Growing Oligopolies, Prices, Output, and Productivity

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Abstract

American industries have grown more concentrated over the last forty years. In the absence of productivity innovation, this should lead to price hikes and output reductions, decreasing consumer welfare. With US Census data from 1972-2012, I use price data to disentangle revenue from output. Industry-level estimates show that concentration increases are positively correlated to productivity and real output growth, uncorrelated with price changes and overall payroll, and negatively correlated with labor's revenue share. I rationalize these results in a simple model of competition. Productive industries (with growing oligopolists) expand real output and hold down prices, raising consumer welfare, while maintaining or reducing their workforces, lowering labor's share of output.

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Does America have a monopoly problem? Market concentration within narrowly defined industries has risen over last forty years. Various papers have systematically and comprehensively laid out the implications of concentration on profits, productive factors, and markups.[1] However, research has not systematically measured consumer welfare and prices, a first order concern for antitrust authorities (Shapiro, 2010, FTC Hearings 2018).[2] In the simplest economics examples (Tirole, 1988), monopolies charge higher prices and restrict output, maximizing profits and reducing consumer welfare. However, monopolies could be caused by innovation from "superstar" firms or scale economies, leading to falling prices or increased output (Autor et al., 2017; Van Reenen, 2018; Armstrong and Porter, 2007; Tirole, 1988; Kehrig and Vincent, 2018).

Monopolists and oligopolists have incentives to both increase prices and/or decrease output.[3] My main research question is simple: is there an empirical relationship between changes in oligopolies and consumer-relevant market outcomes on an economy-wide basis? I test the relationship of prices, quantities, and market concentration across the vast majority of the US economy using 40 years of Census data. I then link these changes on the consumer side to productivity innovations and labor shares.

I directly quantify how changes in industry concentration in the medium to long-run are correlated to changes in prices and real output by combining price data with revenue data.[4] A 10% increase in the national market share of the four largest firms is correlated with a 1% increase in real output. Finding that higher output, but not price, is linked with higher concentration rates, I turn to the role of productivity. Industries with the most real productivity growth are those with the largest increases in industry concentration. A 10% increase in the market share of the largest four firms is linked to a 2% increase in labor productivity. With both industry concentration and productivity, output growth is not accompanied by payroll growth. Growing monopolists and oligopolists are able to produce more output with fewer, but higher paid workers. A 10% increase in the market share of the largest four firms is correlated with a 1% decrease in the labor's share of revenue.[5]

These correlations are interpreted through the perspective of Sutton-style models, where fixed costs are used to reduce marginal costs (Sutton, 1991). This can lead to decreases in competition and increases in output. If fixed costs come from capital expenditures, as opposed to labor expenses, labor

[1] See Autor et al. (2017); Barkai (2016); Furman and Orszag (2015); Grullon, Larkin and Michaely (2016); Gutiérrez and Philippon (2017); De Loecker and Eeckhout (2017); White and Yang (2017).

[2] Markups are relevant to consumer welfare, but if only paired with marginal and average cost data. See De Loecker and Eeckhout (2017) for detailed markup data.

[3] US merger guidelines state that "A merger enhances market power if it is likely to encourage one or more firms to raise price, reduce output, diminish innovation, or otherwise harm customers as a result of diminished competitive constraints or incentives." (Department of Justice 2010) I hold to this spirit in evaluating medium-run changes to market concentration.

[4] What does it mean for output expansion without falling prices? There are a few simple and consistent stories. Marginal cost reductions may be correlated with increases in demands. For example, an increase in demand enlarges the total market, allowing for new natural monopolies. Additionally, changes in marginal cost could be linked with unobservable quality, inducing demand.

[5] Without considering general equilibrium effects, the net effect of oligopoly growth appears to be Pareto improving. This is distinct from Pareto optimal; there may be further Pareto gains from regulating a natural monopoly and redistributing the gains.

shares fall.[6] Furthermore, these models allow for national market concentration increases, holding local market concentration constant (Rossi-Hansberg, Sarte and Trachter, 2018; Rinz, 2018).

Research investigating consumer surplus generally address three main questions. First, has increasing market concentration reduced consumer surplus? Second, could current consumer surplus be higher? Third, what does the future hold? This paper answers the first question on a systematic, economy-wide basis. The second question often requires detailed modeling of supply and demand and has been done for selected industries, but answers lack economy-wide coverage. In particular, if new technologies create natural monopolies, is there a role for regulation and intervention? Monopolies and superstar firms may pass on the benefits from technical innovation as profits, partially offsetting increases in markups. As market power is related with real productivity improvements, this paper lends credibility to this story, but there may be room for further intervention (Covarrubias, Gutiérrez and Philippon, 2019). The third (and perhaps most important) question primarily lies in the realm of speculative analysis, paving the way for future work.

The results from this paper tie directly with a large and growing body of literature and public discussion.[7] The rising trend toward monopolization has been linked to the growth of superstar firms, declining labor compensation (Furman and Orszag, 2015; Autor et al., 2017; Azar, Marinescu and Steinbaum, 2017), and increased profits (Barkai, 2016). This missing link in this literature comes from the focus on upstream factor markets, not on downstream customers. This paper explicitly considers prices and uses this price data to disentangle revenue and real output, allowing consumer welfare comparisons. This approach is complementary with Barkai (2016); Kehrig and Vincent (2018) and Autor et al. (2017), which use similar datasets to fully describe trends in labor shares and productivity within the manufacturing sector.[8] Peltzman (1977) runs a similar analysis on manufacturing from 1947 through 1967. This paper expands analysis to the majority of the private sector, as manufacturing only accounts for 12% economic output. De Loecker and Eeckhout (2017) use data on publicly traded companies to show that markups have increased, but cannot link this to prices. This paper is consistent with higher markups, as that could indicate large fixed costs that reduce marginal production costs. In contrast, Gutiérrez and Philippon (2017) find that declining competition may be responsible for reduced levels of investment.[9]

The finding that productivity and oligopoly are intertwined is related to the discussion of both the business dynamics of the US economy (Decker et al., 2016) and the proliferation of automatization (Acemoglu and Restrepo, 2016, 2017). Industries that become more productive require fewer workers. Industries that become monopolies hire fewer workers. Productivity (and the automatization, computerization, and the robotics that underpin it) enhancements do not appear 'free' and exogenous. Improvements are much more common in industries that move towards higher levels of

[6] This is true if capital is a more dynamic input than labor as in Ackerberg, Caves and Frazer (2015).

[7] For example: Porter (2016) and The Economist (2016).

[8] Autor et al. (2017) performs similar analysis on productivity just within the manufacturing sector and finds broadly comparable results. Azar, Marinescu and Steinbaum (2017) finds that wages fall with industry concentration (monopsony).

[9] Gutiérrez and Philippon (2017) show that investment is negatively correlated with market share, but do not consider if higher investment led to higher market shares in the first place.

monopolization. This paper cannot assign causality. Do productivity improvements lead to higher market shares, or do higher market shares lead to productivity investment? If productivity enhancements require large sunk costs, such as employing more expensive workers and building up intellectual property, this may prevent entry of new firms. The decline in labor share may be due to cheap capital (Karabarbounis and Neiman, 2013), but is there a minimum efficient scale to use this capital?[10]

There have been many case studies that focus on the role of industry concentration, prices, outputs, consumer welfare, and innovation. In the 1950s, cross-industry analysis of profit rates and market concentration was formalized by Bain (1951); however, due to measurement and endogeneity issues[11], the literature was supplanted by "New Industrial Organization (IO)." (Bresnahan, 1989; Sutton, 1991). "New IO" did away with cross-industry analysis and placed more structure on individual industries to understand the interaction of market power, profits, and consumer welfare.[12] A recent literature also addresses market concentration from both international trade and macroeconomic perspectives (Mongey, 2016; Head and Spencer, 2017; Hottman, Redding and Weinstein, 2016).[13]

A new series of papers have aimed at directly understanding the results of the aggregate trend of consolidation on various outcomes. Antón et al. (2016); Azar, Schmalz and Tecu (2016); Azar, Raina and Schmalz (2016) explore common ownership of firms within industries. Within wholesale trade, Ganapati (2016) shows that while market concentration and prices may both increase, downstream customers may still benefit as higher operating profits cover substantial fixed costs to improve customer experiences and increase total overall sales. Looking solely at price, Kwoka Jr (2012) finds that there is a small average increase in price following mergers. Blonigen and Pierce (2016) show that mergers do not seem to improve firm productivity. I consider aggregate market power expansion, including both natural and M&A growth.

I describe the data in Section 1, before considering the relationship of changes in market concentration to economic outcomes in Section 2. I consider the role played by productivity in Section 3 before concluding with a simple explanatory model.

1 Data

Data comes from three main data sources. First, the U.S. Census Bureau's Economic Censuses (EC), conducted ever five years from 1997 to 2012, provide national-level market concentration figures by North American Industry Classification System (NAICS) codes. The same surveys from 1972-1992 compiled data by Standard Industry Classification (SIC) codes. Second, the Manufac-

[10] In the medium run explored in this paper, the change in the price of capital is largely constant between industries - and therefore is difficult to in a difference-in-difference framework with time fixed effects.

[11] See Schmalensee (1989) and Peltzman (1977).

[12] See Armstrong and Porter (2007).

[13] Mongey (2016) uses a general equilibrium model to understand the role of market power on monetary policy. Head and Spencer (2017) argue for the return to oligopolistic competition in analysis of international trade. Hottman, Redding and Weinstein (2016) show significant departures from monopolistic competition models for the largest firms in retail purchase datasets.

turing Industry Database, compiled jointly by the National Bureau of Economic Research and the U.S. Census Bureau's Center for Economic Studies (NBER-CES), provides detailed manufacturing industry statistics, including both input and output price levels. Third, for non manufacturing industries, the U.S. Bureau of Economic Analysis (BEA) provides price index and output volume data from 1977 to 2012. All data, including market shares and prices, refer to domestic producers. While manufactured goods prices may have fallen in aggregate (Feenstra and Weinstein, 2017), I focus on the price of domestically produced goods and follow the international trade literature in assuming there is imperfect substitutability between foreign and domestically produced goods.[14]

The price data used is primarily sourced from the Bureau of Labor Statistics (BLS) Producer Price Indices (PPI), originally called the Wholesale Price Index (WPI) prior to 1978. These time-series measure the average price of US domestic output. Historically, the BLS primarily collected industry-level price data on agricultural commodities, before transitioning to manufacturing data following World War II (Conforti, 2016). As the economy transitioned to services, the BLS started collecting high-quality data on service sectors in the 1980s (Swick, Bathgate and Horrigan, 2006; Bureau of Labor Statistics, 2018).[15]

Due to the slow take-up of BLS PPI data collection on service sectors prior to 1985, the BEA supplemented this data with their own estimates and data collection, with data from a variety of sources, including the Department of Transport, the Federal Communications Commission, Securities and Exchange Commissions and various BLS Consumer Price Indices (Yuskavage, 1996; Streitwieser, 2010; Landefeld and Parker, 1997; Locke et al., 2011).[16] I use the BEA's chained measures, as opposed to fixed weights, minimizing prior issues of substitution bias of products within sectors. (Landefeld, Parker and Triplett, 1995) These chained measures are derived from a BLS computed Laspeyres index, chosen from a representative weighed survey of domestic producers.[17]

Market shares are more difficult to construct. One must identify competitors/industries, allow for companies to compete in multiple segments, and account for varying substitution margins between firms and markets. To simplify the analysis, industry definitions follow those computed by the US Census across firms within a particular NAICS or SIC code. Industries are defined at the 6-digit NAICS level and at the 3 or 4-digit SIC level (depending on historical data availability).[18] I measure market concentration using the aggregate market shares of the four largest firms in an industry by revenue (following Autor et al. 2017).

This combined dataset has market concentration, revenues, prices indices, employment, and

[14]Robustness checks from the Online Appendix adds four further data sources, covering international trade, hourly wages, and regulatory barriers. I directly control of import penetration and the growth of China following permanent normalization of trade relations. Imports have the expected effect, lowering prices, output, workers and wages. Additionally the baseline results hold when dropping all manufacturing sectors.

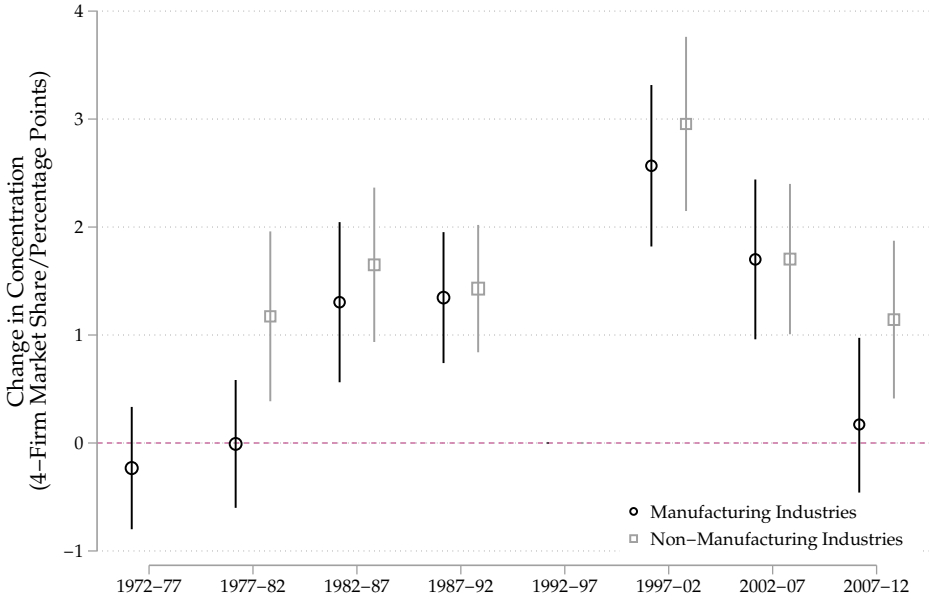
[15]Furthermore, as the BLS uses hedonic prices for a subset of industries, I am able to correct for changes in quality (Moulton et al., 2001).

[16]This ad-hoc and noisy coverage of service sectors prior to 1987 may bias me against finding any results in that time period.

[17]These indices only update weights every 5-years; matching the frequency of our market share statistics (Bureau of Labor Statistics, 2008).

[18]An example 6-digit NAICS category is "327121-Brick and Structural Clay Tile Manufacturing" and a 4-digit SIC category is "3251-Brick and Structural Clay Tile (except slumped brick)."

Figure 1: Average Change in Market Share of 4-Largest Firms over 5-year intervals



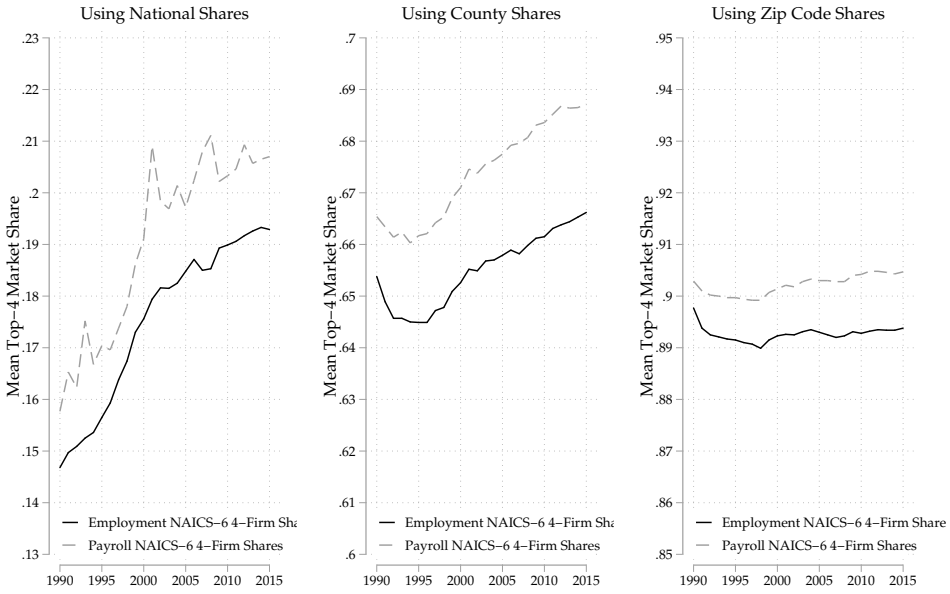
Notes: Results from a regression of change in 4-firm concentration shares by time period. From 1972-1992, average of 4-digit SIC codes for manufacturing industries and lowest levels of aggregation for non-manufacturing industries (A mixture of 3 and 4 digit SIC codes). From 1997 onwards, average of 6-digit NAICS codes for all industries. Data for non-manufacturing firms in 1972 is incomplete. Data from 1992 and 1997 are from non-comparable industrial classification systems.

payroll by industry every five years. I then derive real output, labor productivity, average wage and labor's share of revenue from these initial data points. This covers the majority of the U.S. private sector, with over 75% of gross output in 2012. I measure productivity as gross output per worker (following Decker et al. 2016). All data covers only domestic prices and market shares. The Online Appendix presents summary statistics and considers alternative measures for productivity (total factor productivity and hourly gross output) and for market shares (market shares using levels, the Herfindahl-Hirschman index and correcting for manufacturing import shares).

1.1 Concentration Trends

The largest firms have grown disproportionately in size over the last forty years. Figure 1 shows the average market share growth of the largest four firms (4-Firm Share) across industries in five year intervals. For example, between 1997 and 2002, the largest four firms increased their market share by an average of 2.5 percent. Data for 1992-1997 is unavailable due to a change in the U.S. Census Bureau's industry classification system. If changes in this time period are recovered through interpolation, the market share of the largest four firms in the average industry increased nearly 10 percentage points from 1977-2012, reaching nearly 40% by 2012. I refer the reader to Autor et al. (2017) for a fuller description of this trend.

Figure 2: Market Share by Employment and Payroll, 1990-2015



Notes: These three graphs plot changes in the average market share of the top four firms across 6-digit NAICS codes. Data drawn from a balanced panel from 1990 through 2015, with data weighted using employment levels in 1990. The left plots trends ranking firms using the top four firms by within-NAICS code employment and payrolls, using national market definitions. The center plots trends using county-level market definitions. The right plots trends using 5-digit zip code market definitions. The solid trend-line plots market shares computed using payroll. The dotted trend-line plots market share computed using employment. Data aligned from 1990-2005 to 2012 NAICS codings from the Longitudinal Business Database for all firms with either payroll or employment.

1.1.1 Local versus national market power

One issue is that market concentration is only calculated at national levels, even though competition may be local. If markets are regional and national concentration increases are not correlated with local concentration changes, then downstream market power should remain constant. For example, if an New England grocery chain mergers with a Midwest grocery store chain, downstream market power should stay constant.[19]

In the absence of consistent and comprehensive establishment-level revenue data across all sectors, I compute market shares using employment at different regional aggregations by 6-digit NAICS code from 1990-2015 using a unified crosswalk from Fort and Klimek (2016).[20] In Figure 1, I show that market concentration exhibits similar patterns over different market definitions. In 1990, the largest four firms employed 15% of all workers in the average industry nationally, increasing to 19% in 2015. County-based markets show a similar trend, with equivalent market shares rising from 65% to 67%. Data at the 5-digit Zip code level finds that employment market shares have remained roughly constant, hovering around 90%.[21] The truth lies somewhere in the middle, national data shows increasing concentration, while zip code data shows markets that have always been concentrated, with little variation over time. Concentration matters at different levels of aggregation in different industries. Some goods are non-traded, while others are globally traded, I will consider both possibilities while interpreting results.[22]

2 Market Concentration and Outcomes

Baseline regressions are of the following form:

$$\Delta_5 \log(Y_{it}) = f\left[\Delta_5 \log(Concentration_{it})\right] + \gamma_{st} + \epsilon_{it}$$

Observations are indexed by industry i and year t. $Concentration_{it}$ denotes the market concentration of industry i in year t.[23] The operator Δ_5 takes a five year difference and standardizes

[19] This assumes away both upstream market effects and potential production synergies.

[20] Data on traded firms is available through Compustat, but this data exists only at the national/global level. For example the entry for Amazon not only contains sales data for the United States, but also abroad. In addition to containing sales data for online retailing, this data further mingle data for IT computing services (cloud computing). While US Census establishment level data does not completely solve this aggregation issue, it significantly alleviates these concerns and includes on public and private firms. Data prior to 1990 are riddled with numerous errors and are highly variable.

[21] In terms of HHI indices, average ZIP code levels are between 5700 and 6000. Nearly all markets qualify as "Highly Concentrated", being over the 2500 cutoff.

[22] Notably, Rinz (2018) and Rossi-Hansberg, Sarte and Trachter (2018) find that local market power is often decreasing, even though national market power is increasing. In the Online Index, I show their results may be due to compositional issues. First, extremely small market definitions can lead to locations with zero firms. Second, an unbalanced panel can lead to mis-measuring market power. The dataset used by Rossi-Hansberg, Sarte and Trachter (2018) is not easily available, and the revenue portion of the data set has never been cross-validated with administrative datasets. I follow the approach of Rinz (2018), using US Census administrative data that uses tax data to verify employment and payroll records by establishment.

[23] I use the logarithm of concentration, as opposed to the level or exponent. This is since the data may deflate the level of concentration at the bottom end of the data. Many markets are regional or local, as opposed to national.

the variables. The fixed effect γ_{st} controls for the 2-digit NAICS top-level sector and year.[24] The residual ϵ_{it} reflects any residual unexplained variation and measurement error. Outcome variables Y come from the following interlinked outcomes of economic interest:

$$\begin{aligned}
\Delta_5 \log\left(Price\right) & \\
\Delta_5 \log\left(Real\ Output\right) &= \Delta_5 \log\left(Revenue/Price\right) \\
\Delta_5 \log\left(Labor\ Productivity\right) &= \Delta_5 \log\left(Real\ Output/Employees\right) \\
\Delta_5 \log\left(Average\ Wage\right) &= \Delta_5 \log\left(Wages/Employees\right) \\
\Delta_5 \log\left(Employees\right) &= \Delta_5 \log\left(Quantity/Labor\ Productivity\right) \\
\Delta \log\left(Payroll\right) &= \Delta_5 \log\left(Average\ Wage \times Employees\right) \\
\Delta_5 \log\left(Wage\ Share\right) &= \Delta_5 \log\left(Wages/Revenue\right)
\end{aligned}$$

The five-year time difference reflects medium-run changes and reflects data availability. This controls for aggregate inflation and growth, as well as secular sectoral effects (such as the relative growth of healthcare and the relative decline in manufacturing). The relationships $f\left(\cdot\right)$ are identified off differences in concentration within an industry and across time. This form is convenient as it is (a) parsimonious, (b) uses readily available data, and (c) allows for simple decompositions and extensions.

The primary issue to running regressions that directly test their relationships is that prices and quantities are equilibrium objects. Shifts in both supply and demand can alter both variables (Schmalensee, 1989). Lacking straightforward exogenous shifters of market concentration, these regressions are presented as correlational and are not used to calculate any counterfactual (which likely would need (a) macroeconomic effects and (b) detailed modeling of both the supply and demand sides).

These regressions are motivated by a variety of classic models in the style of Sutton (1991). Market power increases are driven by increases in the implied (endogenous or exogenous) fixed cost of entry. If such fixed costs increase, but do not reflect either product innovation, increased demand, or decreased marginal costs, then there will be a welfare loss. Examples include heightened barriers to entry from anti-competitive incumbent behavior or costly, unproductive regulation. On the other hand if these increased fixed costs reflect sufficient innovation or production efficiency, then welfare will increase.

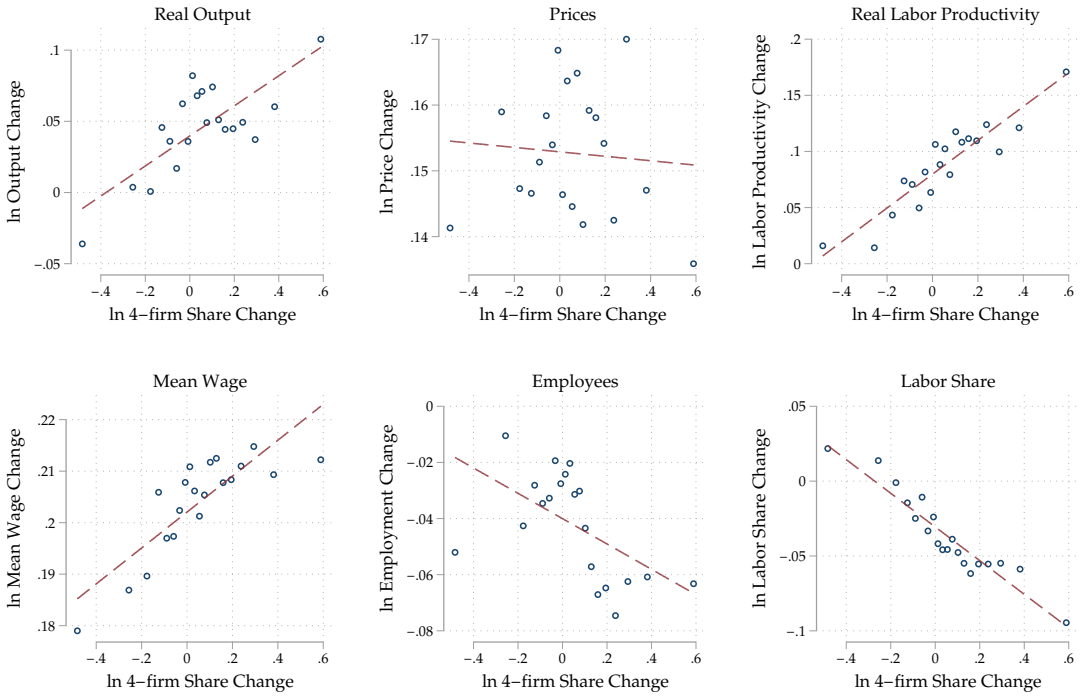
Returning to empirics, the various relationships summarized by the function $f\left(\cdot\right)$ are illustrated in bin-scatter plots in Figure 3.[25] Outcomes can be simply summarized: increases in industry con-

Markets such as retail gasoline and childcare have extremely low market shares. On the other hand, in specialized manufacturing industries that are nationally dominated by one or two firms, a 5% change may simply indicate year-to-year noise. Using using national market shares levels would effectively overweight these latter industries. However, as shown in Section 1.1.1, national market shares are good proxies for more local market shares. Using a logarithms gives these locally monopolistic, but nationally competitive industries more weight. Furthermore, in the Online Appendix, regressions using levels, as opposed to logarithms, gives similar to the baseline results in the main text.

[24] See the Online Appendix for a crosswalk from SIC to 2-digit NAICS.

[25] This figure is replicated as a local polynomial plot in the Online Appendix Figure C.1 and in levels in Appendix

Figure 3: Correlation of Economic Outcomes to Market Concentration



Notes: Results from a bin-scatter regression of 5-year changes change in the combined market share of the four largest firms by time period after controlling for year-sector means. Sectors computed using two-digit sector codes according to Online Appendix Table B.2. From 1972-1992, data uses 4-digit SIC codes for manufacturing industries and lowest levels of aggregation for non-manufacturing industries (A mixture of 3 and 4 digit SIC codes). From 1997 onwards, 6-digit NAICS codes for all industries. Data from 1992 and 1997 are from non-comparable industrial classification systems. Bin-scatters use 20 bins, with equal numbers of observations in each bin.

centration are significantly correlated with higher output, higher revenue, higher labor productivity, average wages, and lower labor income shares. Monopolization is not correlated with significant changes in prices, employment, or aggregate payroll. Specifically a 10% increase in the market share of the largest four firms is linked to a 1% increase in output, flat prices, 1.5% increase in labor productivity, 0.4% increase in wages, 0.3% decrease in employment, flat total payroll, and 1% decrease in labor's share of output.

The choice of 4-firm concentration shares and real labor productivity are motivated by data availability. Alternative measures of productivity on a smaller sample of industries, such as using hours worked or total factor productivity yield similar results. Alternative measures of concentration, such as the Herfindahl–Hirschman Index and simplified regressions where $f(X) = \alpha X$ are conducted. See the Online Appendix for details.

Two endogeneity concerns warrant further discussion. First, a negative demand shock could lead to higher concentration and lower prices. In light of the expansion in output, this seems improbable. An ideal dataset would include a true demand instrument, however in the Online Appendix, I control for pre-trends in demand by including lagged output and a one-period change in lagged output. Results are largely unchanged. Second, a productivity shock may drive these results. As shown in the baseline results in Figure 4, productivity is highly correlated with market concentration. Omitting productivity in the baseline results would lead to potentially misleading results. Growth in output may not be due to oligopoly growth; the true underlying factor may be productivity growth.

3 Productivity

The third panel of Figure 3 highlights the strong relationship between productivity and market concentration. To investigate, I rerun a similar specification as before, but now use:

$$\Delta_5 \log(Y_{it}) = f\left[\Delta_5 \log(Labor\ Productivity_{it})\right] + \gamma_{st} + \epsilon_{it}$$

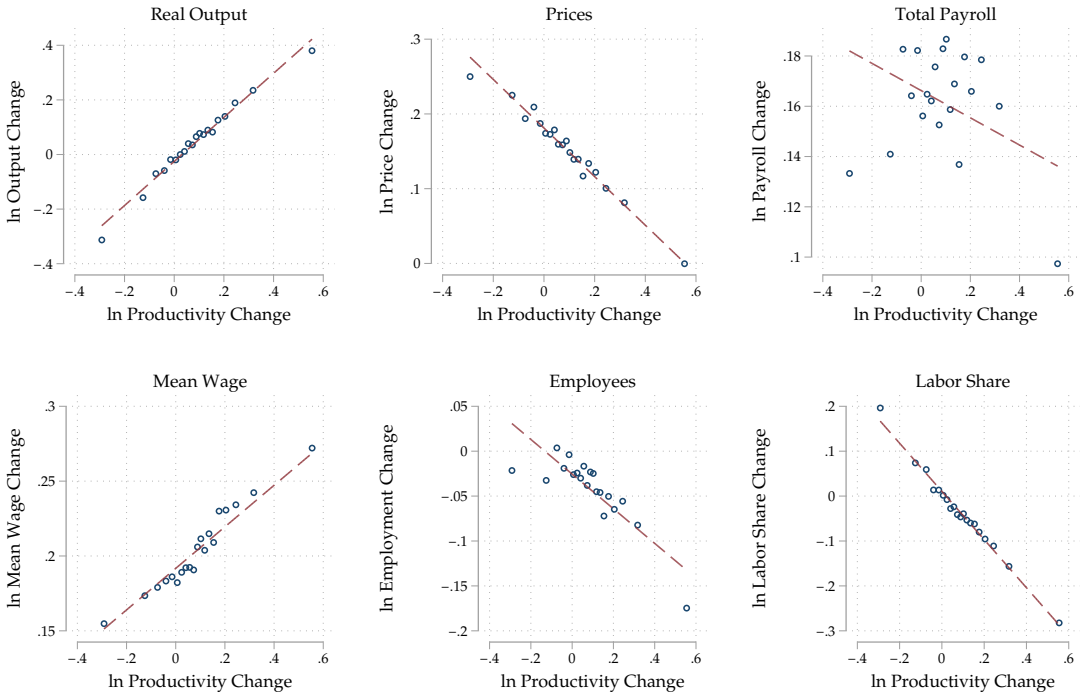
The variables Y represent real output, prices, payroll, mean wages, employees, and labor share. The results are presented as bin-scatter plot in Figure 4.[26] All relationships are similar to those for market concentration, but magnified and precise. Higher labor productivity is correlated with higher output, lower prices, constant payroll, higher wages, fewer employees, lower labor shares. Specifically a 10% increase in the labor productivity is linked to a 8% increase in output, 3% decrease in prices, 1.5% increase in wages, 1.7% decrease in employment, flat total payroll, and 5% decrease in labor's share of output.[27]

Figure C.3. Results are similar.

[26]This figure is replicated as a local polynomial plot in the Online Appendix Figure 4. See the Online Appendix for results with alternative measures of productivity on a smaller sample of industries, such as using hours worked or total factor productivity.

[27]This may be partially mechanical, unlike the market concentration results. For example, $Labor\ Productivity = Revenue/Price/Employment$. If prices fall, and revenue and employment remain constant, productivity must rise. However, these are all equilibrium outcomes and it is unlikely that revenue and employment will remain constant.

Figure 4: Correlation of Economic Outcomes to Labor Productivity



Notes: Results from a bin-scatter regression of 5-year changes in labor productivity after controlling for year-sector means. Sectors computed using two-digit sector codes according to the crosswalk in the Online Appendix. From 1972-1992, data uses 4-digit SIC codes for manufacturing industries and lowest levels of aggregation for non-manufacturing industries (A mixture of 3 and 4 digit SIC codes). From 1997 onwards, 6-digit NAICS codes for all industries. Data for non-manufacturing firms in 1972 is incomplete. Data from 1992 and 1997 are from non-comparable industrial classification systems. Bin-scatters use 20 bins, with equal numbers of observations in each bin.

Table 1: Market Concentration and Productivity Regressions

	Δ Ln Output	Δ Ln Price	Δ Ln Revenue	Δ Ln Labor Productivity
Std Δ Ln 4-Firm Share	-0.000660	0.0128	0.0121	0.208
	(0.00462)	(0.00196)	(0.00535)	(0.0197)
Std Δ Ln Productivity	0.165	-0.0653	0.100	
	(0.00698)	(0.00630)	(0.00896)	
r2	0.360	0.614	0.318	0.189
	Δ Ln Mean Wage	Δ Ln Employees	Δ Ln Payroll	Δ Ln Labor Share
Std Δ Ln 4-Firm Share	0.00450	-0.000660	0.00384	-0.00826
	(0.00146)	(0.00462)	(0.00496)	(0.00210)
Std Δ Ln Productivity	0.0265	-0.0336	-0.00715	-0.107
	(0.00301)	(0.00698)	(0.00756)	(0.00561)
r2	0.590	0.201	0.281	0.547
Observations	4720	4720	4720	4720

Notes: Robust standard errors clustered on BEA industry codes. Regressions include year-sector fixed effects. Sectors computed using two-digit sector codes according to the crosswalk in the Online Appendix. Observations at the NAICS 6-digit level for 1997-2012 and at the SIC 3 and 4-digit level for 1972-1992. Data from 1992 and 1997 are from non-comparable industrial classification systems. Market shares and productivity changes are standardized by subtracting means and dividing by standard errors.
Sources: Author's Calculations based on US BEA, BLS, Census, NBER-CES data

To better compare these relationship between productivity and market concentration, I run regressions of the form:

$$\Delta_5 \log(X_{it}) = \alpha_1 [\Delta_5 \log(Concentration_{it})] + \alpha_2 [\Delta_5 \log(Labor\ Productivity_{it})] + \gamma_{s,t} + \epsilon_{it}.$$

For comparability, concentration and productivity are standardized by subtracting means and dividing by their standard errors. Results are presented in Table 1. It appears that almost the entirety of the correlation of market concentration and the other observed market outcomes is absorbed by productivity. There is a small positive correlation between prices and market concentration, but as shown in Figure 3, this is completely offset in aggregate as growth in productivity is highly correlated with concentration.[28] However both market concentration and productivity are measured with error, preventing a true disentangling of market power and productivity.[29] Over the last 40 years, productivity growth has been intrinsically tied with the rise of monopolies and oligopolies.

[28] Assuming away measurement error, this means there is a small negative effect of monopoly, a one standard deviation increase in monopoly power offsets 1/5 of the price decrease from a one standard deviation increase in productivity. How should a observer interpret this? The most pessimistic reading is that after controlling for productivity, monopolies do increase prices. But this argument assumes that all other conditions including productivity remain constant. In the light of the close linkage of productivity and concentration, this seems untenable. In the Appendix, looking at only non-manufacturing firms that account for over 80% of the economy, this link between price and industry concentration vanishes.

[29] As shown in the Appendix, measures of regulation seem to be uncorrelated with either productivity or market power.

3.1 Robustness

Even though these relationships are purely correlational, they are extremely robust. I consider a set of alternative specifications. These alternative specification are not to attribute causation, but rather test the strength of the baseline relationships. I focus on two specific forms of heterogeneity, across time and across industries.

In the Online Appendix, I further consider long-run trends, trends in homogenous industries, different methods of computing market share changes, weighted results, the role of factor price inputs, total factor productivity, hourly productivity, import penetration in manufacturing, regulations, and time-series demand controls. The core result, that increases in oligopoly are not directly correlated with price increases and output decreases is well supported in the data across all robustness exercises. The interaction between productivity and market power is extremely robust. More market power is extremely highly correlated with increased productivity - regardless of how market power or productivity are measured.

3.1.1 Industry Heterogeneity

There is significant heterogeneity across industries. Due to the sparsity of the data, I follow (Eckert, Ganapati and Walsh, 2019) and create the following top-level groups: Arts and Hospitality, Health Care, Manufacturing, Trade and Transport (Retail, Wholesale, Shipping), Skilled Tradable Services (Finance and Professional Services), and Other Services (Repairs and Household Services).

Table 2 displays the results. All sectors, with exception of the Hospitality sector, exhibit a positive relationship between productivity and concentration.[30] Most sectors exhibit a positive relationship between concentration and output increases, with Manufacturing and Hospitality showing noisy results. Only one sector shows a correlation between prices and market concentration: the Health Care sector. This echoes systematic research (Cooper et al., 2018), showing that price increases in the hospital sector are systematically due to market concentration. While most sectors see a negative correlation between labor shares and market concentration, this is not true in the Health Care sector, suggesting a very different pattern relative to the rest of the economy.

3.1.2 Timeline Heterogeneity

In Table 3, I replicate out baseline results across time. In particular, our headline finding, that increases in market share are correlated with output and productivity increases are stable from 1987-2012. A one standard deviation increase in market concentration is related to a 2-5% increase in output, no changes in prices, 20-30% increase in productivity, and a 2-5% fall in the labor share of income. Data prior to 1987 is imprecise, reflecting the sparsity and quality of market share data prior to 1987.[31]

[30] Aligning with Aghion et al. (2019), showing that BLS price indices have the largest issues measuring restaurant and hotel entry/exit.

[31] See the Online Appendix discussion of issues with BEA and BLS price index data in services prior to the mid-1980s.

Table 2: Sectoral Heterogeneity: 4-Firm Market Share Change Coefficients

	Δ Ln Output	Δ Ln Price	Δ Ln Labor Productivity	Δ Ln Labor Share
Std Δ Ln 4-Firm Share ×				
Resources + Construction	0.281	-0.0305	1.158	-0.212
	(0.0826)	(0.00703)	(0.341)	(0.0679)
Manufacturing	0.0188	0.00349	0.197	-0.0326
	(0.00965)	(0.00346)	(0.0262)	(0.00413)
Trade + Transport	0.0486	-0.00707	0.232	-0.0341
	(0.0115)	(0.00471)	(0.0383)	(0.00729)
Skilled Tradable Services	0.0672	-0.00215	0.327	-0.0554
	(0.0229)	(0.00215)	(0.0733)	(0.0127)
Health Care	0.0218	0.00469	0.0916	-0.00522
	(0.0108)	(0.00173)	(0.0389)	(0.00344)
Arts + Hospitality	-0.0128	-0.00208	0.0799	-0.00183
	(0.0222)	(0.00235)	(0.0765)	(0.0116)
Other Services	0.0342	-0.00175	0.179	-0.0171
	(0.0130)	(0.00139)	(0.0509)	(0.00776)
r2	0.141	0.502	0.194	0.229
Obs	4720	4720	4720	4720

Notes: Robust standard errors clustered on BEA industry codes. Regressions include year-sector fixed effects. Sectors computed using two-digit sector codes according to Online Appendix Table B.2. Observations at the NAICS 6-digit level for 1997-2012 and at the SIC 3 and 4-digit level for 1972-1992. Data from 1992 and 1997 are from non-comparable industrial classification systems. Market shares and productivity changes are standardized by subtracting means and dividing by standard errors.
Sources: Author's Calculations based on US BEA, BLS, Census, NBER-CES data

Table 3: Intertemporal Heterogeneity: 4-Firm Market Share Change Coefficients by Year

	Δ Ln Output	Δ Ln Price	Δ Ln Labor Productivity	Δ Ln Labor Share
Std Δ Ln 4-Firm Share ×				
1972-1977	0.0161	-0.0232	0.268	-0.0254
	(0.0193)	(0.0122)	(0.0691)	(0.00979)
1977-1982	-0.0169	-0.0162	0.0481	0.00849
	(0.0201)	(0.00999)	(0.0734)	(0.0107)
1982-1987	0.0242	0.0117	0.0661	-0.0185
	(0.0175)	(0.00594)	(0.0434)	(0.00767)
1987-1992	0.0340	-0.00731	0.177	-0.0230
	(0.0105)	(0.00471)	(0.0299)	(0.00393)
1997-2002	0.0425	0.000170	0.240	-0.0350
	(0.0140)	(0.00304)	(0.0396)	(0.00643)
2002-2007	0.0296	0.000929	0.221	-0.0334
	(0.0156)	(0.00305)	(0.0309)	(0.00540)
2007-2012	0.0544	0.00582	0.293	-0.0504
	(0.0178)	(0.00338)	(0.0555)	(0.0104)
r2	0.138	0.503	0.193	0.226
Obs	4720	4720	4720	4720

Notes: Robust standard errors clustered on BEA industry codes. Regressions include year-sector fixed effects. Sectors computed using two-digit sector codes according to Online Appendix Table B.2. Observations at the NAICS 6-digit level for 1997-2012 and at the SIC 3 and 4-digit level for 1972-1992. Data from 1992 and 1997 are from non-comparable industrial classification systems. Market shares and productivity changes are standardized by subtracting means and dividing by standard errors.
Sources: Author's Calculations based on US BEA, BLS, Census, NBER-CES data

4 Simple Framework

Competition in individual markets can take many forms of competition - a single model cannot capture all aspects faithfully. I rely on the insights of Sutton-style models (Shaked and Sutton, 1987; Sutton, 1991, 2007), where firms first make sunk investments. These sunk investments may be either exogenous (factories reducing marginal cost) or endogenous (advertising and innovation increasing demand), but are completed before firms compete to sell goods and services. This competition can take a variety of forms, it may be on price, quality, or quantity. Throughout these models, there is one prediction that holds constant; as a market grows in size, market concentration should be weakly decreasing (Sutton, 1991). I do not observe this in the data and it helpful to consider why.

In such models, if fundamental parameters governing sunk costs remain constant, larger markets become more appealing to entrants. However, in a world with technology growth and/or changing production costs, this may not be true. Empirically there is a stark relationship between market concentration growth and productivity growth. Through the lens of these models, if firms pay higher sunk costs over time (say through better automation, R&D, or innovation), then we can break the inverse relationship between market size and concentration. Investments, that once provided limited scope for either increasing demand or decreasing marginal costs, are aided by technical change and now may create winner-take-all economies.

Furthermore to be consistent with the labor share results, the bulk of these fixed costs should be paid to capital, rather than labor. This is consistent with conventional modeling of production functions, where capital is a dynamic investment and labor is more flexible. (See Ackerberg, Caves and Frazer (2015) for a variety of approaches.)[32]

While national market and country market shares are increasing, there is some debate if effective market shares are increasing (Rossi-Hansberg, Sarte and Trachter, 2018). Data at the zip code level shows that 4-firm shares have remained high, averaging 90%. An increase in output, with no change in price, can be also rationalized in a world where the number of firms at the local level is constant. In that case, monopolies represent a more productive national firm simply displacing smaller local rivals.[33]

In the online appendix, I present two extremely simple models that capture this mechanic. One uses Cournot competition and the other uses Nash-in-Prices competition.

[32] In the online appendix, I present two extremely simple models that capture this mechanic. One uses Cournot competition and the other uses Nash-in-Prices competition. In these two textbook models, an increase in output, productivity, and market concentration can only be rationalized with an increase in fixed costs that lead to lower marginal costs. Furthermore if fixed costs are disproportionately paid to non-labor factors, labor share will fall.

[33] Alternatively, a decrease in the slope of demand, will decrease the quantity demanded and leave price constant. For this story, it must be then true that national monopolies are correlated with systematic shifts in reduced consumer price-sensitivity. However, I do find evidence that national monopolies are correlated with increases in productivity (and thus decreases in marginal costs), detracting from this story.

5 Discussion

This paper aims to provide another piece of evidence in the ongoing debate over increases in market power. Industry concentration could theoretically lead to higher prices and lowered output in the absence of true productivity innovation or reallocation to superstar firms. However, concentration increases do not correlate to price hikes and correspond to increased output. This implies that oligopolies are related to an offsetting and positive force - these oligopolies are likely due to technical innovation or scale economies. My data suggests that increases in market concentration are strongly correlated with innovations in productivity.

These price and quantity regressions are purely within-industry results and lack causality. They may suffer from omitted variable biases. Results are from 5-year difference-in-difference estimates and assume away general equilibrium effects. However, they show clear patterns between prices, quantities, productivity, and market concentration. Many - if not most - industries could be developing new and novel economies of scale. In retail, Walmart (Holmes, 2011) and Amazon (Houde, Newberry and Seim, 2017) both exploit economies of scale to lower their marginal cost and increase market shares. While market power may increase, consumers benefit in the short to medium run through price reductions and real choice increases.[34] On the other hand, these effective firms do not expand their workforces, creating more while holding payroll constant.

This is a trend that is consistently noted, especially from 1987-2012, the period coinciding with high quality price data. But there is substantial heterogeneity between industries. For example, the Health Care sector exhibits classic symptoms, where market concentration increases are correlated to price increases. Though notably, market concentration in the Health Care sector is not correlated with a declining labor share, as the benefits of monopoly may accrue to workers.

This modeling framework also highlights directions for possible future work. We need better data on effective market shares. National and highly local market shares are both problematic. Markets are not mutually exclusive, as there is overlap between regions and industries (for example traditional and online retail). Adding complexity, market definitions may be changing over time, due to changes in both consumer preferences and producer technologies. Additionally, while regional consumption and price data exists for some markets, such as consumer packaged retail goods (Handbury and Weinstein, 2014), further work needs to be done to integrate such data across all markets with appropriate market share data. Welfare in many situations can be quickly summarized by both price and output levels, market power alone is rarely a sufficient statistic.

Finally, taking the superstar firm hypothesis seriously does not imply that antitrust authorities should be powerless. Dominant firms may entrench themselves and use their newly dominant market positions to engage in anti-competitive behavior. Natural monopolies can give way to anti-competitive monopolies that act to raise prices and squelch innovation (Coll, 2017). Monopolies may be taking a bigger share of productivity innovations for themselves and only passing a small share of the gains to the consumer. Effective regulators may want to force monopolies to share a

[34] For an international trade context, see Atkin, Faber and Gonzalez-Navarro (2015).

greater share of their surplus with the public (Watzinger et al., 2017).[35]

[35]The classic example is the 1956 consent decree between the US Department of Justice and the AT&T, leading to the widespread dissemination of lasers, solar cells Unix operating system, while allowing AT&T to continue as a telecommunications monopoly for another 30 years.

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