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Industrial organization and *The Rise of Market Power* ☆

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ABSTRACT

This article addresses developments in the literature on *The Rise of Market Power*. First, it summarizes research about the result of De Loecker et al. (2020) that the sales-weighted average markup has increased in the United States. Second, it summarizes and evaluates a set of industry studies that examine market power over long time horizons in specific settings. A theme that emerges from these industry studies is that technological advancements matter a great deal for the evolution of economic outcomes. By contrast, the studies do not point to weak antitrust enforcement as contributing to greater market power. The article concludes by outlining directions for future research.

1. Introduction

Market power is the central subject of industrial organization (IO) as a field of economics. Although this may be self-evident to many, it also can be confirmed by perusing the chapters of the recently-published *Handbook of Industrial Organization* (vols 4 and 5). These chapters examine the causes and consequences of market power under different market structures (e.g., Asker and Nocke, 2021; Lee et al., 2021; Jullien et al., 2021) and explore how market power interacts with the institutional details of markets in which there is a particular policy interest, such as finance, health care, and energy markets (Clark et al., 2021; Handel and Ho, 2021; Kellogg and Reguant, 2021). Perhaps the prototypical approach of modern IO involves the estimation of a structural model of oligopoly competition that is tailored to a particular institutional setting, and which can be used to understand how economic outcomes may change under a variety of counterfactual scenarios (e.g., Aguirregabiria et al., 2021; Berry and Haile, 2021; Gandhi and Nevo, 2021).

For this IO economist, one of the striking developments of the previous decade has been the emergence of a literature that finds significant increases in market power among firms in the United States—what I will refer to as *The Rise of Market Power*. This literature does not employ the modern toolkit of IO. Indeed, perhaps the seminal contribution, that of De Loecker et al. (2020) ["DLEU"], uses an approach that originates in the fields of macroeconomics and international trade to recover price-cost markups, not just in one specific setting, but for all publicly-traded firms and spanning multiple decades. The emergence of this literature has coincided with a resurgence of political interest in market power and antitrust enforcement. Thus, there are important intellectual and practical reasons for IO to engage with the prospect that the degree of market power firms exercise may be greater presently than in earlier eras.

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[1] *Disclaimer:* I regularly consult with antitrust authorities and private companies on antitrust matters, and some of those consulting relationships are confidential. In 2022, I testified on behalf of the United States about the Northeast Alliance of American Airlines and JetBlue Airlines. I also have consulted with Alaska Airlines and Hawaiian Airlines about their merger. I have had no consulting relationship in the past three years related to the other industries discussed in this article.

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I seek to make two contributions in this article. The first is to summarize the results of DLEU and describe the empirical challenges of the "production approach" to recovering markups (Section 2). In doing so, I attempt to consolidate knowledge from a large and growing number of articles on the subject. The target audience of this section includes applied economists who have some exposure to production function estimation (e.g., Olley and Pakes, 1996; Levinsohn and Petrin, 2003), and who are looking to learn about how it has been applied to study markups over time. In focusing on DLEU, I consider only part of the literature on *The Rise of Market Power*. Other aspects—for example, the observation that some measures of concentration are increasing—are well discussed in other review articles (e.g., Shapiro, 2018; Syverson, 2019; Shapiro and Yurukoglu, 2024).[2]

Although the modern IO toolkit is not inherently well-suited for research questions that are macroeconomic in scope, IO research nonetheless has an important role to play in assessing and understanding *The Rise of Market Power*. The reason is that structural models of demand and supply have the potential to provide insights into the mechanisms that drive changes in economic outcomes, including through counterfactual analysis. These mechanisms are interesting as an intellectual matter, and understanding them could help provide a more sound basis for policy, in antitrust and elsewhere. Structural modeling also can help researchers better recover objects of interest that are not observed in data. The challenge for IO researchers is to apply the modern IO toolkit rigorously, at a scale sufficient to inform the broader literature.

The second contribution I make is to review a number of recent studies of specific industries over long time horizons (Section 3). These studies are at the frontier of what can be accomplished with IO tools, and each is significant on its own. However, my ultimate focus is on whether there is even more to be learned by reading them together. Is it possible that, as a group, the industry studies allow us to evaluate the trends estimated in DLEU and to obtain insights into the mechanisms that drive changes in economic outcomes? Alternatively, perhaps it is the case that generalizing across industries is simply too difficult, such that broader insight is elusive. My approach is to describe the industry studies in detail and then evaluate their similarities and differences. The target audience of this section includes economists, including macroeconomists, who are interested in learning about what IO research indicates about how market power has evolved in recent decades.

The industry studies cover consumer packaged goods (Brand, 2021; Atalay et al., 2023; Döpper et al., 2023), portland cement (Miller et al., 2023), wholesaling (Ganapati, 2024), steel (Collard-Wexler and De Loecker, 2015), automobile manufacturing (Grieco et al., 2023), and airlines (Bet, 2021). These are industries that are amenable to empirical modeling because they feature reasonably stable institutions and high-quality data that spans decades. Some of the industries appear so frequently in IO research that they have been referred to as "model industries."[3] Economists in the field understand their institutional details reasonably well, so it is sensible to turn to them for an initial set of findings.

The theme that I draw from the industry studies is that the changes we observe in the industries, measured across decades, are predominantly due to technological advances. The particular technologies that matter vary across the industries, and so too do the implications for economic outcomes. However, even among the industries for which technological change appears to support greater market power in the long run, the industry studies indicate that improvements in quality and reductions in marginal cost dominate, so that consumer welfare improves over time, or at least does not decline. The industry studies do not point to lax antitrust enforcement as a significant driver of greater market power.

My analysis is based on results obtained for a selected sample of industries that have particular features (e.g., stable institutions and good data). As such, the sample should not be interpreted as fully representative of the broader economy. However, at least some recent articles corroborate my interpretation of the industry studies that technological change, not weak antitrust enforcement, is the more important catalyst for rising markups (Section 4). In particular, I discuss the research of Conlon et al. (2023), which correlates the rising markups of DLEU with price changes, and then turn to related studies that examine the efficacy of antitrust enforcement more directly. A useful complement to this section is Shapiro and Yurukoglu (2024), which reviews the antitrust literature in greater depth and reaches similar conclusions. I conclude the article by outlining possible directions for future IO research (Section 5).

2. Macroeconomic evidence of rising markups

2.1. DLEU and the production approach

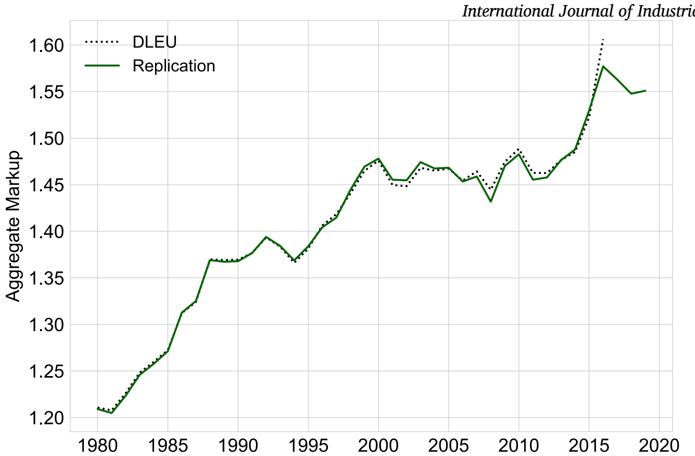
DLEU recover markups using the so-called "production approach" (e.g., Hall, 1986, 1988, 1990; De Loecker and Warzynski, 2012).[4] Assume that firms have continuous and twice differentiable production functions, that they are price takers in factor markets, and that at least one factor is a "variable input" that can be freely adjusted each period.[5] Letting i and t subscripts refer to firms and periods, respectively, a first order condition for cost minimization can be written as:

[2] With regard to market concentration, I add only that recent research indicates that concentration may be *decreasing* in some markets that are defined narrowly, either in geographic space (Rossi-Hansberg et al., 2020) or product space (Benkard et al., 2021), and that, in the manufacturing sector specifically, concentration does not increase if one accounts for import competition (Amiti and Heise, 2024).

[3] Berry, Steven [@steventberry]: "I was reading about "model organisms" in biology research. Maybe RTE cereal, airlines and cement are IO's model industries—our versions of mice, fruit flies and tapeworms." (Twitter, January 26, 2021).

[4] De Loecker (2011) provides a useful overview of the production approach, including a discussion of how methodological innovations and better micro-data allowed researchers to build upon the modeling approach of Hall (1986, 1988, 1990). See also De Loecker and Syverson (2021).

[5] The production approach can be extended to examine market power in input markets (e.g., Yeh et al., 2022; Rubens, 2023). Some research indicates that markup estimates can conflate downstream markups with upstream markdowns (Hashemi et al., 2022) if both are not accounted for in the model.



Notes: The black dashed line is the aggregate markup that is provided in the DLEU replication files. The green solid line extends the aggregate markup through 2019. It is calculated by the author using the output elasticities in the DLEU replication files and Compustata data. The output elasticities over 2017-2019 are assumed to be the same as those in 2016.

Fig. 1. Sales-Weighted Average Markup.

$$\mu_{it} \equiv \frac{P_{it}}{MC_{it}} = \theta^V_{it} \frac{P_{it}Q_{it}}{P^V_{it}Q^V_{it}} \tag{1}$$

The multiplicative markup, μ_{it}, is defined as the ratio of the output price, P_{it}, to marginal cost, MC_{it}. On the right-hand side, θ^V_{it} is the elasticity of output with respect to the variable input. Output is Q_{it}, so the numerator $P_{it}Q_{it}$ is revenue. The price and quantity of the variable input are P^V_{it} and Q^V_{it}, respectively, so that the denominator $P^V_{it}Q^V_{it}$ is the expenditure on the variable input. It follows that the multiplicative markup can be recovered from knowledge of the output elasticity, and data on revenues and expenditures. A derivation is provided in the appendix.

DLEU implements the production approach using accounting data from Compustat, which provides harmonized financial reports of publicly-traded companies in the United States. The cost of goods sold (COGS) is treated as the variable input. DLEU uses a number of approaches to obtain the output elasticity. In the baseline specification, DLEU assumes a Cobb-Douglas production function, and that the output elasticities are time-varying but common to all firms with the same two-digit NAICS industry code. Similar results are obtained with a translog production function and output elasticities that are time invariant. The production functions are estimated using a proxy function to account for unobserved, persistent productivity (e.g. Olley and Pakes, 1996; Levinsohn and Petrin, 2003; Ackerberg et al., 2015; Gandhi et al., 2020). DLEU then applies equation (1) to recover markups.[6]

The headline result is that the revenue-weighted average markup increases from 1.21 in 1980 to 1.61 in 2016 (Figure I of DLEU). A reproduction based on the replication of DLEU is provided in Fig. 1. It also extends the analysis through 2019.[7]

DLEU show that much of the action is in the upper tail of the markup distribution. The revenue-weighted median markup is flat, for example. A decomposition exercise demonstrates that the change is largely due to a reallocation of revenue from lower-markup firms to higher-markup firms. DLEU also finds that markup changes correlate with changes in profitability measures (market capitalization and dividends) and with expenditures on SG&A, R&D, and advertising. In addition, the elasticity of output with respect to a change in all inputs (the "scale elasticity") increases from 1.03 to 1.08 between 1980 and 2016, consistent with a modest increase in scale economies.

These results are consistent with a phenomenon in which a subset of firms increasingly incur fixed costs (e.g., SG&A, R&D, and advertising) that support higher markups in equilibrium, and account for a greater share of total revenue over time.[8] Because estimated within-firm markup growth is limited, the results of DLEU do not obviously point to weak antitrust enforcement as a main driver of the empirical trends.

However, DLEU provides limited insights into mechanisms. While the multiplicative markup can be inferred from an output elasticity and a corresponding ratio of revenues to expenditures (equation (1)), price and marginal cost are not separately identified. Therefore, whether rising markups are due to higher prices or lower costs cannot be answered, at least not directly. To the extent that prices are higher, this could be due to better products or reduced competition, but these possibilities are difficult to disentangle.

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[6] In robustness analyses, DLEU examines Census data on manufacturing, wholesale, and retail establishments. Labor and materials are the variable input. For the manufacturing data, DLEU imputes time-varying output elasticities using the "cost share" approach; I describe this in the next section. The wholesale and retail data contain less information, so DLEU uses the output elasticities that are estimated from Compustat.

[7] Edmond et al. (2023) derives that the "wedge" in aggregate employment and investment decisions depends on cost-weighted average markups, rather than sales-weighted average markups. Because firms with higher markups tend to grow faster in the DLEU sample, the rise in cost-weighted average markups is somewhat less stark than the rise in sales-weighted markups. See also Karabarbounis and Neiman (2019).

[8] Hasenzagl and Pérez (2023) finds empirical support for the relevance of this mechanism: "We find that despite the rise in market power, the [micro-aggregated] profit share has been constant at 18% of GDP because the increase in monopoly rents has been completely offset by rising fixed costs and changes in technology."

Additionally, because estimation is conducted at scale to capture the broad trends that exist, it is less well suited (by design) to reliably capture changes in the economic realities of specific firms and industries. These limitations motivate the review of the industry studies that I undertake later in this article.

2.2. Methodological challenges

DLEU has been influential in the literature, and with influence comes scrutiny. I now describe some of the main difficulties economists face when recovering markups using the production approach. I bucket these as follows: (i) challenges that arise when revenue and expenditures, rather than prices and quantities, are observed in the data, (ii) challenges from unobserved demand heterogeneity, and (iii) challenges associated with the use of accounting data to measure economic variables. DLEU makes significant efforts to overcome these challenges, and I also describe these efforts. My goal is to provide an overview that consolidates information available elsewhere.

Before proceeding, it is notable that (i) and (ii) above relate to the estimation of the production function. Yet DLEU obtain similar results if the output elasticity, θ^V, is simply held constant at 0.85.[9] Thus, the growth in the sales-weighted average markup is mostly due to a decrease in COGS relative to revenue. If COGS is interpreted as a measure of variable costs, then the raw data indicate rising variable-cost markups, and that alone is an empirical phenomenon that merits attention.

2.2.1. Unobserved prices and quantities

The Compustat data on which DLEU rely contains information on revenues and expenditures, but not on prices or quantities. This has implications for whether it is possible to obtain a consistent estimate of the output elasticity that enters equation (1). Take the Cobb-Douglas production function that is the baseline specification of DLEU:

$$q_{it} = \theta_t^V \upsilon_{it} + \theta_t^K k_{it} + \omega_{it} + \epsilon_{it} \tag{2}$$

where q_{it}, υ_{it}, and k_{it} are log output, the log quantity of the variable input, and log capital, respectively, ω_{it} is a Hicks-neutral productivity shock that is known to the firm when it chooses υ_{it}, and ϵ_{it} is a productivity shock that is realized after all input decisions are made.[10] Neither productivity shock is observed by the econometrician. The objects of interest in estimation are the time-varying output elasticities, θ_t^V and θ_t^K.

The estimation of equation (2) is nontrivial, in large part due to the relationships between ω_{it} and υ_{it} (Marschak and Andrews, 1944). However, the difficulties compound when input and output quantities are not observed. To convert the model to revenues and expenditures, one need only add and subtract price terms:

$$p_{it} + q_{it} = \theta_t^V \left(p_{it}^V + \upsilon_{it}\right) + \theta_t^K \left(p_{it}^K + k_{it}\right) + \omega_{it} + \epsilon_{it} + \left(p_{it} - \theta_t^V p_{it}^V - \theta_t^K p_{it}^K\right) \tag{3}$$

where the left-hand side is log revenue ($p_{it} + q_{it}$) and the right-hand side depends on log expenditures (e.g., $p_{it}^V + \upsilon_{it}$). This version of the production function is more amenable to estimation with accounting data. However, the unobservables now include a wedge between the output and input prices of the firm. This creates a risk of omitted variable bias because the profit-maximizing input expenditures can depend on those prices.

In some special cases, the unobserved prices may not be problematic. If firms are homogeneous, such that the price wedge exhibits only time-series variation, then time fixed effects absorb the confounding variation. Alternatively, if firms are heterogeneous, but output and input prices move together (e.g., higher quality output might require higher quality inputs), then firm and time fixed effects together absorb the wedge. These special cases require strong assumptions that are seemingly difficult to justify if the regression sample includes a broad class of firms.[11]

There are two econometric approaches that deal with the more general case, though they come with their own conceptual difficulties. The first involves using an instrumental variable to isolate variation in variable input expenditure that is orthogonal to the wedge in prices. The difficulty is that a valid instrument may not exist due to a functional dependence problem. The reason is that if output prices solve a static profit maximization problem, then they depend on the entire vector of state variables, including the capital stock, unobserved productivity, and any variables that shift demand for the output. The profit-maximizing expenditure on labor depends on these same state variables. Thus, determinants of labor expenditure—candidate instruments—are unlikely to satisfy the exclusion restriction.[12]

The second approach involves controlling for the price wedge. DLEU estimate the production function controlling for various measures of the firm's market share in the output market. A version of the functional dependence problem extends: if the control variables fully absorb all the variation that contributes to the price wedge, then they also absorb labor expenditure. In special cases,

[9] DLEU choose 0.85 because it is the average cost share of COGS.

[10] The production function as expressed is for single-product firms, but a number of papers consider extensions to multi-product firms (e.g., De Loecker et al., 2016; Orr, 2022).

[11] An even more knife-edge case would involve a price-setting rule of $p_{it} = \theta^V p_{it}^V + \theta^K p_{it}^K$, in which case the price wedge disappears, and fixed effects are not needed to absorb its influence. This price-setting rule places a strong restriction on the pass-through of a firm's input costs into the output price.

[12] For one discussion of this point, see Section 3 of Bond et al. (2021). That article is perhaps better known for the observation that knowledge of the elasticity of revenue with respect to the variable input quantity (rather than variable input expenditure) does not identify markups if firms set prices that maximize profit. This non-identification result does not apply to DLEU, because DLEU regresses revenue on input expenditure, rather than on input quantity.

functional dependence may not arise. DLEU point out that if output markets feature Bertrand competition and logit demand, then the market share is a summary statistic for markups that may preserve variation in labor expenditure.[13] This requires stronger assumptions on the output markets than otherwise would be required to implement the production approach. An additional econometric problem that has received less attention is that market shares depend on the unobserved productivity shocks.[14]

2.2.2. *Unobserved heterogeneity in demand*

A second class of methodological challenges arises due to the use of the so-called proxy-function approach to absorb the productivity shock that is observed by the firm prior to its decision about how much variable input to use. For background, the proxy function approach is intended to address omitted variable bias that could arise due to a relationship between the unobserved Hicks-neutral productivity shock, ω_{it}, and either variable input quantity (with equation (2)) or expenditure on the variable input (with equation (3)).

The basic idea is that there is some choice variable of the firm—the classic examples being capital investment (Olley and Pakes, 1996) and variable input quantities (Levinsohn and Petrin, 2003)—that, under cost minimization, is strictly monotonic in productivity. The use of investment can be micro-founded using a dynamic model of endogenous firm capital accumulation, whereas the use of variable input quantity can be micro-founded from an input demand function. Using the variable input, one might express the profit-maximizing choice as $v_{it} = h(\omega_{it}, k_{it})$, where $h(\cdot)$ is the quantity demanded for the variable input. With strict monotonicity, it follows that $\omega_{it} = h^{-1}(v_{it}, k_{it})$. Thus, adding a non-parametric function of capital and the variable input (e.g., a polynomial approximation) to equations (2) or (3) absorbs the confounding variation.[15]

The proxy function approach breaks down if there is unobserved heterogeneity in demand. Let $v_{it} = h(\omega_{it}, k_{it}, \xi_{it})$, where ξ_{it} is an unobserved demand-shifter. The proxy function becomes $h^{-1}(v_{it}, k_{it}, \xi_{it})$, and this cannot be added to the regression equation as a control because ξ_{it} is unobserved. The example involves a violation of the "scalar unobservable" assumption that limits the dimensionality of the unobservables affecting firm behavior (e.g., Ackerberg et al., 2007). To state the obvious, it is the heterogeneity in the demand-shifters that matters. If $\xi_{it} = \xi$ for all i and t, then the term can be absorbed with a constant. Alternatively, if $\xi_{it} = \xi_t$ or $\xi_{it} = \xi_i$, then time or firm fixed effects could address the concern. A reasonable interpretation of the literature is that heterogeneity is not usually so restricted (e.g., Berry et al., 1995; Foster et al., 2008).[16]

In special cases, markups can be a summary statistic for an unobserved demand-shifter. Assume that firms have the Cobb-Douglas production function of equation (2), and that output prices are set to maximize profit, given differentiable and downward-sloping demand for the output. Then the firm's demand for the variable input is:

$$V_{it} = \left(\theta_t^V \frac{P_{it}}{P_{it}^V} \left(1 - \frac{1}{\eta_{it}(P_{it}, \xi_{it})} \right) e^{\omega_{it}} K_{it}^{\theta_t^K} E[e^{\nu_{it}}] \right)^{\frac{1}{1-\theta_t^V}} \tag{4}$$

where $\eta_{it}(P_{it}, \xi_{it})$ is the elasticity of output demand with respect to price. At the profit-maximizing prices, the Lerner condition familiar in industrial organization holds:

$$\frac{P_{it} - MC_{it}}{P_{it}} = \frac{1}{\eta_{it}(P_{it}, \xi_{it})} \tag{5}$$

Therefore,

$$1 - \frac{1}{\eta_{it}(P_{it}, \xi_{it})} = \frac{MC_{it}}{P_{it}} \equiv \frac{1}{\mu_{it}} \tag{6}$$

where μ_{it} again is defined as the multiplicative markup. Plugging (6) into (4), taking logs, and inverting for ω_{it} obtains

$$\omega_{it} = (1 - \theta_t^V) v_{it} - \theta_t^K k_{it} - (p_{it} - p_{it}^V) + \log(\mu_{it}) - \log(E[e^{\epsilon_{it}}]) \tag{7}$$

The right-hand side provides the proxy function $h^{-1}(\cdot)$, which has an analytical expression in this case. Markups appear as a summary statistic for the unobserved demand-shifter. However, *markups are unobserved at this stage in the analysis*, as the purpose of

[13] This result may be somewhat more general, as it obtains in the broader class of aggregative games studied in Nocke and Schutz (2018). Nested logit demand can be accommodated if all of the firm's products are in the same nest. The result does not extend to the random coefficients logit models, which are widely used in industrial organization because they allow for more flexible substitution patterns.

[14] De Ridder et al. (2022) estimate markups using a sample of firms for which both revenue and output is observed. They follow DLEU, and use measures of market shares as control variables. The markups that are estimated using revenue data exhibit bias; nonetheless they are positively correlated with markups that are estimated using output data. The paper provides a theoretical/econometric model in which such a positive correlation exists, suggesting that its empirical results may extend to other settings. Based on this, the authors state: "We conclude that analyses of markup variation, such as trends over time or dispersion over the cross-section, can be performed well with markup estimates that are based on revenue data."

[15] The proxy function also absorbs the variable input, which motivates the two-step estimator of Ackerberg et al. (2015), but that is not the most relevant consideration here.

[16] Bond et al. (2021) and Doraszelski and Jaumandreu (2023) raise this concern in the context of the DLEU results specifically. The latter article provides numerical evidence that the degree of bias increases with the correlation between the unobservable demand-shifter and the variable used to construct the proxy function (e.g., the variable input or investment). Both articles conjecture that dynamic panel methods (e.g., Blundell and Bond, 2000) may be better suited than the proxy function approach for applications that feature unobserved demand heterogeneity. There are trade-offs, as the quasi-differencing used in the dynamic panel method requires that productivity follow a linear process.

the production function estimation is to obtain the output elasticities that allow markups to be recovered. This is why Doraszelski and Jaumandreu (2023) states that the identification argument can become "circular" in the presence of unobserved demand heterogeneity.

DLEU uses the proxy function approach to address the relationship between ω_{it} and the variable input, using the two-step estimation procedure of Ackerberg et al. (2015). Constructing the proxy functions with capital investment (following Olley and Pakes (1996)) and the variable input (following Levinsohn and Petrin (2003)) obtains similar results. To account for demand-side heterogeneity, DLEU adds observables to the proxy function. For example, when the proxy function is constructed using the variable input, they use $\omega_{it} = h^{-1}(v_{it}, k_{it}, z_{it})$, where z_{it} includes measures of market shares.

In special cases of the model, including that of Bertrand competition and nested logit demand, the market share can be a summary statistic for markups. Thus, if markups also are a summary statistic for the unobserved heterogeneity, as they are with a Cobb-Douglas production function and downstream profit maximization, then including market shares as a control variable allows the proxy function to absorb ω_{it}, as intended. The same issues described at the end of Section 2.2.1, about using market shares as a control variable, exist here. See Doraszelski and Jaumandreu (2023) for a useful discussion.

2.2.3. Reliance on accounting data

The final class of methodological challenges that I discuss relates to the use of accounting data. This may be unsurprising to industrial organization economists, as analogous concerns contributed to the shift away from empirical tests of the structure-conduct-performance paradigm a number of decades ago (Fisher and McGowan, 1983; Schmalensee, 1989). Compustat allocates operating expenditures to COGS and SG&A, and DLEU assumes that COGS is a freely-adjustable variable input. Syverson (2019) describes COGS and SG&A as follows:

> Accounting data are not constructed for the sake of measuring economic categories like variable costs. Accounting data include two primary categories of costs: (1) cost of goods sold and (2) selling, general, and administrative (SG&A) expenses. COGS includes direct costs associated with purchasing and transforming inputs into the product a company sells and as such is thought to be composed primarily of variable costs. The SG&A category includes most other costs and as such captures many fixed costs. That said, some SG&A expenses might plausibly scale with the size of operations, while some costs in COGS might arguably be fixed. Indeed, accounting standards actually allow classification of expenses by COGS and SG&A to vary by sector.

The accounting standards that Syverson references are the Generally Accepted Accounting Principles (GAAP), which help ensure that the financial data of publicly-traded firms are transparent and consistent across firms within the same industry. Standards are industry-specific and adjust over time. Grieco et al. (2023) reports that, for automobile manufacturers, COGS includes the fixed overhead associated with manufacturing, corroborating that COGS and SG&A may not cleanly separate variable and fixed costs as a general matter.

The choice of COGS as the variable input matters for markup estimates. Traina (2018) finds that if one instead uses operating expenses (i.e., COGS plus SG&A), then both the level and growth of markups are considerably diminished. The discrepancy is explained, at least in part, by the fact that the COGS share of operating expenses decreased by nearly 8 percentage points over 1980-2016. Traina and DLEU differ in their interpretation, however. Taking into account corrections for selection, Traina concludes that "I find that firm market power has either remained flat or declined." However, although SG&A may capture some variable costs, in most settings, it captures more fixed costs. DLEU view the markup estimates obtained using operating expenses more as profit rates that take into account fixed costs, and interpret them as being consistent with their baseline results.

The extent to which COGS reflects variable or fixed costs may not be the most relevant consideration, however. Consider the first order condition in equation (1). As Basu (2019) notes, if the "variable cost" measure includes some fixed costs, then the revenue-to-expenditure ratio decreases, but this should be offset by a commensurate increase in the estimated scale elasticity. Thus, the markup would be unaffected. To offset *changes* in the composition of the variable cost measure, in estimation, it would be necessary to allow for changes in the output elasticity. The baseline specification of DLEU—a Cobb-Douglas production function with year-specific output elasticities—allows for such flexibility.

Potentially more important is whether variation in the measure of variable costs reflects changes in the use of a freely-adjustable input, as required by the production approach to markup estimation. In many industries, labor and material are significant components of variable costs. Labor is often thought to be sticky.[17] Depending on the setting, materials can be purchased in spot markets, or with medium- or long-term contracts. Such timing issues may contribute to the finding of Raval (2022) that markup estimates are sensitive to whether the freely-adjustable input is assumed to be labor or materials.[18] Basu (2019) argues that ideally one could isolate an input that is more adjustable, such as energy or production worker hours (in some industries), but that data on such inputs are not available for many of the firms in Compustat.

A final observation about the Compustat accounting data is that the unit of observation is a firm-year. This affects a basic trade-off that researchers face when estimating production functions. In order to estimate the parameters with econometric precision, it helps

[17] As one example, Foster et al. (2022) state that "adjustment costs for labor imply that labor is not a variable factor even at an annual frequency."

[18] The sensitivity to the choice of the flexible input is corroborated in Foster et al. (2022). The interpretation of Raval (2022) is that non-neutral productivity changes—e.g., changes that make labor relatively more productive than other inputs—explain the difference. Dermirer (2022) accounts for non-neutral productivity change in production function estimation, and finds that doing so implies somewhat more modest markup growth. A related result is obtained in Kusaka et al. (2023), which explores the Japanese cement industry.

to group more firms together as part of the same "industry," as this increases the number of observations. However, implementations that use larger groupings of firms also carry a greater risk of bias, due to unobserved demand heterogeneity (Section 2.2.2) and misspecifications of the production function (to the extent production functions differ across firms). Faced with this trade-off, DLEU obtains baseline results using industries defined at the level of two-digit NAICS codes, which can reasonably be interpreted as quite broad.[19]

Foster et al. (2022) revisits the aggregation of firms into industries using Census data on manufacturing. Because the Census data are available at the establishment-year level, it is possible to obtain econometric precision using industries that are more narrowly defined. The results indicate more modest markup increases. For example, if a Cobb-Douglas production function is estimated using an approach similar to that of DLEU, then markups increase by 24% from 1977 to 2007 if industries are defined at the two-digit level, and by 8% if industries are defined at the four-digit level. Foster et al. (2022) presents empirical evidence consistent with the broader industry definitions masking the influence of technological change. I examine the role of technological change in explaining economic outcomes over long time horizons in the next section.

3. Results from industrial organization

I turn now to the industry studies, which cover consumer packaged goods (Brand, 2021; Atalay et al., 2023; Döpper et al., 2023), portland cement (Miller et al., 2023), wholesaling (Ganapati, 2024), steel (Collard-Wexler and De Loecker, 2015), automobile manufacturing (Grieco et al., 2023), and airlines (Bet, 2021). Many of the studies use the so-called *demand approach* to recover markups. This involves estimating demand with data on prices and quantities, and then inferring what marginal costs must be to rationalize observed prices under an assumption about firm conduct (often Bertrand competition). As the assumptions and data requirements of the demand approach differ from those of the production approach, the settings for which they are best suited also differ. With sufficient data, it is possible to use both approaches—De Loecker and Scott (2022) does so for the beer industry and finds that the two approaches obtain similar markups.[20]

I first discuss each of the industry studies in turn (Section 3.1), and then evaluate their similarities and differences (Section 3.2).

3.1. The industry studies

3.1.1. Consumer packaged goods

Three studies examine market power over time in the consumer packaged goods (CPG) industry (Brand, 2021; Atalay et al., 2023; Döpper et al., 2023). This is a natural place to start because the industrial organization literature has so frequently estimated models of differentiated-products price competition within CPG categories, like ready-to-eat cereal, yogurt, and beer (e.g., Nevo, 2001; Villas-Boas, 2006; Asker, 2016).

All three studies use the retail scanner data of Kilts Nielsen to estimate discrete choice demand models in a number of different categories, and infer markups from firms' first order condition for profit maximization. Brand (2021) focuses on eight categories in 2006 and 2017, Atalay et al. (2023) focuses on 72 categories over 2006-2018, and Döpper et al. (2023) focuses on 133 categories over 2006-2019. Other differences exist. Brand estimates random coefficients logit models of demand under the assumption that prices are exogenous; Atalay et al. estimates nested logit models of demand using Hausman instruments to address price endogeneity; and Döpper et al. estimates random coefficients logit models using a covariance restriction to address price endogeneity.[21] All three studies assume differentiated-products Bertrand competition among CPG manufacturers.[22]

I focus especially on Döpper et al. (2023), which is the study I know best. The results of Brand and Atalay et al. are broadly similar. The main result is that average CPG markups—measured by the Lerner Index (i.e., $\frac{p-c}{p}$ as in equation (5))—have increased by about 25% on average. The aggregate trend is driven by changes within products over time rather than by consumer substitution toward higher-markup products.

Mechanically, rising markups must involve rising prices or falling marginal costs. Döpper et al. (2023) finds that real prices are 7% higher in 2012 than 2006, but this trend reverses, such that real prices are only 2% higher in 2019 than in 2006. Thus, rising markups are mostly due to marginal cost reductions, which Döpper et al. (2023) places at an average of 2.1% per year. The finding that marginal costs are falling may not be surprising because companies have a profit incentive to make their operations more efficient. Procter & Gamble, one of the largest CPG companies, began a "productivity and cost savings plan" in 2012 that reduced annual costs by $3.6 billion in 2019 (see the 2019 Annual Report). Similarly, the 2019 Annual Report of Unilever claims cost savings of 6 billion Euros over 2017-2019. As a general matter, marginal cost reductions can also be due to lower factor prices. The CPG industry studies do not quantitatively distinguish between these possibilities.

[19] To give a sense of the aggregation involved, I provide the NAICS hierarchy for a two-digit industry code ("Information") in Appendix Table A.1. The NAICS hierarchies are available at https://www.naics.com.

[20] Analogous comparisons are made in Appendix 7 of DLEU. Also related is De Loecker and Fleitas (2024), which applies the production approach to recover markups the hospital industry and compares the results to those reported in other articles that use the demand approach. Pellegrino (forthcoming) estimates a general equilibrium oligopoly model of the US economy and analyses markups over 1995-2021.

[21] An innovation of Atalay et al. is that a clustering algorithm is used to group products into nests. Hausman instruments refer to prices in other regions (Gandhi and Nevo, 2021). The covariance restriction used in Döpper et al. helps scale nonlinear estimation; its properties are analyzed in MacKay and Miller (2023).

[22] This equilibrium concept is probably reasonable for most CPG categories, though the literature indicates there may be exceptions (e.g., Miller and Weinberg, 2017).

This raises the question of why marginal cost reductions have not produced lower prices. Partly, this can be attributed to incomplete pass-through. But the estimation results point to another factor: CPG consumers appear to become less price sensitive over the sample period. Döpper et al. (2023) points to data showing that consumers now spend less time in the store and use coupons less frequently, and conjecture that an increase in the opportunity cost of time could explain the results.[23] On the other hand, changes in consumer demographics, market concentration, and product quality do not appear to play as much of a role in explaining rising markups in these markets.[24]

In summary, the industry studies point to higher markups in the CPG industry due to (approximately) flat prices paired with marginal cost reductions. Anecdotal evidence indicates that firm investments contribute to the marginal cost reductions.

3.1.2. Cement

Miller et al. (2023) examines market power in the cement industry over 1974-2019. Though cement is frequently studied in the literature, some background may be helpful.[25] Cement is a dry powder that forms concrete when mixed with water and aggregate. It is used in construction projects, and the main buyers are large construction firms and ready-mix concrete plants. Transportation costs are a significant portion of buyers' overall costs, and this creates spatial differentiation among cement plants. Imports are competitive when domestic consumption approaches or exceeds domestic capacity. Finally, the production process for cement entails feeding limestone into large rotary kilns that are fueled with coal or natural gas.

Miller et al. (2023) shows that the number of cement plants nearly halved over the sample period—falling from 163 to 89—even as consumption, production, and industry capacity increased. Concurrently, the real national average price fluctuated with macroeconomic conditions and fuel prices, but was remarkably similar in 1974 and 2019. What makes sense of these trends is a new technology, specifically the *precalciner kiln*, that improves fuel efficiency, increases plant-level capacity, and creates greater economies of scale. With modern technology, it takes far fewer plants to meet the same amount of demand, and they can do so more efficiently. At the start of the sample, the vast majority of plants operate older, less efficient kilns; by the end, precalciner kilns dominate. Economic theory indicates that simultaneous reductions in marginal costs and competition should produce higher markups, all else equal, but that the effect on prices is ambiguous.

To make empirical progress, Miller et al. (2023) estimates a structural model of oligopoly competition exploiting region-level variation in average prices, consumption, production.[26] In the model, cement plants compete to win the business of buyers that are located throughout the United States. Consistent with the importance of transportation costs in the industry, a main source of differentiation is proximity to the buyer. The model also features upward-sloping marginal cost functions that incorporate the observed capacity constraints of plants. At the estimated parameters, equilibrium can be simulated to recover the total production for each plant, the shipments that each plant makes to each county, and the average prices that those shipments obtain. The results indicate that the quantity-weighted median county-level Herfindahl-Hirshman Index (HHI) increases from 2171 to 2895 over the sample period. The quantity-weighted markup also increases, but only by about 5%, more modest than what is reported in DLEU for the manufacturing sector. Average national-level prices do not meaningfully increase.

These changes in the HHI, markups, and prices reflect equilibrium responses to a number of factors: plant closures, precalciner adoption, entry, mergers, fuel price variation, and demand fluctuations. Miller et al. (2023) assesses the relative importance of these factors using counterfactual simulations in which each change is introduced, in turn, until the 1974 outcomes transform into 2019 outcomes. Each simulation in this decomposition exercise converges to a *short run* equilibrium; the exercise does not incorporate long run effects.

The results indicate that plant closures account for most of the increase in the HHI, with mergers and entry also having meaningful effects that offset. The main drivers of higher markups are plant closures and mergers. Many factors affect price, with plant closures increasing it, and precalciner adoption decreasing it. These results are consistent with the main short run effects of precalciner adoption being marginal cost reductions that are passed through to buyers. To the extent that precalciner adoption contributes to rising concentration and markups, the results indicate that it is through its effect on long run decisions, including on plant closures. However, it may be reasonable to attribute plant closures to precalciner technology, because precalciners not only lower marginal costs, but also increase productive capacity.

In summary, research on the cement industry finds rising markups and greater local market concentration, with prices that are not higher. This can be understood as an effect of precalciner kilns, which lowered marginal costs and increased capacity, thereby contributing to an industry shakeout in which many plants closed.

[23] Two other possibilities are worth mentioning. The first, highlighted in Brand (2021), is that there are new, "niche" products that better match consumers' individual preferences. With such products available, price may play a smaller role in purchasing decisions. The second is that CPG manufacturers have reduced sales and promotions activities, thereby "training" consumers to care less about price. The question of why CPG consumers have become less price sensitive (if indeed they have) would benefit from additional research.

[24] Bhattacharya et al. (2023) provides reduced-form evidence about the price effects of CPG mergers that have occurred over 2006-2017. They find that prices increase by 1.5% on average, and quantities decrease by 2.3% on average, with significant heterogeneity in outcomes across mergers.

[25] In addition to its role as a "model industry," cement is interesting from an environmental policy standpoint, because CO2 and other pollutants are emitted during production (e.g., Ryan, 2012; Fowlie et al., 2016).

[26] The structural model uses the second-score auction framework of Miller (2014). Estimation involves computing equilibrium for each candidate parameter vectors, as in Miller and Osborne (2014). Related models are estimated in Allen et al. (2013) and Beckert et al. (2021).

3.1.3. Wholesaling

Ganapati (2024) examines the merchant wholesalers that connect manufacturers to retailers (and to other buyers) using data from the Census Bureau and other sources. Ganapati observes that the share of manufactured good deliveries that involve wholesalers increases from 32% in 1992 to nearly 50% in 2012. The bulk of that growth comes from the largest wholesalers. These "superstar" wholesalers also increase the number of imported varieties they offer and the number of domestic locations for which they provide service. In addition, average operating costs are lower, average prices are flat (or, more precisely, slightly decreasing), and concentration is increasing due to the growth of already-large firms.

Ganapati interprets these facts through the lens of the endogenous sunk costs framework of Sutton (1991). Increasing globalization and international trade allows superstar wholesalers to profitably invest in their ability to source goods from a wider array of manufacturers, and to distribute goods more extensively and efficiently to buyers. These superstars benefit from greater economies of scale. They also benefit from more market power because they become more differentiated from other wholesalers. From a technological standpoint, these profitable investments probably take the form of expenditure on information technology, at least in part. Ganapati shows that information technology accounts for a large share of total investment for wholesalers, both in absolute terms and relative to manufacturers and retailers, but interprets this as suggestive evidence.

To make additional empirical progress, Ganapati estimates a multi-stage game in which wholesalers first make sunk investments in their global sourcing capability and their domestic warehouse locations, and then compete in prices given a differentiated-products demand system. Marginal costs are recovered from the demand estimates and the pricing first order conditions, and sunk costs are recovered using a bounds approach (e.g., Eizenberg, 2014). In the model, sunk investments are more profitable if there are more manufactured products to source abroad and if the domestic "market size" is larger.

The demand results confirm that buyers benefit when wholesalers offer more varieties and more local warehouses. Because wholesalers have improved along these dimensions and prices have been flat (or slightly decreasing), the model implies that buyer welfare has improved on average. The baseline supply-side specification indicates the marginal costs decrease more than price, consistent with the empirical analysis of operating costs described above. Thus, markups increase. In counterfactual simulations, Ganapati explores the role of global sourcing and obtains results that are consistent with the Sutton (1991) endogenous sunk cost framework. If wholesalers cannot access global markets, then the market supports a greater number of small, domestic-only wholesalers, markups and concentration decrease, and buyers are worse off because, to the extent they access global markets, they must do it directly, rather than with the assistance of wholesalers.

Thus, the interpretations of Miller et al. (2023) and Ganapati (2024) for cement and wholesalers, respectively, are similar in part, and different in part. The similarity comes from technological advances—precalciner kilns and information technology—that improve firms' capabilities and provide scale economies. The distinction is that globalization likely plays a relatively smaller role motivating precalciner adoption, as plants in the United States have not historically shipped much cement abroad. The endogenous sunk cost framework of Sutton (1991), in which expansions of demand induce firms to make sunk costs investments, appears to fit wholesaling better than cement.

In summary, research on wholesaling markets finds rising markups and greater concentration, with prices that are not higher. The changes can be attributed to globalization and advances in information technology. Together, they provide the incentive and ability for wholesalers to make sunk investments in their efficiency and the breadth of their service.

3.1.4. Steel

I turn now to the steel industry, and specifically the research of Collard-Wexler and De Loecker (2015), which uses Census data spanning 1963-2002. The primary focus is on identifying the mechanisms through which productivity growth occurs. A motivating fact is that the NBER-CES dataset indicates that total factor productivity (TFP) in the steel industry increased by 28% over the sample period, far exceeding the median increase of 3% for the manufacturing sector overall. What explains this exceptional performance?

The answer appears to be technological change. At the start of the sample, steel was manufactured in *vertically integrated mills*. Such mills operate blast furnaces that convert iron ore, limestone, and coke into pig iron, and basic oxygen furnaces that convert pig iron into steel. The vertically integrated mills were increasingly displaced by new *minimills*, which use electric arc furnaces to convert scrap steel and direct reduced iron into new steel. By the end of the sample, minimills accounted for nearly half of all shipments. This transition increased TFP directly because minimills were (initially) more productive than the average vertically integrated mill. It also increased TFP indirectly because many of the less efficient vertically integrated mills closed, presumably due to competitive pressures. Collard-Wexler and De Loecker (2015) find that these effects together explain almost half of the TFP growth in the steel industry.[27]

The typical minimill operates at a much smaller scale than the typical vertically integrated mills. Therefore, its implications for market power differ significantly from those of the precalciner kiln in the cement industry (for example), because scale-decreasing technology can allow a greater number of firms to coexist in long run equilibrium. Collard-Wexler and De Loecker (2015) recovers markups using the production approach.[28] The results indicate falling multiplicative markups (p/c) over the sample period, from 1.8 to 1.1 for minimills, and from 1.4 to 1.2 for vertically integrated mills. The article states that "We see this aggregate pattern as evidence that product market competition intensified due to the expansion of [minimill] production...."

[27] In a related study, Hendel and Spiegel (2014) find three ways in which the productivity of minimills increase over time: shorter maintenance periods, faster heat cycles, and the use of more scrap inside the furnace.

[28] The steel data contain prices and quantities, and unobserved demand heterogeneity among steel plants probably is less pronounced than it is among firms in broad two-digit NAICS codes. Therefore, many of the challenges associated with recovering markups using the production approach do not arise.

In summary, research on the steel industry finds that markups decrease over time, with the change being attributable, at least in part, to the emergence of minimill production technology. The research also indicates that output prices decrease, though this is difficult to interpret on its own, because input prices also decrease.

3.1.5. Automobiles

Grieco et al. (2023) examines market power in the automobile manufacturing industry over 1980-2018. An important aspect of the setting—one that distinguishes it from cement and steel—is that the physical attributes of the product change over the sample period. In the raw data, it is apparent that horsepower and fuel efficiency have improved, and that vehicles are larger. Features such as air conditioning, power windows, anti-lock brakes, and side airbags become ubiquitous by the end of the sample period. Also in the raw data, real prices increase, and market concentration, measured by the HHI, decreases.

To make progress, Grieco et al. (2023) estimates a model of random coefficients logit demand and differentiated-products Bertrand competition. The demand-side specification is notable in that it captures an unusually rich amount of heterogeneity in consumer preferences for different vehicle attributes. This is possible from an econometric standpoint because information is available about how consumer demographics correlate with purchase decisions, and how some buyers view their “second choices.” Grieco et al. (2023) also applies an assumption, proposed first in Pakes and Berry (1993), that allows for changes in the unobserved quality of automobiles to be disentangled from changes in the quality of the outside good. These aspects of the demand system help the model capture how changes in vehicle attributes affect consumer welfare.

The results of the model indicate that marginal costs increase over the sample period, on average, and that they increase more than prices. Thus, markups fall. The reason that marginal costs increase is that improved vehicle attributes (e.g., more horsepower) are expensive to produce. The higher marginal costs are not fully passed through to prices. Interestingly, the results also indicate gains in productive efficiency. That is, conditional on a fixed set of vehicle attributes, marginal costs decrease by 1.4% per year.[29] These efficiency gains contribute about half of the total welfare gains that are realized in the market. Grieco et al. (2023) also finds that consumer surplus increases more than five-fold from 1980-2018, despite the higher prices. Producer surplus also increases, but does so more modestly. Therefore, consumers appear to be the main beneficiaries of quality improvements.

In summary, research on automobile manufacturing finds falling markups and higher prices. This can be understood as an effect of quality improvements that raise marginal cost, and, to a lesser extent, prices. Consumers gain despite the higher prices because they have access to better products.

3.1.6. Airlines

The final industry study that I discuss is Bet (2021), which examines the commercial airline industry over 1990-2019. This is a complicated period for the industry due to a number of inter-related factors: continuing adjustments to deregulation (e.g., Borenstein and Rose, 2014), fluctuations in fuel prices and macroeconomic conditions, a broadening of hub-and-spoke networks by legacy carriers, the emergence of low cost carriers (LCCs) and ultra low cost carriers (ULCCs), mergers, and bankruptcies. In the raw data, Bet shows that the average ticket price per mile decreases over the sample period, with most of the reductions occurring in the first ten years. A data limitation is that the ticket price does not include the fees that consumers pay for baggage, seats, or other purposes.

Bet performs two main empirical exercises. The first exercise involves estimating multiplicative markups using the production approach. The results indicate that average markups are higher at the end of the sample period than at the beginning.[30] The path that average markups take, however, is not linear. Roughly, there are increases in the 1990s, a dip around 2001, a near-complete recovery, and then another increase in the last five years of the sample. Fuel prices and macroeconomics conditions significantly affect these changes. Furthermore, Bet reports meaningful differences between firms—legacy carriers like American, Delta, and United have higher markups than others.

The second exercise involves estimating a structural model using the subset of data that span 2012-2019. The model incorporates some of the hub-and-spoke structure that is relevant in the industry. For example, demand for a carrier’s route is allowed to depend on the how many flights the carrier operates at the origin airport of the route. The model also incorporates conduct parameters that summarize the intensity of competition between legacy carriers. In estimation, the conduct parameters are pinned down by moments constructed from the markups obtained with the production approach. That is, they allow the model to match a set of pre-estimated markups. The results of the structural model suggest softer price competition between the legacy carriers, especially over 2015-2017.

Given the importance of technological innovation in the other industries (a theme that I discuss below), it would be interesting to know more about how the growth of hub-and-spoke networks among the legacy carriers, and the development of the LCC business model, have affected economic outcomes, as both can be interpreted as process innovations. This is outside the scope of Bet (2021), because the production function does not incorporate the route network, and the structural model focuses on the more recent years.

In summary, research on airlines suggests higher markups over time, alongside lower prices (not accounting for fees). The role that process innovation had in shaping these trends would be an interesting topic for future research.

3.2. Analysis of the industry studies

Table 1 describes what the industry studies indicate for changes in market power, prices, cost and product quality, and scale economies. I group changes in cost and product quality together because they both can indicate changes in firms’ capabilities, though,

[29] The magnitude of these conditional marginal cost reductions is similar the results of Döpper et al. (2023) for consumer packaged goods (1.4% vs. 2.1%).

[30] Similar results obtain if a cost function is estimated instead of a production function.

Table 1
Analysis of the Industry Studies.

		Market Power?	Higher Prices?	Lower Costs? Better Quality?	Greater Scale?	Technological Change?
1	CPG	more	no	yes	n/a*	yes*
2	Cement	more	no	yes	yes	yes
3	Wholesalers	more	no	yes	yes	yes
4	Steel	less	no	yes	opposite	yes
5	Automobiles	less	yes*	yes	no	yes
6	Airlines	more	no	yes*	no	maybe*

Notes: The table summarizes the results of the industry studies. See Section 3.1 for greater discussion and detail. Consumer Packaged Goods ("CPG") receives an "n/a*" for scale economies because scale economies are not explored in the studies; it receives a "yes*" for technological change due to anecdotal evidence. Automobiles receive a "yes*" for whether prices increase because, while the average price increases over the sample period, it is notable that the average quality-adjusted price decreases. Airlines receive a "yes*" for whether costs have decreased because the study finds support for lower costs, but this may be due in part to factor prices rather than improvements in technical efficiency. Airlines receive a "maybe*" for technological change because hub-and-spoke networks and the low cost carrier business model can be interpreted as process innovations.

of course, factor prices also can contribute to cost changes. The table also lists whether technological innovation is a main driver of change. For the most part, I consider my interpretations of the industry studies to be straightforward given the discussions above; where there is relevant nuance, I add an asterisk and explain in the table notes.

There are some similarities among sets of the industries. Take the first three: consumer packaged goods (CPG), cement, and wholesaling. In each case, the studies indicate rising markups due to marginal cost reductions that have not led to price reductions of the same magnitude. For cement and wholesaling, this pattern appears related to technologies that provide greater economies of scale. The marginal cost reductions in CPG may also be due to technological change, although this is not explored in detail by the industry studies. Indeed, the hypothesis of Ganapati (2024) about the role of information technology could extend to CPGs. This suggests a mechanism for *The Rise of Market Power* in which technological change reduces marginal costs over time and, due to incomplete pass-through, increases markups. Where this process requires firms to incur greater sunk costs or fixed costs, it also produces greater scale economies and more concentration in the long run.[31]

The remaining industry studies indicate that other mechanisms also are at play. With steel and automobiles, the industry studies indicate *less* market power over time. Steel is especially interesting in comparison to cement, as both feature technological innovation that lowers average cost. With cement, this entails higher fixed costs and lower marginal costs, whereas with steel it is the opposite. As a result, scale economies decrease in the steel industry, there are more plants in long run equilibrium, and markups fall. The automobile industry features quality gains and improved cost efficiency, even if marginal cost increases due to the quality gains. Because competition limits price increases, markups decrease. Finally, the industry study indicates more market power in airlines. Among the main drivers appear to be factor prices and the intensity of competition.

That the industry studies indicate rising market power in some contexts and not others is unsurprising.[32] The production technologies, consumer preferences, and government policies that shape long run outcomes vary widely across industries. Similar heterogeneity exists in the mode of competition, how prices are set, and so on. For these same reasons, a single mechanism should not be expected to emerge from the industry studies, and indeed one does not. The institutional details appear to matter greatly.

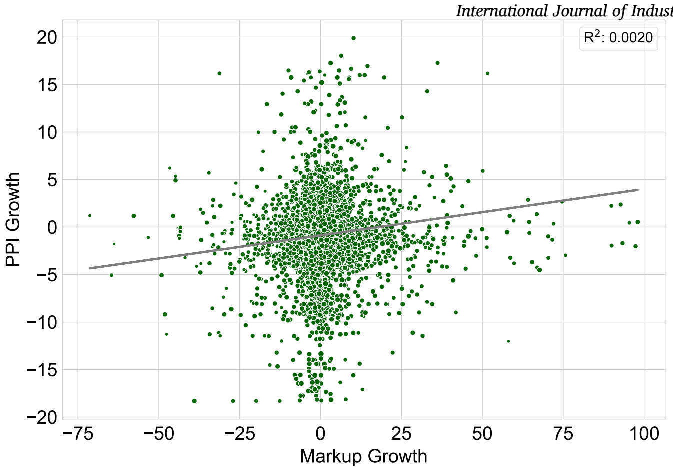
At the same time, the literature does suggest a theme. Roughly stated, it is this: the changes we observe in industries, measured across decades, are predominantly due to technological change. How technological change manifests across industries varies, as do the economic incentives that it creates. Even so, for each of the first five industries listed in Table 1, the literature is consistent with technological change improving the productive efficiency of firms, yielding gains in product quality, or both. For the sixth—airlines—hub-and-spoke networks and the low cost carrier business model can be interpreted as process innovations that likely have meaningful consequences for the economic outcomes, even if they receive less attention in the industry study. Furthermore, in all of the industries listed in Table 1, real prices or real quality-adjusted prices have decreased or remained flat, so technological innovation does not appear to have harmed consumers. In some of the industries, consumers benefit.

4. Antitrust enforcement

To the extent that market power has increased broadly, across the economy, the industry studies as a group point to technological change, rather than weak antitrust enforcement, as the more important catalyst. Conlon et al. (2023) documents an interesting empirical pattern that corroborates this interpretation. The question is whether the rising markups of DLEU correlate with price

[31] DLEU finds that overhead costs only partially offset higher markups, and that measures of accounting profit increase with markups. See also the quantitative general equilibrium modeling in De Ridder (2024) and the analysis of Hasenzagl and Pérez (2023).

[32] It also is consistent with the finding of DLEU that changes in average markups vary considerably across the two-digit industry codes.



Notes: The figure shows the PPI CAGR (vertical axis) and markup CAGR (horizontal axis) for firms in the matched samples. The line of best fit is estimated with weighted least squares, using CPI-adjusted sales for the period closest to 2019. I exclude 17 firms with PPI or markup growth outside the range of the axes.

Fig. 2. Annualized Changes in Markups and Prices, 1980-2019.

increases. The exercise is relevant to the mechanisms that may have contributed to greater market power over time. Conlon et al. states that:

> "Rising markups could be due to weakening competitive pressure that enables higher prices and a transfer of surplus from consumers to firms. Alternatively, or in addition, they could reflect changing production technologies that lower marginal costs (and possibly raise fixed costs) paired with an imperfect pass-through of marginal costs to prices."

If weak antitrust enforcement explains rising markups, then there should be a positive correlation between markup changes and price changes. Alternatively, if technological innovation explains rising markups, then there may be little or no correlation.

A challenge in implementation is that prices are not observed in the Compustat data. The article proceeds by using the firm-level NAICS codes assigned by Compustat to match firms to industries (most often these are at the six-digit level). For many of the industry codes, the Bureau of Labor Statistics provides a Producer Price Index (PPI). Thus, changes in firm-level markups can be compared to changes in (deflated) industry-level prices. A number of caveats apply. The DLEU markups are taken as given, so the discussion in Section 2.2 is relevant. Many firms may engage in economic activity spanning multiple six-digit NAICS codes, or may change their operations over time. The PPI is intended to be representative of domestic producers, whereas Compustat covers only publicly-traded firms. Furthermore, while PPI data are available for most of the industry codes assigned by Compustat, there are some industry codes for which this is not the case.

With these caveats stated, the results of Conlon et al. (2023) are stark: there is almost no empirical relationship between markup changes and price changes over 1980-2018.[33] A scatter plot reveals a symmetric-looking cloud of data points, and a regression of PPI growth on markup growth yields an R^2 of only 0.0005. Fig. 2 provides a version of this analysis that spans 1980-2019. The patterns are similar (e.g., R^2 of 0.0020). Mechanically, markup changes must be due to changes in prices or marginal costs, and the results of these analyses suggest the latter may tend to dominate. Thus, the empirical analysis does not support a hypothesis that weak antitrust enforcement explains rising markups.

Although a complete review of the antitrust literature goes beyond the scope of this article, some recent research is consistent with this interpretation. With respect to collusion, the Department of Justice revised its leniency program in 1993, and the empirical evidence is consistent with the revisions both strengthening deterrence and increasing the likelihood that active cartels are detected (Miller, 2009). The legal consequences of being convicted for collusion—in terms of fines and prison sentences—also have become more severe.

With respect to mergers and acquisitions, Macher and Mayo (2023) examines merger filings over 1979-2017 and find that:

> "[C]ontrary to the popular narrative, regulators have become more likely to challenge proposed mergers over time. Controlling for the number of merger proposals submitted to the agencies, the likelihood of a merger challenge has more than doubled over this period."

[33] Conlon et al. (2023) also examines the 2018-2022 period in order to assess whether market power may have contributed to inflation. There is almost no relationship between markup growth and price growth in this more recent period.

Empirical evidence also indicates that judicial standards in merger trials may have become more pro-enforcement over time (Macher et al., 2024). Asker and Nocke (2021) conducts a systematic review of the merger retrospectives literature and finds that:

> "Studies find a wide range of impacts. Some price[s] go up, at times by a lot. Others find no impact. Some find prices go down. The wide range of price outcomes reported following a merger is what we find most striking about these studies when examined collectively."

Shapiro and Yurukoglu (2024) also examines the merger retrospectives literature, and determines that it does not indicate that major changes in antitrust practice are necessary.

If technological change tends to drive economic outcomes over long time horizons, it does not follow that stringent antitrust enforcement is unimportant—quite the opposite. First, in some of the industries discussed above, enforcement actions likely have helped ensure that the benefits of technological innovation are shared between firms and consumers.[34] Second, economic theory indicates that some forms of technological change can amplify the economic value of enforcement. For example, scale-increasing technology can result in fewer firms in long run equilibrium, so that collusion becomes easier to sustain, and it can also increase markups, amplifying the unilateral effects of mergers. Thus, it is possible to simultaneously conclude that weak antitrust enforcement has not contributed significantly to aggregate markup trends, and that aggregate markup trends make stringent antitrust enforcement more important in many industries.

5. Conclusion

I have attempted to provide a useful update on the literature on the subject of *The Rise of Market Power*. First, I have summarized the many articles that have been written about the result of De Loecker et al. (2020)—that sales-weighted average markups have increased over time. Second, I have tried to draw connections among the relatively small number of studies that explore the evolution of market power over long time horizons in specific industries. The theme that emerges from these studies is that technological change matters a great deal when comparing economic outcomes over the span of decades.

The extent to which my interpretations of the existing industry studies generalize to other market settings is an open question. Given the state of the literature, analyses of other industries would have obvious value. This is especially true for industries that are not among the "model industries" of IO, and for nations other than the United States. Some early progress has been made (e.g., Adam et al., 2023; Avignon and Guigue, 2023; Hahn, 2023; Kusaka et al., 2023) but more is needed. Such studies will need to wrestle with the challenge of applying the IO toolkit at scale, while preserving methodological rigor. The industry studies that do exist indicate that this challenge can be met.

A limitation inherent to this research agenda is that the industries amenable to empirical analysis across decades must have the requisite data. They also are likely to have stable institutions, although this is not strictly necessary if the researcher can identify and control for changes in the relevant institutions. Thus, the industries most suitable for empirical analysis are unlikely to be fully representative of the broader economy. This is essentially a sample selection problem, and it should be taken seriously. Industry studies may prove more useful in identifying the mechanisms that may be operating more generally, than in helping to assess or measure aggregate trends. An implication is that the field of IO is likely to provide only part of the answer to many of the research questions about *The Rise of Market Power*. This indicates to me that a more robust dialogue between IO and macroeconomics could make sense to pursue, although, admittedly, I am unsure of how such a dialogue could most productively be shaped.

Finally, to the extent that technological advancements are the primary drivers of the economic changes that we observe in industries over longer time horizons, it becomes all the more straightforward to motivate research on the conditions that facilitate innovation and the diffusion of new technologies across firms, markets, and nations; similarly for research on how the gains of innovation are distributed through society. IO researchers have an important role to play, because, as is well understood, the competitive environment helps shape innovation incentives (e.g., Gilbert, 2006; Shapiro, 2012) and how firms are likely to pass-through efficiency gains to consumers (e.g., Weyl and Fabinger, 2013). Although empirical progress can be difficult due to the complications associated with modeling strategic, dynamic decisions, and a paucity of high-quality innovation data, a number of recent articles glean insight from specific settings (e.g., Goettler and Gordon, 2011; Igami, 2017; Igami and Uetake, 2020; Macher et al., 2021; Watzinger and Schnitzer, 2022). Additional research would have a clear benefit to IO on its own, and would also provide a useful complement to the industry studies that have been the focus of this article.

CRediT authorship contribution statement

Nathan H. Miller: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

[34] For example, Miller et al. (2023) identifies six merger challenges in the cement industry over 1996-2019, using a publicly-available Federal Trade Commission database.

Table A.1
NAICS Hierarchy for Information (NAICS Code 51).

5121	Motion Picture and Video Industries	
	512110	Motion Picture and Video Production
	512120	Motion Picture and Video Distribution
	512131	Motion Picture Theaters (except Drive-Ins)
	512132	Drive-In Motion Picture Theaters
	512199	Teleproduction and Other Postproduction Services
5122	Sound Recording Industries	
	512230	Music Publishers
	512240	Sound Recording Studios
	512250	Record Production and Distribution
	512290	Other Sound Recording Industries
5131	Newspaper, Periodical, Book, and Directory Publishers	
	513110	Newspaper Publishers
	513120	Periodical Publishers
	512230	Book Publishers
	512240	Directory and Mailing List Publishers
	512291	Greeting Card Publishers
	512299	All Other Publishers
5132	Software Publishers	
	513210	Software Publishers
5161	Radio and Television Broadcast Systems	
	516110	Radio Broadcast Systems
	516120	Television Broadcast Systems
5162	Media Streaming Distribution Services, Social Networks, [...]	
	516210	Media Streaming Distribution Services, Social Networks, [...]
5171	Wired and Wireless Telecommunications (except Satellite)	
	517111	Wired Telecommunications Carriers
	517112	Wireless Telecommunications Carriers (except Satellite)
	517121	Telecommunications Resellers
	517122	Agents for Wireless Telecommunications Services
5174	Satellite Telecommunications	
	517410	Satellite Telecommunications
5178	All Other Telecommunications	
	517810	All Other Telecommunications
5182	Computing Infrastructure Providers, Data Processing, Web Hosting, [...]	
	518210	Computing Infrastructure Providers, Data Processing, Web Hosting, [...]
5192	Web Search Portal, Libraries, Archives, and Other Information Services	
	519210	Libraries and Archives
	519290	Web Search Portals and All Other Information Services

Notes: The tables provides the hierarchy of NAICS codes for "Information" (NAICS code 51). Sourced from https://www.naics.com.

Appendix A. Materials

In this appendix, I derive the first order condition for cost minimization that links markups to an output elasticity of a variable input, revenue, and expenditure on the variable input. Consider a firm with the production function $Q = Q(\Omega, \boldsymbol{V}, K)$ where Ω is productivity, $\boldsymbol{V} = (V_1, V_2, \ldots, V_N)$ is a vector of variable inputs that can be freely adjusted each period and K is capital. For any given level of output, let the firm minimize its costs, given by:

$$C(\boldsymbol{V}, K) = \boldsymbol{P}^V \boldsymbol{V} + rK + F \tag{A.1}$$

where $\boldsymbol{P}^V$ is a vector of factor prices for the variable inputs, r is the rental rate of capital, and F is a fixed cost. This is a constrained minimization problem. The Lagrangian is

$$\mathcal{L}(\boldsymbol{V}, K, \lambda_{it}) = \boldsymbol{P}^V \boldsymbol{V} + rK + F - \lambda \left(Q(\Omega, \boldsymbol{V}, K) - \overline{Q} \right) \tag{A.2}$$

where $\overline{Q}$ is the amount to be produced. As the Lagrangian multiplier, λ, is the shadow cost of the constraint, it represents the cost savings that could be realized if the firm produces marginally less. Thus, λ is marginal cost. Setting the derivative with respect to an arbitrarily selected variable input, V_n, to zero obtains a first order condition for cost minimization:

$$P_n^V = \lambda \frac{\partial Q(\Omega, \boldsymbol{V}, K)}{\partial V_n} \tag{A.3}$$

First, multiplying and dividing the right-hand side by Q/V_n obtains

$$P_n^V = \lambda \frac{Q}{V_n} \left(\frac{\partial Q(\Omega, \boldsymbol{V}, K)}{\partial V_n} \frac{V_n}{Q} \right) \tag{A.4}$$

Next, multiplying both sides by the downstream price, P, and dividing both sides by P_n^V and λ obtains

$$\frac{P}{\lambda} = \left(\frac{\partial Q(\Omega, \boldsymbol{V}, K)}{\partial V_n} \frac{V_n}{Q} \right) \frac{PQ}{P_n^V V_n} \tag{A.5}$$

Finally, letting $\theta_n \equiv \frac{\partial Q(\Omega, \boldsymbol{V}, K)}{\partial V_n} \frac{V_n}{Q}$ be the output elasticity of variable input i obtains an expression that is equivalent to equation (1) in the text:

$$\frac{P}{\lambda} = \theta_n \frac{PQ}{P_n^V V_n} \tag{A.6}$$

Data availability

The data that has been used is confidential.

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