, only a handful deals have been recorded prior to 1980. The complete SDC database includes a list of consolidation deals with numerous variables (about 1700, most of them irrelevant to this research). The data is near-universal according to Barnes et al. (2014). For this study, from the universe of M&As we only select deals that are labeled in the dataset as "complete," and where both the acquiring company and the target company are based in the United States. For each deal, we know the primary industry (NAICS-6 code) of the target and the acquiror, and the year when the deal was completed. To align our merger data with other data sources in our project, we construct a measure of consolidation activity by industry and year. We

¹¹ Like the regulation data, the M&A database uses 2007 as the reference year for NAICS classification.

do so by counting merger by year and by primary industry of the acquiror, even if the target company is in a different industry.

Figure 4 shows M&A activity from 1985 through 2023. Activity increased more or less steadily from 1985, with a slight acceleration during the dot com boom of the 1990s, before dropping just before the dot com bust. Activity increased again after the economic recovery following the 9/11 terrorist attacks, before dropping again with the Great Recession.

Figure 4: M&A trends (1985-2023)



Because our census data are available only every five years and mergers in unsampled years might impact concentration, we use the cumulative number of M&As in the preceding five-year window.¹² More specifically, we calculate cumulative merger activity $CM\&A_{it}$ for i for year t as

$$CM\&A_{it} = \frac{\sum_{s=t-5}^{t-1} M\&A_{is}}{N_{it}}, \quad (3)$$

where N_{it} denotes the number of firms in industry i in year t .

3.6. Productivity and other measures

We incorporate several measures to examine productivity and scale economies. Economies of scale should be accompanied with a decline in the use of labor relative to production when production economies result from automation and/or improved division of labor. One way to represent the relationship between labor and output is to calculate the ratio of labor costs to industry revenue. An industry with increasing economies of scale should experience a declining labor cost relative to revenue. We calculate this ratio from the Economic Census by dividing the total payroll by the total revenue generated, i.e., W_{it}/Y_{it} , where W_{it} is the industry payroll for that year and Y_{it} is the total revenue of an industry. This ratio should be positively correlated with industry concentration if there are economies of scale. Another representation of productivity would be the relationship between industry employment and revenue, which we calculate as Y_{it}/L_{it} , where L_{it} is the number of employees in the industry. This ratio should be negatively correlated with industry concentration when economies of scale are present.

¹² For example, if $t = 2017$, then the numerator captures the sum of mergers and acquisitions in the years 2012-2016. We choose 5 years to be the aggregating period, as this is the duration of the interval between two consecutive waves of the Economic Census.

4. Modeling

On an abstract level, we hypothesize that concentration in year t for industry i is a function of regulatory restrictions, M&A activity, use of IT, imports, and productivity. We examine this using the available data to fit a simple OLS regression with fixed effects for industry and time:

$$CR4_{it}^d = \alpha \cdot \log \mathbf{Z}_{it}^d + f_i + f_t + e_{it} \quad (4a)$$

for domestic analysis and

$$CR4_{it} = \alpha \cdot \log \mathbf{Z}_{it} + f_i + f_t + e_{it} \quad (4b)$$

for domestic plus import estimations, where α is a vector of coefficients, $\mathbf{Z}_{it}^d = \left\{ R_{it}, CM\&A_{it}, IT_{it}, \frac{W_{it}}{Y_{it}}, \frac{Y_{it}}{L_{it}}, I_{it} \right\}$, $\mathbf{Z}_{it} = \left\{ R_{it}, CM\&A_{it}, IT_{it}, \frac{W_{it}}{Y_{it}}, \frac{Y_{it}}{L_{it}} \right\}$, $f_i + f_t$ are industry and time fixed effects respectively, IT_{it} is our IT variable, and e_{it} is the error term. All industry concentration ratios follow the same pattern (see Section 3.2), so we choose the 4-firm ratio for convenience. On the right-hand side, we have the logarithms for regulatory restrictions, M&A intensity, IT intensity, imports, and productivity measures. The inclusion of time fixed effects reduces the risk of results being confounded by time-specific factors. The use of industry fixed effects in turn lets us interpret the regression results in terms of within-industry changes, i.e., how industry concentration changes as regressors change, while keeping the industry constant. Table 1 contains a list of variables used in our estimation, and Table 2 shows summary statistics thereof.

Table 1: Variables and their definitions

Variable name	Symbol	Abbreviation	Variable definitions
Domestic concentration ratio	$CR4_{it}^d$	dconc4	Share of the domestic industry revenue generated by the 4 largest firms in industry i in year t
Concentration ratio with imports	$CR4_{it}$	conc4	Share of the domestic industry revenue plus imports generated by the 4 largest firms in industry i in year t
Regulation	R_{it}	restrictions	Number of regulations in industry i in year t
Merger & Acquisition intensity	$CM\&A_{it}$	merger rate	Cumulative number of M&As in the preceding five-year window in industry i , divided by the number of firms in that industry in year t
Information Technology intensity	IT_{it}	itshr	Share of hours worked by IT personnel in industry i in year t
Relative labor costs	$\frac{W_{it}}{Y_{it}}$	labor_share	Total payroll divided by total revenue for industry i in year t
Labor productivity	$\frac{Y_{it}}{L_{it}}$	productivity	Total revenue divided by total employment for industry i in year t
Industry payroll	W_{it}	payann1	Total payroll costs for industry i in year t
Industry revenue	Y_{it}	ship1	Total revenue of industry i in year t
Industry employment	L_{it}	emp1	Total employment in industry i in year t
Imports	I_{it}	imports	Dollar volume of imports in industry i in year t

Table 2: Summary statistics of variables included in regression analysis

Statistic	Mean	Median	St. Dev.	Min	Max	N
dconc4	37	33	22	0.6	100	2428
conc4	32	29	21	0.6	99	2406
restrictions	5913	1514	13318	171	92353	3089
merger_rate	0.039	0.0056	0.23	0	8	2453
itshr	2.7	1.6	4.6	0	53	2487
labor_share	0.21	0.18	0.13	0.0049	1.5	2422
productivity	404	217	798	20	17899	2422
payann1	4135007	1206071	10377573	4255	176591132	2422
ship1	28448568	7342944	73464759	14831	872619072	2422
emp1	102958	32417	272497	185	4603747	2422
imports	1421155	0	9828103	0	320706547	3089

Variables *dconc4* and *conc4* are in %; *restrictions* is the expected restriction count per industry, as defined in Section 3.2; *merger_rate* is the number of mergers per firm in the preceding 5-year window; *itshr* is the proportion of labor force working in IT, *productivity* is expressed in \$1000/worker, *payann1*, *ship1*, and *imports* are in \$1000, and *emp1* is given by the number of employees.

5. Results

We find that industry concentration largely results from larger firms having greater productivity than smaller firms, creates greater productivity, or both. Regulatory restrictions are the second most important relationship, implying that more regulation leads to greater concentration, results from greater concentration, or both. Imports are negatively related with industry concentration and M&A activity has the smallest economic significance. These results are robust across all specifications of our models.

Table 3 shows our initial estimation, which omits imports, i.e., we regress equation (4a) and set $I_{it} = 0$. Standard errors are clustered by industry to allow for within-industry correlation in the error terms. Given the skewed distributions of our regressors, we use a linear-logarithmic specification, so that our coefficients can be interpreted as semi-elasticities, i.e., a one percent change in a regressor is associated with a 0.01α change in the dependent variable.

Table 3: Regressions of domestic industry concentration

	dconc4	dconc4	dconc4	dconc4	dconc4
log(restrictions)	2.798** (1.213)	2.170* (1.147)	2.396** (1.128)	2.232* (1.138)	2.269** (1.148)
log(merger_rate)	0.706*** (0.263)	0.699*** (0.261)	0.594** (0.256)	0.654** (0.260)	0.624** (0.258)
log(itshr)	-0.344 (0.371)	-0.482 (0.368)	-0.427 (0.366)	-0.468 (0.366)	-0.440 (0.365)
log(labor_share)		-13.404*** (2.220)		-7.902** (3.640)	
log(productivity)			12.011*** (2.028)	5.645* (3.113)	
log(payann1)					-7.863** (3.656)
log(ship1)					13.457*** (2.247)
log(emp1)					-6.288* (3.326)
Num.Obs.	1996	1980	1980	1980	1980
R2	0.962	0.967	0.967	0.967	0.967
R2 Within	0.012	0.127	0.124	0.133	0.133
Std.Errors	by: naics	by: naics	by: naics	by: naics	by: naics
FE: naics	X	X	X	X	X
FE: year	X	X	X	X	X

* p < 0.1, ** p < 0.05, *** p < 0.01

The first column of results in Table 3 omits productivity and scale variables, while the remaining columns provide results with different combinations of variables omitted in the first column. We find that a 10% increase in regulatory restrictions is associated with an increase in industry concentration by about 0.22-0.28 percentage points depending on specification. This result remains robust and statistically significant across specifications. Moreover, a 10% increase in merger rate is associated with about 0.06-0.07 percentage point increases in industry concentration, about one-fourth the impact of regulatory restrictions. Next, the effect of IT is not statistically distinguishable from zero throughout all specifications. In contrast, the estimates corresponding to productivity are large in magnitude and highly significant: A 10% increase in wages relative to revenue translates to a 1.3 percentage point decrease in industry concentration. The revenue per employee ratio provides similar results. Including both (column 4) decreases the impacts and statistical significance of both, but statistical significance remains, implying that the two are measuring similar, yet different industry properties. These productivity measures explain a substantial portion of the variation in industry concentration, as evidenced by the jump in within-R2 from column 1 to column 2.

Table 4 shows the results of including imports in the measure of industry size, i.e., regressing equation (4b). The primary impact is to decrease the effects of M&A, although the change is small. This might mean that there are situations where imports somewhat offset whatever increase in industry concentration that might have happened.

Table 4: Regressions of import-augmented industry concentration

	conc4	conc4	conc4	conc4	conc4
log(restrictions)	3.236*** (1.150)	2.495** (1.105)	2.716** (1.087)	2.559** (1.097)	2.392** (1.075)
log(merger_rate)	0.557** (0.271)	0.620** (0.268)	0.517** (0.262)	0.573** (0.268)	0.708*** (0.259)
log(itshr)	-0.045 (0.380)	-0.246 (0.377)	-0.193 (0.373)	-0.232 (0.375)	-0.360 (0.387)
log(labor_share)		-13.227*** (2.310)		-7.517** (3.771)	
log(productivity)			11.913*** (2.101)	5.859* (3.195)	
log(payann1)					-7.690** (3.727)
log(ship1)					13.778*** (2.335)
log(emp1)					-2.983 (3.290)
Num.Obs.	1980	1980	1980	1980	1980
R2	0.955	0.960	0.960	0.961	0.961
R2 Within	0.011	0.118	0.116	0.124	0.138
Std.Errors	by: naics	by: naics	by: naics	by: naics	by: naics
FE: naics	X	X	X	X	X
FE: year	X	X	X	X	X

* p < 0.1, ** p < 0.05, *** p < 0.01

Table 5 shows results for regressing equation (4a) with imports as an explanatory variable. Imports have a negative impact on industry concentration, although the effect is even smaller than that of M&A. The effects of regulation are slightly smaller and have less statistical

significance, implying that there may be some commonality between how regulation and imports affect concentration. Otherwise, including imports as an explanatory variable has little impact on the results.

Table 5: Regressions of industry concentration with import as additional regressor

	conc4	conc4	conc4	conc4	conc4
log(restrictions)	2.765** (1.216)	2.105* (1.147)	2.335** (1.128)	2.166* (1.137)	2.203* (1.147)
log(merger_rate)	0.699*** (0.263)	0.687*** (0.260)	0.581** (0.255)	0.641** (0.259)	0.611** (0.257)
log(itshr)	-0.322 (0.369)	-0.445 (0.363)	-0.390 (0.360)	-0.431 (0.361)	-0.403 (0.360)
log(imports + 1)	-0.132 (0.114)	-0.238** (0.105)	-0.236** (0.101)	-0.244** (0.102)	-0.243** (0.102)
log(labor_share)		-13.591*** (2.215)		-8.008** (3.626)	
log(productivity)			12.177*** (2.031)	5.732* (3.114)	
log(payann1)					-7.970** (3.643)
log(ship1)					13.651*** (2.242)
log(emp1)					-6.365* (3.329)
Num.Obs.	1996	1980	1980	1980	1980
R2	0.962	0.967	0.967	0.967	0.967
R2 Within	0.013	0.131	0.127	0.136	0.137
Std.Errors	by: naics	by: naics	by: naics	by: naics	by: naics
FE: naics	X	X	X	X	X
FE: year	X	X	X	X	X

* p < 0.1, ** p < 0.05, *** p < 0.01

6. Summary

We study several possible explanations behind the intertemporal variability in output concentration and dispersion among US industries. We find that concentration is larger when productivity, regulation, and M&A activity are higher, and this finding is consistent with the existing literature. We find a small inverse relationship between concentration and imports. In contrast to prior studies, we find no support for the hypothesis that rise of IT would drive concentration.

One of the limitations of this study is that it is merely correlational. Although we absorb much of the variation through fixed effects, still some potential remains for endogeneity in the error terms. Notably, our model may suffer from reverse causality. It could be, for example, the case that big firms in more concentrated industries have more lobbying power, which they exercise to precipitate increased favorable regulation, so that they are more likely to prevent market entry and disproportionately increase the burden on smaller firms. This phenomenon has been to some extent documented by Singla (2023).

Another limitation of our study is that it currently omits some other factors that might be potentially explaining variation in industry concentration, such as the degree of antitrust enforcement, or the volume of lobbying expenditures.

These limitations imply opportunities for further research. Causation will be difficult to model, but the implications are important. Also, more research is needed on the implications of the determinants of output at the firm level. If there is indeed a tradeoff between more dispersed output and greater productivity, this becomes an important consideration in the debate over the antitrust enforcement.

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Figures and Tables

Table 1: Variables and their definitions

Variable name	Symbol	Abbreviation	Variable definitions
Domestic concentration ratio	$CR4_{it}^d$	dconc4	Share of the domestic industry revenue generated by the 4 largest firms in industry i in year t
Concentration ratio with imports	$CR4_{it}$	conc4	Share of the domestic industry revenue plus imports generated by the 4 largest firms in industry i in year t
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Merger & Acquisition intensity	$CM\&A_{it}$	merger rate	Cumulative number of M&As in the preceding five-year window in industry i , divided by the number of firms in that industry in year t
Information Technology intensity	IT_{it}	itshr	Share of hours worked by IT personnel in industry i in year t
Relative labor costs	$\frac{W_{it}}{Y_{it}}$	labor_share	Total payroll divided by total revenue for industry i in year t
Labor productivity	$\frac{Y_{it}}{L_{it}}$	productivity	Total revenue divided by total employment for industry i in year t
Industry payroll	W_{it}	payann1	Total payroll costs for industry i in year t
Industry revenue	Y_{it}	ship1	Total revenue of industry i in year t
Industry employment	L_{it}	emp1	Total employment in industry i in year t
Imports	I_{it}	imports	Dollar volume of imports in industry i in year t

Table 2: Summary statistics of variables included in regression analysis

Statistic	Mean	Median	St. Dev.	Min	Max	N
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conc4	32	29	21	0.6	99	2406
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itshr	2.7	1.6	4.6	0	53	2487
labor_share	0.21	0.18	0.13	0.0049	1.5	2422
productivity	404	217	798	20	17899	2422
payann1	4135007	1206071	10377573	4255	176591132	2422
ship1	28448568	7342944	73464759	14831	872619072	2422
emp1	102958	32417	272497	185	4603747	2422
imports	1421155	0	9828103	0	320706547	3089

Variables *dconc4* and *conc4* are in %; *restrictions* is the expected restriction count per industry, as defined in Section 3.2; *merger_rate* is the number of mergers per firm in the preceding 5-year window; *itshr* is the proportion of labor force working in IT, *productivity* is expressed in \$1000/worker, *payann1*, *ship1*, and *imports* are in \$1000, and *emp1* is given by the number of employees.

Table 3: Regressions of domestic industry concentration

	dconc4	dconc4	dconc4	dconc4	dconc4
log(restrictions)	2.798** (1.213)	2.170* (1.147)	2.396** (1.128)	2.232* (1.138)	2.269** (1.148)
log(merger_rate)	0.706*** (0.263)	0.699*** (0.261)	0.594** (0.256)	0.654** (0.260)	0.624** (0.258)
log(itshr)	-0.344 (0.371)	-0.482 (0.368)	-0.427 (0.366)	-0.468 (0.366)	-0.440 (0.365)
log(labor_share)		-13.404*** (2.220)		-7.902** (3.640)	
log(productivity)			12.011*** (2.028)	5.645* (3.113)	
log(payann1)					-7.863** (3.656)
log(ship1)					13.457*** (2.247)
log(emp1)					-6.288* (3.326)
Num.Obs.	1996	1980	1980	1980	1980
R2	0.962	0.967	0.967	0.967	0.967
R2 Within	0.012	0.127	0.124	0.133	0.133
Std.Errors	by: naics	by: naics	by: naics	by: naics	by: naics
FE: naics	X	X	X	X	X
FE: year	X	X	X	X	X

* p < 0.1, ** p < 0.05, *** p < 0.01

Table 4: Regressions of import-augmented industry concentration

	conc4	conc4	conc4	conc4	conc4
log(restrictions)	3.236*** (1.150)	2.495** (1.105)	2.716** (1.087)	2.559** (1.097)	2.392** (1.075)
log(merger_rate)	0.557** (0.271)	0.620** (0.268)	0.517** (0.262)	0.573** (0.268)	0.708*** (0.259)
log(itshr)	-0.045 (0.380)	-0.246 (0.377)	-0.193 (0.373)	-0.232 (0.375)	-0.360 (0.387)
log(labor_share)		-13.227*** (2.310)		-7.517** (3.771)	
log(productivity)			11.913*** (2.101)	5.859* (3.195)	
log(payann1)					-7.690** (3.727)
log(ship1)					13.778*** (2.335)
log(emp1)					-2.983 (3.290)
Num.Obs.	1980	1980	1980	1980	1980
R2	0.955	0.960	0.960	0.961	0.961
R2 Within	0.011	0.118	0.116	0.124	0.138
Std.Errors	by: naics	by: naics	by: naics	by: naics	by: naics
FE: naics	X	X	X	X	X
FE: year	X	X	X	X	X

* p < 0.1, ** p < 0.05, *** p < 0.01

Table 5: Regressions of industry concentration with import as additional regressor

	conc4	conc4	conc4	conc4	conc4
log(restrictions)	2.765** (1.216)	2.105* (1.147)	2.335** (1.128)	2.166* (1.137)	2.203* (1.147)
log(merger_rate)	0.699*** (0.263)	0.687*** (0.260)	0.581** (0.255)	0.641** (0.259)	0.611** (0.257)
log(itshr)	-0.322 (0.369)	-0.445 (0.363)	-0.390 (0.360)	-0.431 (0.361)	-0.403 (0.360)
log(imports + 1)	-0.132 (0.114)	-0.238** (0.105)	-0.236** (0.101)	-0.244** (0.102)	-0.243** (0.102)
log(labor_share)		-13.591*** (2.215)		-8.008** (3.626)	
log(productivity)			12.177*** (2.031)	5.732* (3.114)	
log(payann1)					-7.970** (3.643)
log(ship1)					13.651*** (2.242)
log(emp1)					-6.365* (3.329)
Num.Obs.	1996	1980	1980	1980	1980
R2	0.962	0.967	0.967	0.967	0.967
R2 Within	0.013	0.131	0.127	0.136	0.137
Std.Errors	by: naics	by: naics	by: naics	by: naics	by: naics
FE: naics	X	X	X	X	X
FE: year	X	X	X	X	X

* p < 0.1, ** p < 0.05, *** p < 0.01

Figure 2: Industry concentration trends 1997-2017

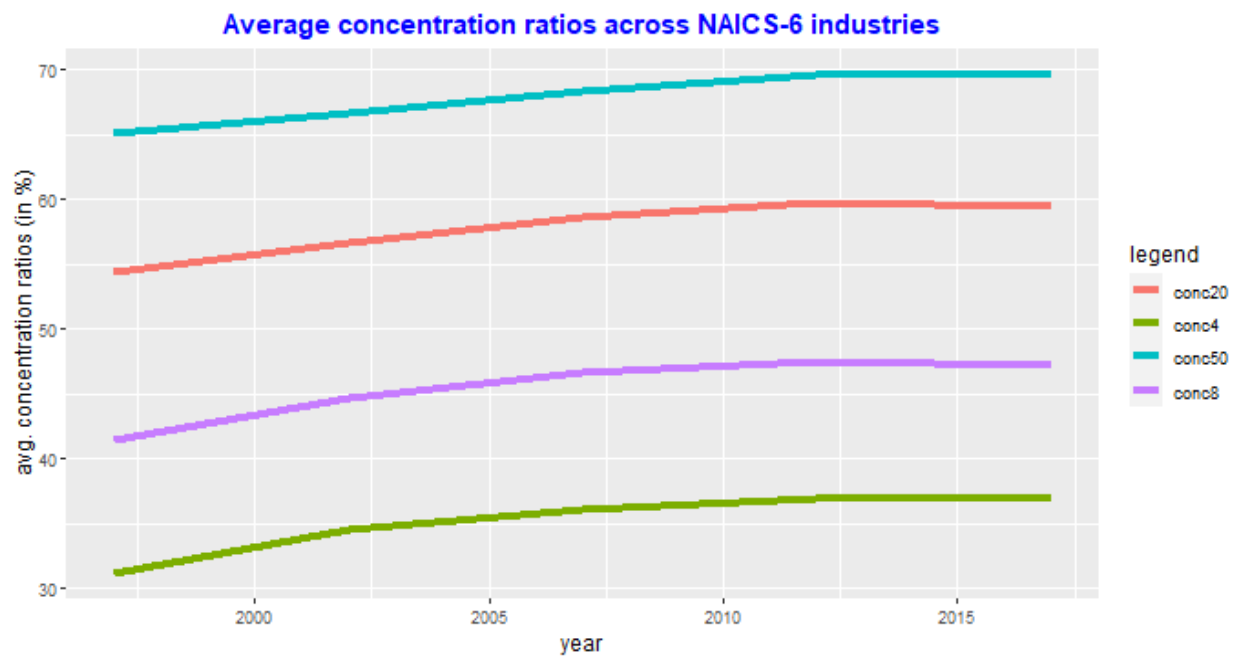


Figure 2: Regulatory restriction trends (1970-2020)

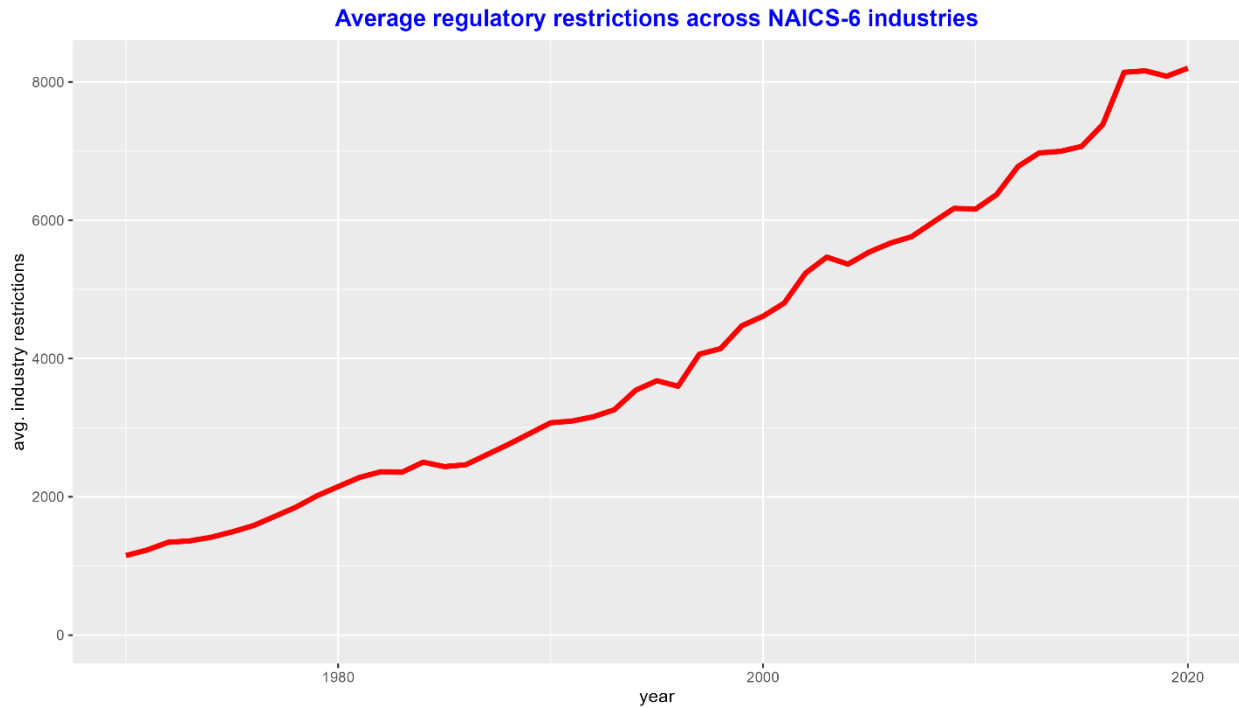


Figure 3: Cross-sectional correlations between regulatory restrictions and industry concentration

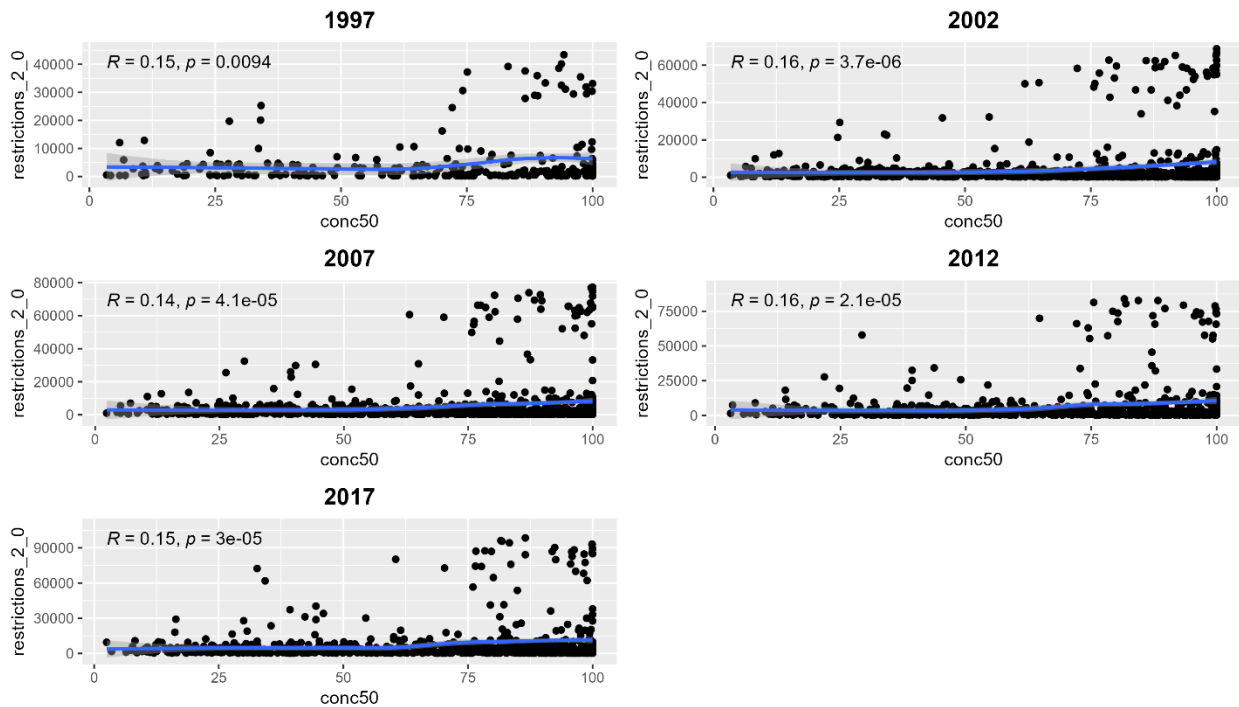


Figure 4: M&A trends (1985-2023)

