Antitrust Policy in a Globalized Economy*

Linyi Cao[†] Lijun Zhu [‡]

October 2019

Abstract

Antitrust policies have been relaxed and the number of mergers and acquisitions (M&A) has risen rapidly since the 1980s in the United States. This paper provides a framework to evaluate the cost and benefits of antitrust policy in a global context. M&A reallocate resources from small to large and typically more productive firms, while also increasing their monopoly power. An optimal antitrust policy seeks a balance between the positive productivity effect and the negative markup effect. In a globalized economy, increasing productivity fully accrues to domestic firms/workers while a higher markup only partially hurts domestic consumers. The weakening antitrust policy since the 1980s is thus an optimal response to the increasing globalization in the same period. We present a dynamic general equilibrium model of M&A, and show that welfare, measured as aggregate consumption/production in stationary equilibrium, is a hump-shaped function of the antitrust policy parameter in model. We are extending the model to an open economy, and aim to formalize the intuition that openness to trade demands a more lenient antitrust policy and to explore its quantitative implications for aggregate markup and welfare.

JEL classification: E10, F60, K21, L40
Keywords: mergers and acquisitions, markup, globalization

*We are grateful to Michele Boldrin, Paco Buera, Rody Manuelli, and Yongs Shin for their guidance and suggestions.

[†]Department of Economics, Washington University in St. Louis, email: l.cao@wustl.edu
[‡]Institute of New Structural Economics, Peking University. email: lijunzhu@nsd.pku.edu.cn.

1 Introduction

The measured markup, i.e. the difference between price and marginal cost, has been increasing since the 1980s in the US (De Loecker and Eeckhout (2017), Barkai (2016)). An increasing markup leads to efficiency loss as it lowers aggregate production and raises price comparing to the social optimal level. Further, if the rise of markup among firms varies, misallocation caused by markup differences among heterogenous firms worsens. On the other hand, as an important tool to restrain monopoly power, antitrust policy in the U.S. has been relaxed, and number of Mergers and acquisitions has surged since the 1980s. This paper provides a framework to evaluate cost and benefits of antitrust policy in a global context. M&A reallocate resources from small to large and typically more productivity firms, while also increase monopoly power of the latter. Optimal antitrust policy seeks a balance between the positive productivity effect and the negative markup effect.

We first measure markup among US public firms using the method proposed in De Loecker and Warzynski (2012) and De Loecker and Eeckhout (2017), and empirically establish a connection between M&A activity and markup at firm level. The average markup, weighted by cost of goods sold, increases from about 4% in 1980 to 16% in 2017. Comparing to 1980, the distribution of markup among public firms in 2015 clearly shifts to the right. By combining Compustat public firm data and SDC mergers and acquisition data, we find that increase of a firm's markup in the next year is about 2% higher, in relative terms, if this firm has merged or acquired at least one other firm in the current year. This amplification effect is stronger if the acquirer has a larger per-merger markup.

We then build a dynamic general equilibrium mode of M&A to analyze optimal antitrust policy. Our model builds on David (2017), which developed a model of Mergers and acquisitions in a firm dynamics framework. Firm heterogeneity is summarized by a productivity parameter, which determines firm size. The M&A market is characterized as a two-sided costly search and matching. To capture complementarity between acquirer and targets, M&A is assumed to increase the acquirer's post-merger productivity, while the magnitude of increase depends on the pre-merger size of the target. Upon a successful M&A, the target exits the economy.

The main difference of our model from David (2017) is that we incorporate heterogeneous markup into the framework. Monopoly power is an important dimension of mergers and acquisitions, and our model allows to study optimal antitrust policy. Firms with different size charge different markups. In the model, large firms face a less elastic demand and charge a higher markup. Mergers and acquisitions increase acquirers' size as well as post-merger markup. Heterogeneous markup across firms result in misallocation, and a larger dispersion due to increase in markup of large firms amplifies productivity loss due to misallocation.

Antitrust policy is modeled though a search cost function in the M&A market. That is, a stricter antitrust policy imposes a higher merger cost. Optimal antitrust policy seeks to balance the positive productivity and the negative markup effect. The productivity effect reallocates resource to larger and more productive firms and increases aggregate production, while the markup effect increases misallocation and lowers aggregate output. As both effects are reflected in the aggregate output, we use aggregate production/consumption to measure welfare. Initially strict, a more lenient antitrust policy might increase production as it allows more productivity-enhancing reallocation. This increase is eventually reversed as the M&A technology admits decreasing return to scale on the acquirer side. Therefore, after a certain point, a further relaxation of antitrust policy starts to decrease total output as the productivity effect becomes limited and the markup effect takes over.

We quantitatively show that total consumption (or/and output) is a hump-shaped function of the antitrust policy variable in the model. The optimal policy corresponds to the one that maximizes total consumption. In a work in progress, we are extending the model to an open economy, and aim to formalize the intuition that open to trade demands a more lenient optimal antitrust policy and explore its quantitative implications for aggregate markup and welfare.

The rest of paper is organized as following: In section II, we present empirical facts regarding markup and Mergers & Acquisitions, and show that there is positive effect of M&A on firms' markup. The model, first in a closed economy and then extended to an open economy framework, is shown in Section III. Section IV provides a quantitative analysis, while a concluding remark is offered in Section V.

2 Facts

This section provides empirical facts regarding markup, firm size and M&As. We measure markup using the method proposed in De Loecker and Warzynski (2012) and De Loecker and Eeckhout (2017)[1]. The measurement bases on the following observation: firm's markup, i.e. ratio of price to marginal cost, is equal to the ratio of the output elasticity with respect to an input without significant adjustment cost, to the cost share of this input[2]. The latter can be directly calculated from firms balance sheet, while the former is estimated by using a control function approach from the production estimation literature (Olley and Pakes (1996), Levinsohn and Petrin (2003)).

We apply the method mentioned above and use Compustat data to estimate firm level markups[3]. There are in total 321,315 $firm \times year$ valid observations from 1951 to 2017[4].

[1] See appendix a brief introduction of the method

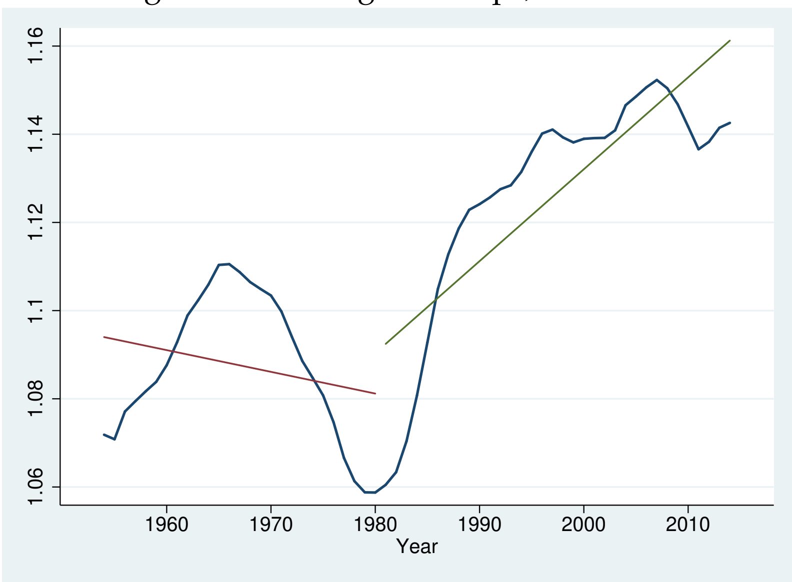
[2] This equivalence can be seen clearly from firm's cost minimization problem, as shown in appendix.

[3] Following De Loecker and Eeckhout (2017), we choose "cost of goods sold" in compustat as the choice input, and estimate output elasticity to this input for each 2 digit NAICS sector. In the baseline estimation, we assume this elasticity does not change over time.

[4] This number only includes $firm \times year$ observations for which data is available for the estimation of markup, and thus excludes observations with missing data. See Table 6.1 in appendix for NO in each year.

After obtaining firm level markup, we average them across firms by using input cost as the weight. The resulted average markup is plotted in Figure 2.1[5]. With up and downs, the average markup in early 1980s is at about the same level as in 1950s. However, over the last 3-4 decades, the measured markup has greatly increased from about 4% in 1980 to about 16% in 2017.

Figure 2.1: Average markups, 1950-2017



Note: Average markups among public firms, with weights equal to cost of goods sold. The value for year t is a moving average of original values from year $t-2$ to year $t+2$.*Data source:* Compustat.

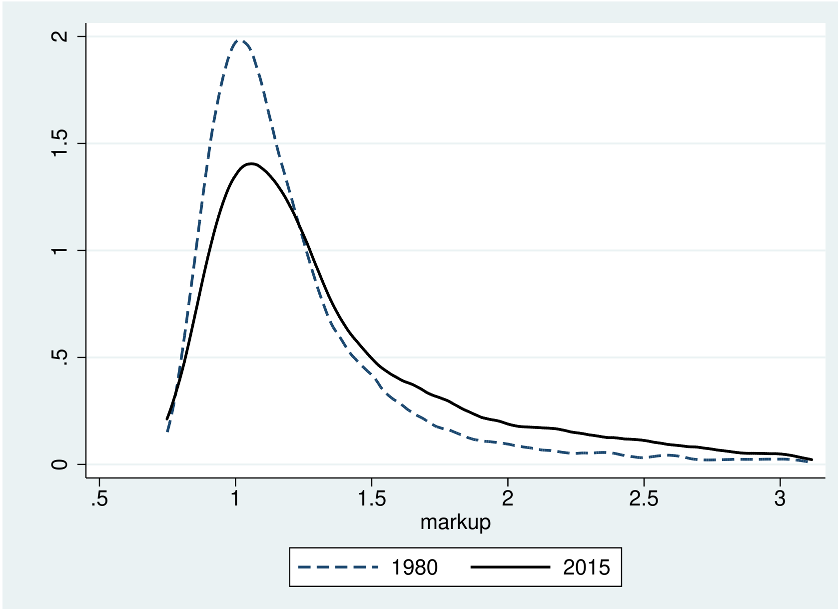
Figure 2.2 presents the distribution of markup (i.e. estimated $\frac{price}{marginal\ cost}$) among Compustat public firms in 1980 and 2015[6]. The distribution in these two years show a clear difference[7]. The distribution in 2015 has more firms with markups on the right tail, while the 1980 distribution is characterized by a concentration of markups at the left tail. The median markup in 1980 is 1.10, 75% is 1.33 and 90% 1.76. These three numbers in 2015 are 1.20, 1.66, and 2.71 respectively. A rising average markup is mainly driven by a rise of markup on the right tail.

[5]Figure 6.1 in appendix shows both cost-weighted average markup and sales-weighted average markup.

[6]We rank estimated markups among all public firms across all years in Compustat. To rule out extreme values, Figure 2.2 presents this distribution conditional on markup values locates between 5 and 95 percentiles. Distribution of markup values between 1 and 99 percentiles is shown in Figure 6.4 in Appendix.

[7]There are % of firms that have an estimated markup below 1, See De Loecker and for an explanation.

Figure 2.2: Distribution of markups among public firms in 1980 and 2015



Note: Distribution of markups conditional on markup values between 5 and 95 percentiles of the whole distribution. *Data source:* Compustat.

Within a sector, large firms tend to have higher markups. Table 2.1 presents the correlation between firm size and measured markup. We simply run a regression of markup (in log) to a measurement of firm size. In particular, firm size can be measured using sale, capital, or employment. After controlling for year and sector fixed effect, the correlation between firms size and markup is positive and significant.

Table 2.1: Dependent variable: $\ln(markup)$

	(1)	(2)	(3)
$\ln(sale)$	0.057***		
	(0.0005)		
$\ln(capital)$		0.025***	
		(0.0005)	
$\ln(emp)$			0.016***
			(0.0006)
Year D		Yes	
Sector D		Yes	
R^2	0.06	0.03	0.03
NO	321,339	321,339	286,658

Note: Data source: Compustat, 1980-2017

The fact that average markup has been rising is also related to increasing concentration in many industries in the U.S. since the 1980s, as documented in Autor, Dorn, Kats, Patterson, and Van Reenen (2017) and Boldrin and Zhu (2018). Figure 6.2 in appendix presents concentration index in the Manufacturing sector, which was relatively stable from the 1960s to the early 1980s, but has been increasing over the past three to four decades. The index for the aggregate economy, averaged over 2-digit NAICS sectors and shown in Table 2.2, has risen steadily from 1987 to 2012.

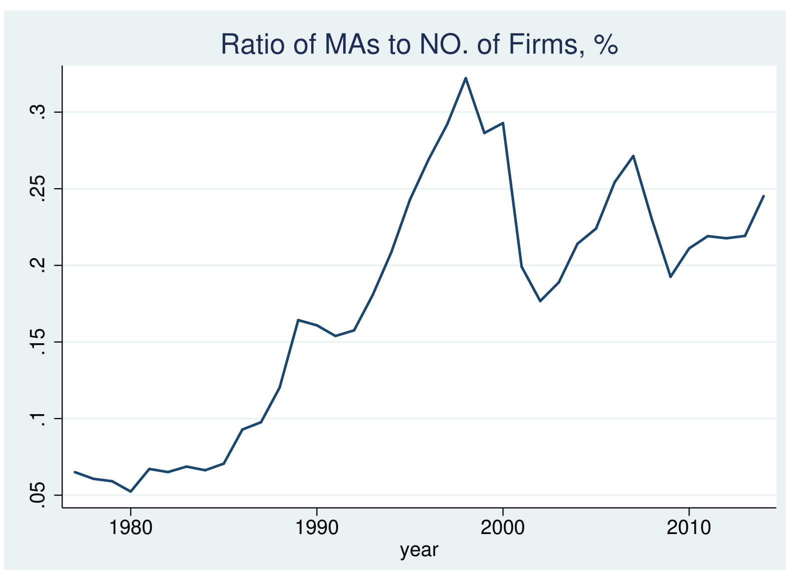
Table 2.2: Economy-wide Concentration, sales share of Top-50 Firms

Year	1987	1992	1997	2002	2007	2012
Share50	26.00%	26.57	26.69	29.52	30.51	31.31

Data source: Boldrin and Zhu (2018)

On the other hand, since the Reagan administration took office in the early 1980s, antitrust policy implementation has been relaxed drastically (Mueller, 1984). A more lenient antitrust policy is reflected in a rising Mergers and acquisitions cases after the 1980s. Figure 2.3 presents the ratio of total M&As to total NO of firms in the U.S. from 1977 to 2015[8]. This ratio was 0.065% in 1977, relatively stable in the late 1970s and early 1980s, and has risen to 0.245% in 2014. M&A activity in Figure 2.3 demonstrates a clear up-and-down wave patterns. In current paper, we focus on the long run trend from the 1980s on wards, and do not address this wave pattern. Figure 6.3 in appendix shows total number of M&A from 1850 to present. The post-1980s period stands out in even longer historical horizons.

Figure 2.3: Ratio of M&As to NO. of Firms, 1977-2015



Data source: https://imaa-institute.org.

[8]Total value of M&As increases from 306 trillion U.S. dollars in 1985 to 1741 in 2017, an increase of 469%.

Market power is an important consideration in antitrust policy implementation. Empirically, firm's M&A activity is expected to be closely related to its markup. To test the effect of M&A on markup, we first merge Compustat firm data with SDC-M&A data, which starts in 1980. From 1980 to 2015, there are $246,452$ *firm* $\times$ *year* observations in Compustat[9]. Among which $40,291$, or 16%, have at least one M&A.

Using the combined data, we run the following regression

$$\ln\left(\frac{markup_{i,t+1}}{markup_{i,t}}\right) = \beta_0 + \beta_1 MA_{i,t} + \beta_2 \ln(markup_{i,t}) + controls + \epsilon$$

where $MA_{i,t}$ is a dummy variable and equals to 1 if firm i has at least one mergers & acquisitions in year t. The dependent variable is the relative change in markup for firm i from year t to year $t+1$. Firm's current markup is added as a control as relative change is expected to be small given a firm already have a large value of markup today. Year and sector dummies are also added as controls in the regression. Table 2.3 presents the regression results

Table 2.3: Effect of M&A on markup

Dep. var.: $\Delta \ln(markup)$	(1)	(2)
$\ln(markup)$	-0.240***	-0.246***
	(0.001)	(0.001)
I^{MA}	0.019***	0.001
	(0.003)	(0.003)
$\ln(markup) \times I^{MA}$		0.06***
		(0.005)
Year D	Yes	Yes
Sector D	Yes	Yes
R^2	0.12	0.12
NO	221,213	221,213

Date source: Compustat and SDC-MA

Column 1 shows the baseline results. The coefficient in front of I_{MA} is positive and significant. The effect is economically sound, firm's markup increases 1.9% in average after an M&A activity. Column 2 adds the interaction term between markup and the M&A dummy, to capture the conjecture that the amplification effect of M&A on markup might be larger for firms which have already had a larger markup. Year and sector dummies are also added. As in column 1, the coefficient in front of the interaction term is positive and significant.

[9]This number is counted after dropping observations with missing values.

3 The Model

We are now ready to provide a modeling framework to evaluate costs and benefits of antitrust policy. The model here builds on David (2017), which is a firm dynamics model with Mergers and acquisitions. Firms are heterogeneously endowed with a productivity, which can be changed through M&A and is otherwise constant. Upon paying a cost, firms search for potential targets/acquirers and successfully matched pairs decide whether to consummate a M&A deal. Due to technical complementarity between acquirers and targets, acquirers increase their productivity by merging other firms, with the magnitude of increase depends on the pre-merger size of targets. We introduce heterogeneous markup and international trade into that framework. In particular, heterogeneous markup is modeled as a result of different elasticity of demand faced by different firms. We start with a closed economy version of the model and then extend it to an open economy.

3.1 Close economy

The economy consists of two sectors, an intermediate goods sector where each single firm monopolies in producing an intermediate variety, and a final good sector where firms produce competitively by aggregating over intermediate goods. We start with the competitive final good sector.

Final good The final good is produced competitively by aggregating over intermediate goods according to the following aggregator

$$\int \sigma(\frac{y_t(\omega)}{Y_t})d\omega = 1$$

where Y_t denotes quantity of the final good in period t and $y_t(\omega)$ intermediate variety ω. Following Kimball (1995), $\sigma(x)$ is a strictly increasing and strictly concave function, satisfying $\sigma(1) = 1$. The case where $\sigma(x) = x^{\frac{\epsilon-1}{\epsilon}}$ gives the typical CES aggregator.

Normalize the price of final good as 1 and denote $p_t(\omega)$ the price of intermediate goods ω. Final good producers optimally choose intermediate varieties to maximize profit, i.e.

$$\max_{y_t(\omega)} \quad Y_t - \int p_t(\omega)y_t(\omega)d\omega$$

subject to the production function above. The maximization problem gives the demand function facing the producer of intermediate variety ω as

$$p_t(\omega) = \sigma'(\frac{y_t(\omega)}{Y_t})D_t$$

where D_t is the common term facing all intermediate goods producers and defined as

$$D_t \equiv (\int \sigma'(\frac{y_t(\omega)}{Y_t})\frac{y_t(\omega)}{Y_t}d\omega)^{-1}$$

One property of the derived demand function facing intermediate varieties is that, depending on the functional form of $\sigma(\cdot)$, the elasticity of demand might vary across intermediate goods producing firms. This generates heterogeneous markups among intermediate firms.

Intermediate goods Each intermediate good is produced by a single firm. An intermediate firm with productivity z uses labor as the only input and accesses to the following linear production technology

$$y_t = z\ell_t^{\delta}, \quad \delta \in (0,1]$$

Intermediate firms optimally choose quantity and price of its products and the amount of labor to employ, ℓ, to maximize current period profit

$$\pi_t(z) \equiv \max_{p_t(\omega), y_t(\omega), \ell_t(\omega)} p_t(\omega)y_t(\omega) - W_t\ell_t(\omega)$$

where W_t is common wage rate in period t. Intermediate firms are subject to the demand scheme from the final goods sector.

As in Klenow and Willis (2016) and Edmond, Midrigan and Xu (2018), we choose the following specification of the kimball aggregator

$$\sigma(q) = 1 + (\beta - 1)\exp(\frac{1}{\alpha})\alpha^{\frac{\beta}{\alpha}-1}\left[\Gamma(\frac{\beta}{\alpha}, \frac{1}{\alpha}) - \Gamma(\frac{\beta}{\alpha}, \frac{q^{\alpha/\beta}}{\alpha})\right]$$

where $\alpha \geq 0$ and $\beta > 1$, and $\Gamma(a,b) \equiv \int_b^{\infty} x^{\alpha-1}e^{-x}dx$ is the upper incomplete Gamma function. Under this aggregation, the term $\sigma'(q)$, with $q \equiv \frac{y}{Y}$ representing the relative size of the intermediate firm, in the intermediate goods demand function, is given by

$$\sigma'(q) = \frac{\beta - 1}{\beta}\exp(\frac{1 - q^{\alpha/\beta}}{\alpha}),$$

which is a decreasing function of relative size. That is, large firms (i.e. with larger $q's$) face a smaller demand elasticity and optimally charge a higher markup. To see this, use this demand function to substitute away price in intermediate firms' profit maximization problem and rewrite it as

$$\begin{aligned} \pi(z) &\equiv py - W\ell \\ &= \max_q [\sigma'(q)q - \frac{WY^{\frac{1}{\delta}-1}}{Dz^{\frac{1}{\delta}}} \cdot q]DY \end{aligned}$$

where we use the fact that in equilibrium, $\ell = (\frac{y}{z})^{\frac{1}{\delta}}$. The optimal condition with respect to q yields

$$\sigma'(q)(\frac{\beta - q^{\alpha/\beta}}{\beta}) = \frac{WY^{\frac{1}{\delta}-1}}{Dz^{\frac{1}{\delta}}}$$

From this first order condition, we can easily verify that $q^*(z)$ is strictly increasing in z. Firms with a higher productivity have a larger market shares. The markup, i.e. the ratio of price of marginal cost, satisfies

$$\mathcal{M} \equiv \frac{p}{MC} = \frac{\beta}{\beta - (q^*)\alpha/\beta}$$

That is, markup is an increasing function of q. larger firms charge a higher markup. The profit of an intermediate firm is

$$\pi(z) = \sigma'(q)\frac{(q^*)(\alpha+\beta)/\beta}{\beta}DY,$$

which is strictly increasing in q^* in the interval of $[0, (\alpha+\beta)^{\beta/\alpha}]$. Since $q^*(z) \leq \beta^{\beta/\alpha}, \forall z$, the profit $\pi(z)$ is also strictly increasing in z, although we no longer have a simple closed form of it as in the CES case ($\alpha = 0$).

Mergers and acquisitions To single out the effect of M&A, we assume that intermediate firms' productivity and size can change after M&A, and stay constant otherwise. Following David (2017), M&A is modeled under a search and matching framework. Each firm simultaneously decide to search to be an acquirer or/and a target in the M&A market. Upon successfully match with a target which has a productivity z_t, the post-merger productivity of an acquirer firm with pre-merger productivity z_a is

$$z_m = m(z_a, z_t)$$

It is assumed that m is an increasing function in both of its arguments. The function captures the productivity increase due to technological complementarity between acquirers and targets. Denote $V(z)$ the value of firm with productivity z, which will be specified below. M&A possibly increases acquirer's size and value, and the potential gain from M&A is

$$G(z_a, z_t) = V(z_m) - V(z_a) - V(z_t)$$

and a M&A will be proposed if and only if $G(z_a, z_t) > 0$.

A M&A proposal has a probability $\tau(z_a, z_t) \in [0, 1]$ of being passed by the policy maker. τ is allowed to be dependent on (z_a, z_t). If a M&A is proposed and passed, the surplus is split between the acquirer and the target through Nash Bargaining, denote γ as the bargaining power of the acquirer. Define G_a and G_t as the expected net gains for the acquirer and target, from a successful matching, respectively. It follows that

$$G_a(z_a, z_t) = \max\Big\{\tau(z_a, z_t)\gamma G(z_a, z_t), 0\Big\};$$
$$G_t(z_a, z_t) = \max\Big\{\tau(z_a, z_t)(1-\gamma) G(z_a, z_t), 0\Big\}.$$

In a consummated M&A, the acquirer pays the target

$$P(z_a, z_t) = V(z_t) + (1-\gamma)G(z_a, z_t)$$

and continues with the post-merger productivity z_m, while the target exits the economy. If the M&A does not happen, both firms continues with their original productivity. We omit the possible financial constraints, and assume that an acquirer can always afford to pay $P(z_a, z_t)$, either by a lump-sum transfer or a long-term contract.

As in David (2017), firms simultaneously choose search intensities $\lambda(z)$ of meeting a potential target and $\mu(z)$ of meeting a potential acquirer, with the associated costs given by

$$c(x;\phi), \quad \textit{for} \quad x = \lambda, \mu$$

$c(\cdot\,;\,\cdot)$ is increasing in x, implying a higher cost for a higher search intensity, and also increases with ϕ, which represents the strength of antitrust policy. A higher value of ϕ implies a larger M&A cost, and therefore represents a stricter antitrust policy. A relaxation of antitrust policy is modeled as a decrease in the value of ϕ.

Market tightness on the acquirer (target) side is defined as the total search intensity from potential targets (acquirers) to that from potential acquirers (targets). A higher tightness implies a higher matching rate. Denote $F(z)$ the distribution of active firms, which will be specified below. The market tightness on the acquirer and target side is[10]

$$\theta_a = \frac{\int \mu(z)dF(z)}{\int \lambda(z)dF(z)}, \quad \theta_t = \frac{\int \lambda(z)dF(z)}{\int \mu(z)dF(z)}$$

The rate a type z_a acquirer meets a type z_t target, and vice versa, is given by

$$\lambda(z_a)\theta_a \underbrace{\frac{\mu(z_t)dF(z_t)}{\int \mu(z)dF(z)}}_{\Omega(z_t)}; \quad \mu(z_a)\theta_t \underbrace{\frac{\lambda(z_a)dF(z_a)}{\int \lambda(z)dF(z)}}_{\Phi(z_a)}$$

where $\lambda(z_a)\theta_a$ denotes the rate the acquirer z_a meets a target, and $\Omega(z_t)$ denotes the conditional probability that this target has productivity z_t. A symmetric interpretation applies on the target side.

Value functions Assume that firms exit at an exogenous rate η. The value of a firm as a function of the state variable, productivity z, is

$$(\rho+\eta)V(z) = \max_{\lambda,\mu} \ \pi(z) - c(\lambda;\phi) - c(\mu;\phi) + \lambda\theta_a \mathbb{E}_{z_t}[G_a(z,z_t)] + \mu\theta_t \mathbb{E}_{z_a}[G_t(z_a,z)]$$

Firms optimally choose search intensities, both as an acquirer and a target[11]. The flow value of a firm with productivity z is equal to, the instantaneous profit π, plus the expected net benefit from searching in the M&A market.

[10] Note that as the model is in continuous time, these two tightness index do not have to be smaller than 1.

[11] In an infinitely small interval of time, the probability of simultaneously meeting a potential target and a potential acquirer is zero.

Entry, exit and equilibrium As mentioned earlier, firms exit with an exogenous rate η. A firm enters the economy by paying a fixed cost c_e, then draws its initial productivity z from an exogenous distribution $H(z)$. Free entry implies the expected value of entry equals this fixed entry cost, i.e.

$$\int V(z)dH(z) = c_e$$

Denote M_e total mass of entrants, and M mass of all active firms. The distribution of firm productivity, $F(z)$, evolves according to the following Kolmogorov forward equation.

$$\begin{aligned} d\dot{F}(z) = & \underbrace{\int \lambda(z_a)\theta_a\Big[I\Big(G\big(z_a, m^{-1}(z,z_a)\big) > 0\Big)\Omega\Big(m^{-1}(z,z_a)\Big)\Big]dF(z_a)}_{\text{inflow through M\&A}} + \underbrace{\frac{M_e}{M}dH(z)}_{\text{inflow through entry}} \\ & - \underbrace{\lambda(z)\theta_a dF(z)\int I(G(z,z_t) > 0)\Omega(z_t)}_{\text{outflow through merging}} - \underbrace{\mu(z)\theta_t dF(z)\int I(G(z_a,z) > 0)\Phi(z_a)}_{\text{outflow through being merged}} \\ & - \underbrace{\eta dF(z)}_{\text{outflow through exog. exit}} \end{aligned}$$

This law of motion decompose changes in probability over any state z into 5 possible channels: Firms with a different productivity might merger other firms and obtain a post-merger productivity z; Exogenous entrants might draw a productivity z; Firms originally with productivity z might merger other firms and arrive at a new (higher) productivity; Firms originally with productivity z might be merged by other firms and exit the economy; Firms originally with productivity z might exit upon being hit by the exogenous exit shock. In a stationary equilibrium, the mass at each state is constant. That is, change is equal to zero,

$$d\dot{F}(z) = 0, \quad \forall\, z.$$

The economy admits a representative household, who owns all firms, and wage and firm profits. It also pays the entry cost c_e. The household consumes all it income every period as saving is not allowed. It is endowed with 1 unit of labor, and supplies it inelastically.

We close the model with market clearing conditions. Labor is used in producing intermediate goods, all employed workers in the intermediate goods sector should equal to total supply, i.e.

$$M\int (\frac{y(z)}{z})^{\frac{1}{\delta}}dF(z) = 1$$

The final good can be used in three ways: consumption, payment of search cost in the M&A market, and payment of entry cost. Market clearing implies

$$Y = C + Y_s + M_e C_e$$

where total search cost equals that for acquirers and targets. That is

$$Y_s = M\int c(\lambda(z);\phi)dF(z) + M\int c(\mu(z);\phi)dF(z).$$

Now we can formally define the equilibrium in our model.

Definition 1. *We focus on a **S**tationary **E**quilibrium of the economy, which in the closed economy version of model consists of: aggregate variables,* $\{Y, W, C, M, M_e, F(z)\}$*; Firm's policy function and profit function from the static profit maximization problem,* $\{q(z), \pi(z)\}$*; Firm's search intensity policy functions and value function from the dynamic search and matching problem,* $\{\lambda(z), \mu(z), V(z)\}$*, such that*

1. *Policy functions solve their corresponding maximization problems;*
2. *The free entry condition is met;*
3. *The goods and labor markets clear;*
4. *The evolution of firm characteristic distribution is consistent with the stationary conditions.*

4 Quantitative analysis

This section provides the quantitative results. We first specify a few function forms. The merger technology is set as

$$z_m = A z_a^{\kappa} z_t^{\epsilon}$$

where $A > 0$, $\kappa > \epsilon > 0$. The latter implies that post-merger productivity relies more heavily on the productivity of acquirers, and it is therefore more likely that large firms acquire small ones. The search cost function is chosen to be

$$c(x; \phi) = \frac{\phi^{\nu-1}}{\nu} x^{\nu}$$

where $\phi > 0$, $\nu > 1$. As detailed in the model part, the Kimball aggregator is set to be the Klenow-Willis form.

Parameters There are 12 parameters in the model. For M&A technology related parameters, A, κ and ϵ, we borrow the estimated values from David (2017), and for parameters in the kimball aggregator from Edmond, Midrigan, and Xu (2018). We pick the discount rate to be 0.05 to match an annual interest rate of 5%, and η to be 0.04 to target an annual exit rate of 4%. δ, which governs the decreasing return to scale in intermediate goods production, is chosen to be 0.8 to match a 20% of profit rate. The entry cost c_e is normalized to 1.[12] Table 4.1 summarizes the current parameterization

[12] We are currently working on a more deliberate calibration.

Table 4.1: Parameter values

Para.	meaning	values	source
ρ	discount rate	0.05	interest rate
δ	para. in intermediate prod. func.	0.8	20% profit rate
η	exit rate	0.04	
γ	bargaining power	0.49	
ξ	para. in new entrant's prod. distr.	10	
A	scale para. in M&A tech.	1.05	David'17
κ	acquirer productivity elasticity	0.91	David'17
ϵ	target productivity elasticity	0.53	David'17
ν	para. in search cost func.	8	
c_e	entry cost	1	normalization
α	para. in kimball aggr.	2.18	EMX'18
β	para. in kimball aggr.	11.55	EMX'18

We pick ϕ and τ as 'technology parameter' and 'policy parameter', and try to pin down their optimal values. We then experiment on different c_e and q^F, try to figure out their effects on the optimal parameter values. We hope this exercise would shed light on why the antitrust policy has been weakened since the 1980s.

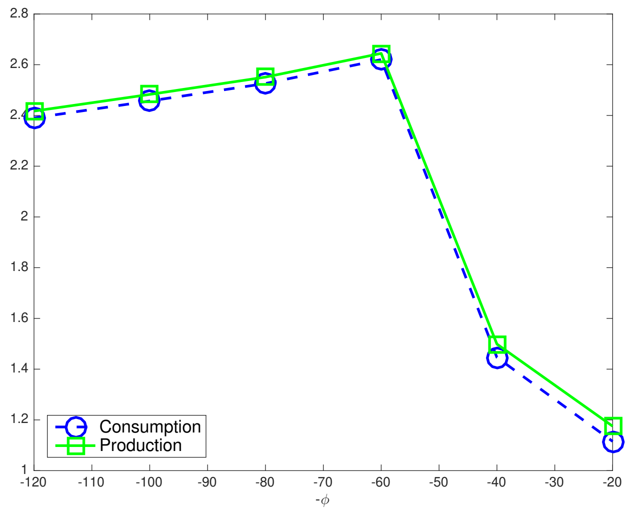
Under the benchmark parameterization and set $\tau = 1$, household welfare shows a clear hump-shaped curve as we vary ϕ.

ϕ	10	20	40	60	80	100
C	1.7334	1.7777	2.1741	2.2072	2.1202	2.0849
Y	1.9171	1.9478	2.2603	2.2811	2.2119	2.1830

This implies an optimal technology parameter value $\phi^* = 60$.[13] Figure 6.3 plots consumption and output under different values of ϕ.

[13]Unfortunately, we don't observe such pattern when we keep ϕ constant and vary τ. So we pick ϕ as our 'parameter of interest' and do comparative statics.

Figure 4.1: Cons./output under different values of ϕ



4.1 Extension: international trade and entrant quality

The model we present so far has no international trade. We extend the model into an open economy framework in the following way: now with trade, assume the production function of the final good becomes

$$\int \sigma(\frac{y_t(\omega + y_t^F(\omega))}{Y_t})d\omega = 1$$

where $y_t^F(\omega) > 0$ implies net import, and $y_t^F < 0$ implies net export. $y_t(\omega)$ is total amount of intermediate variety ω. In equilibrium, it always holds that $y_t^*(\omega) + y_t^F(\omega) > 0$. To simplify analysis, $p_t^F(\omega)$ are set to the same as $p_t(\omega)$.

Now the intermediate good demand function is

$$p_t(\omega) = \sigma'(\frac{y_t(\omega) + y_t^F(\omega)}{Y_t})D_t$$

Intermediate firms' profit maximization problem becomes

$$\pi(z) = \max_q \left[\sigma'(\max(q + q^F(z), 0))q - \frac{WY^{\frac{1}{\delta}-1}}{Dz^{\frac{1}{\delta}}}\right] DY$$

where $q^F(z)$ is exogenously given.[14]

[14]Note that when $q^F < 0$, the concavity of the maximization problem above could be violated locally

With a correctly specified marginal cost $W/D < \sigma'(\max(q^F(z), 0))$, we could reach interior solutions for all z. The implied markup function is

$$\mathcal{M} = \frac{p}{MC} = \frac{\sigma'(q^* + q^F)}{\sigma'(q^* + q^F) + \sigma''(q^* + q^F)q^*}$$

The M&A, entry, exit, stationary distribution, and the labor market clearing condition do not change. The only change comes from the final good market clearing condition, which now is

$$Y = C + Y_s + M_e C_e + Y^F$$

where C, Y_s and M_e are defined as in the close economy, and

$$Y^F = M \int p^F(z) y^F(z) dF(z)$$

is payment to (from) foreign market, with

$$p^F(z) = p(z) = \sigma'(q^*(z) + q^F(z))D.$$

The next section presents results we have experimented with several versions of the $q^F(z)$ function. If $q^F(z) > 0$ (< 0), the economy is net importing (exporting) in all varieties with characteristic z. We keep $c_e = 1$ in this exercise.

Case 1: $q^F(z) = x^{index} - 1$

x	1.00	1.02	1.05	1.08	1.10	1.15	1.20
ϕ^*	60	60	60	60	60	60	40
Y^F/Y	0%	7.34	17.70	26.76	32.63	48.42	69.43

Case 2: $q^F(z) = x^z - 1$

x	1.00	1.10	1.15	1.20
ϕ^*	60	40	40	40
Y^F/Y	0%	19.05	26.35	31.47

Case 3: $q^F(z) = z^x - yz$

x, y	1.00 , 1.00	1.30 , 0.70	1.50 , 0.90	2.00 , 0.95
ϕ^*	60	40	60	40
Y^F/Y	0%	42.60	32.80	52.87

ϕ^* still doesn't move much, and with no deterministic pattern. Issue remains when we narrow the range down to $[40, 60]$.

We have then done an exercise where international trade has been shut down, but the quality of entrants is allowed to vary. We change z_{peak} of $H(z)$, while keep it as a Pareto distribution on $[z_{peak}, \infty]$. Table 4.1 presents the result

Table 4.2: Entry quality and optimal ϕ

z_{peak}	1.00	1.10	1.21	1.32	1.45
ϕ^*	60	60	80	120	140

As the new entrant firm's productivity distribution shifts to the right, the optimal ϕ^* increases. If the productivity of young firms relative to old incumbent firms decline over time, the implied optimal antitrust policy should be more lenient.

5 Conclusion

This paper provides a framework to evaluate the costs and benefits of antitrust policy in a dynamic general equilibrium framework. We first provide empirical evidence for evolving distribution of markup across public firms and the effect of mergers and acquisitions on acquiring firms' markup. We then present a dynamic general equilibrium model that incorporates both the productivity enhancing and markup increasing effect of mergers and acquisitions. Optimal antitrust policy seeks a balance between these two forces. We showed that in a closed economy version of our model, Welfare, measured as aggregate consumption in a stationary equilibrium, is a hump-shaped function of antitrust policy.

In a current work in progress, we are extending the model to an open economy and aim to formalize the following intuition: in a globalized economy, increasing productivity fully accrues to domestic firms while a higher markup only partially hurts domestic consumers. A weakening antitrust policy since the 1980s is thus an optimal response to the increasing globalization in the same period.

References

[1] Barkai, Simchar, ”Declining Labor and Capital Shares”, *working paper*, 2017.

[2] Boldrin, Michele and Lijun Zhu, ”Technical Progress and Movements in the Labor Share”, *working paper*, 2018

[3] David, Joel, ”The Aggregate Implications of Mergers and Acquisitions”, *working paper*, 2017.

[4] De Loecker, Jan, and Frederic Warzynski, ”Markups and Firm-Level Export Status”, *American Economic Review,* 2012, 102, 2437-2471.

[5] De Loecker Jan, and Jan Eeckhout, ”The Rise of Market Power and the Macroeconomic Implications”, *working paper*, 2017.

[6] Edmond, Chris, Virgiliu Midrigan, and Daniel Yi Xu, ”How Costly are Markups”, *working paper*, 2018.

[7] Fox, Eleanor M., ”Cases and Materials on U.S. Antitrust in Global Context”, 2012, 3rd edition, published by Thomson Reuters

[8] Grullon, Gustavo, Yelena Larkin, and Roni Michaely, ”Are US Industries Becoming More Concentrated?” *working paper*, 2016

[9] German, Gutierrez, and Thomas Philippon, ”Declining Competition and Investment in the US”, *working paper*, 2017

[10] German, Gutierrez, and Thomas Philippon, ”How EU Markets Became More Competitive than US Markets: A Study of Institutional Drift”, *working paper*, 2018

[11] Kimball, Miles S., ”The Quantitative Analytics of the Basic Neomonetarist Model’, *Journal of Money, Credit, and Banking*, 1995, 27, 1241-1277.

[12] Klenow, Peter J., and Jonathan L. Willis, ”Real Rigidities and Nominal Price Changes”, *Economica*, 2016, 83, 443-472.

[13] Levinsohn, James A., and Amil Petrin,”Estimating Production Functions Using Inputs to Control for Unobservables.” *Review of Economic Studies*, 2003, 70, 317-40.

[14] Mueller, Willard F., ”Antitrust in the Reagan Administration”, *Revue Francaise d’Etudes Armericaines*, 1984, 427-434.

[15] Olley, Steve G., and Ariel Pakes, ”The Dynamics of Productivity in the Telecommunications Equipment Industry”. *Econometrica*, 1996, 64, 1263-97.

6 Appendix

6.1 Measurement of markups

We use the price-marginal cost markup, $\frac{P_i}{MC_i}$, to indicate the monopoly power of firm i, and measure it by using methods proposed in De Loecker and Warzynski (2012) and De Loecker and Eeckhout (2017). The method starts with the typical cost minimization problem of firm i is[15]

$$\mathcal{L}(V_i, K_i, \lambda_i) = P_i^V V_i + r_i K_i - \lambda_i (F(V_i, K_i) - \bar{Y})$$

where P_i^V and V_i are the price and quantity of the variable input, r_i and K_i are the user cost and quantity of capital. $F(.)$ is the production function and $\bar{Y}$ is the targeted output level, and λ_i is the Lagrangian multiplier. The advantage of writing in this way is that $\lambda = \frac{\partial \mathcal{L}}{\partial \bar{Y}}$, i.e. λ_i gives the marginal cost of firm i. The first order condition *w.r.t.* V_i reads

$$P_i^V - \lambda_i \frac{\partial Y_i}{\partial V_i} = 0$$

$Y_i \equiv F(V_i, K_i)$ denotes total output. Equivalently

$$\epsilon_i^V \equiv \frac{\partial Y_i}{\partial V_i} \frac{V_i}{Y_i} = \frac{1}{\lambda_i} \frac{P_i^V V_i}{Y_i}$$

It follows that markup, $\mu_i = \frac{P_i}{\lambda_i}$, equals to

$$\mu_i = \epsilon_i^V \frac{P_i Y_i}{P_i^V V_i}$$

where $P_i Y_i$ and $P_i^V V_i$ are observed in data, and $\epsilon_i^V \equiv \frac{\partial Y_i}{\partial V_i} \frac{V_i}{Y_i}$ is the elasticity of output *w.r.t.* the variable input and can be estimated from data.

Assume the production function is, $Q = F(V, K) \exp(z)$[16]. Take log on both sides and use lower case letters to denote natural logarithmic of variables,

$$q = \xi_v v + \xi_k k + z + \epsilon$$

Demand of the variable input, V, is a function of capital stock, K, and unobserved productivity, Z, V=g(K, Z). We can then represent productivity, $Z(z)$, as a function of $K(k)$ and $V(v)$, i.e., $z = h(k, v)$. In the first stage, run the following regression non-parametrically (or approximate ϕ by a polynomial)

$$q = \phi(v, k) + \epsilon$$

[15]Note the implicit assumption here is that

[16]We assume the same production function at 2-digit NAICS sector level among Compustat firms.

Further assume the exogenous productivity follows a $AR(1)$ process

$$z_{t+1} = \rho z_t + \epsilon_z$$

Obtain $\hat{z} = \hat{\phi}(v,k) - \xi_v v - \xi_k k$ from the first stage, and we then apply general method of moments to estimate ξ_v, by using the following moment conditions:

$$E[(\hat{z}_t - \rho \hat{z}_{t-1}) X_{t-1}] = 0.$$

In the baseline case, we include capital stock in period t, k_t, and variable input in period $t-1$, v_{t-1}, in X_{t-1}.

6.2 Solution Algorithm

- Guess
  - Loop1: Guess $w \equiv W/D$, solve for $q^*(z)$ [17] from
  $$\max_q \quad \sigma'\left(max\left(q + q^F, 0\right)\right) q - \frac{w}{z} q$$
  - Loop2: Guess $dF(z)$, solve for $M, D, W, Y, \pi(z)$ from
  $$M \int \sigma\left(q^* + q^F\right) dF(z) = 1$$
  $$D = \left(M \int \sigma'\left(q^* + q^F\right)\left(q^* + q^F\right) dF(z)\right)^{-1}$$
  $$M \int \frac{q^* \cdot Y}{z} dF(z) = 1$$
  $$\pi(z) = \left[\sigma'\left(q^* + q^F\right) q^* - \frac{w}{z} q^*\right] DY$$
  - Loop3: Guess $V(z)$, construct $G(z_a, z_t)$ matrix based on $V(z)$.
  - Loop4: Guess $\mu(z)$ and θ_a, solve for $\lambda(z)$ and θ_t from (2).
- Update
  - Loop4: Use $\lambda(z)$ and θ_t to solve for new $\mu(z)$ and θ_a from (2), update till converge.
  - Loop3: Use $\mu(z)$, $\lambda(z)$, θ_a, θ_t to get a new $V(z)$ from (1), update till converge and choose step small.

[17] As we see in the model part, equilibrium q^* will surely such that $q^* + q^F \geq 0$.

- Loop2: Use $G(z_a, z_t)$, $\mu(z)$, $\lambda(z)$, θ_a, θ_t and M to solve for M_e from:

$$M_e = M\eta + M \int \mu(z_t)\, \theta_t \left[\int \tau(z_a, z_t)\, I(G(z_a, z_t))\, \Phi(z_a) \right] dF(z_t)$$

  With the exogenous $dH(z)$, we can use the KFE to get a new

$$dF_{+1}(z) = dF(z) + step \cdot (RHS\ of\ KFE)$$

  update till converge.

- Loop1: Check the free entry condition, if value¿cost, increase w, otherwise reduce it, till free entry condition is met or the change is too small.

Value function iteration in continuous time model. We update the value function as

$$V^{n+1}(z) = V^n(z) + \Delta$$

where

$$\Delta = \Big\{ \pi(z) - C(\lambda^n(z)) - C(\mu^n(z)) + \lambda^n(z)\theta_a^n E_{z_t}[G_a^n(z, z_t)] + \mu^n(z)\theta_t^n E_{z_a}[G_t^n(z_a, z)] \Big\} - (\rho + \eta)V^n(z)$$

This is equivalent to set

$$V^{n+1} = \tau \cdot \frac{\{...\}}{\rho + \eta} + (1 - \tau) \cdot V^n$$

where $\tau = \rho + \eta$.

6.3 Table and Figures

Table 6.1: NO of firms in Compustat sample

Year	NO	Year	NO	Year	NO	Year	NO
1951	441	1968	3015	1985	5929	2002	7299
1952	456	1969	3623	1986	6242	2003	7048
1953	474	1970	3717	1987	6430	2004	6873
1954	486	1971	3768	1988	6369	2005	6680
1955	516	1972	3885	1989	6231	2006	6553
1956	553	1973	3956	1990	6203	2007	6309
1957	573	1974	4354	1991	6293	2008	6027
1958	608	1975	5785	1992	6502	2009	5972
1959	637	1976	5804	1993	6867	2010	5757
1960	663	1977	5776	1994	7269	2011	5607
1961	1281	1978	5672	1995	7632	2012	5543
1962	1667	1979	5495	1996	8487	2013	5758
1963	1934	1980	5381	1997	8534	2014	5712
1964	2183	1981	5432	1998	8207	2015	5458
1965	2435	1982	5421	1999	8453	2016	5217
1966	2620	1983	5810	2000	8234	2017	4915
1967	2819	1984	5950	2001	7797		

Data source: Compustat

Table 6.2: Concentration in 2-digit sectors

	Share50, 2-digit				Share04, 6-digit average			
	1997	2002	2007	2012	1997	2002	2007	2012
Wholesale Trade	20.3%	27.2	24.9	27.6	24.3%	31.4	29.1	30.8
Retail Trade	25.7	31.7	33.3	36.9	18.5	26.8	31.0	34.6
Transportation	30.7	33.0	42.7	42.1	23.6	24.5	30.8	35.2
Utilities	64.5	69	70.1	69.1	25.8	23.2	23.0	24.2
Information		62	62	62.3		49.8	52.4	52.0
Finance	38.6	44.9	46	48.5	26.0	32.0	36.1	35.4
Real Estate	19.5	24.4	26.1	24.9	18.8	24.0	25.1	23.3
Prof. Sci. Tech.	16.2	16.5	18.6	19.0	15.0	15.1	17.9	18.3
Administrative	22.1	21.9	23.0	23.7	21.8	23.1	24.4	24.4
Education	19.6	23.2	23.5	23.8	16.6	19.4	19.4	19.4
Health Care	18.8	17.2	17.4	19.6	16.2	15.1	15.1	17.0
Entertainment	21.8	23.5	24.1	24.3	19.2	20.5	21.5	21.6
Accommodation	21.1	23.1	23.7	21.2	13.8	17.4	18.5	16.0
Other Services	12.8	14	13.8	12.6	13.8	14.7	15.0	14.1

Note: For most services sectors in 1997, statistics are only available for establishments subject to federal income taxes (instead of all establishments) in Service sectors. To be consistent, the same criteria is applied to 2002, 2007, and 2012.

Table 6.3: Total NO of Firms in economy (unit: thousand)

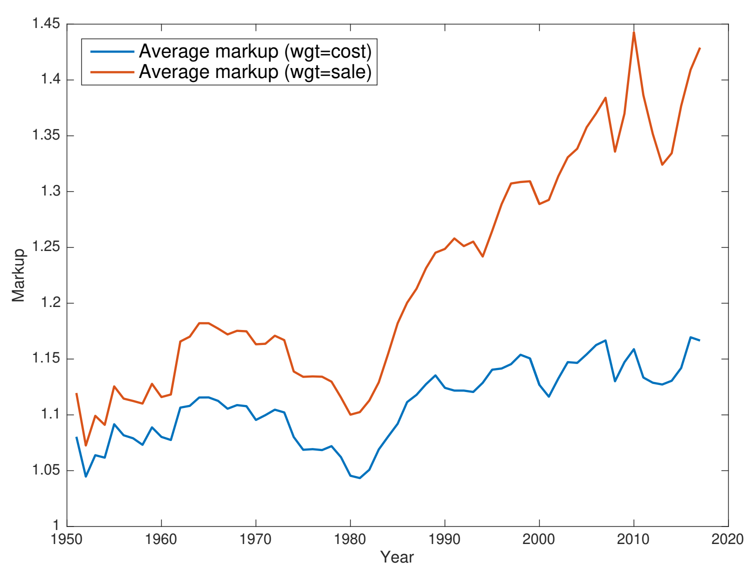
Year	1977	1982	1987	1992	1997	2002	2007	2012
Economy	3147.9	3604.0	4179.8	4377.1	4752.3	4908.7	5240.0	4979.5
MFG	261.2	272.9	290.8	296.0	303.2	283.4	267.8	234.4
WHO	277.9	307.6	337.0	354.8	372.9	349.6	341.4	310.8
RET	942.8	912.7	953.0	939.8	955.6	949.5	980.0	953.0
TCP	121.3	130.5	153.9	162.2	187.9	190.1	195.6	185.4
FIRE	298.0	299.5	347.2	358.1	393.7	429.8	489.7	435.9
SRV	1122.5	1288.5	1600.8	1741.6	1924.9	2055.0	2344.1	2355.5

Note: MFG-Manufacturing; WHO-Wholesale trade; RET-Retail trade; TCP-Transportation, communication and public utilities; SRV-Services.
Source: Business Dynamics Statistics

Table 6.4: Policy parameter ϕ and aggregate consumption/production

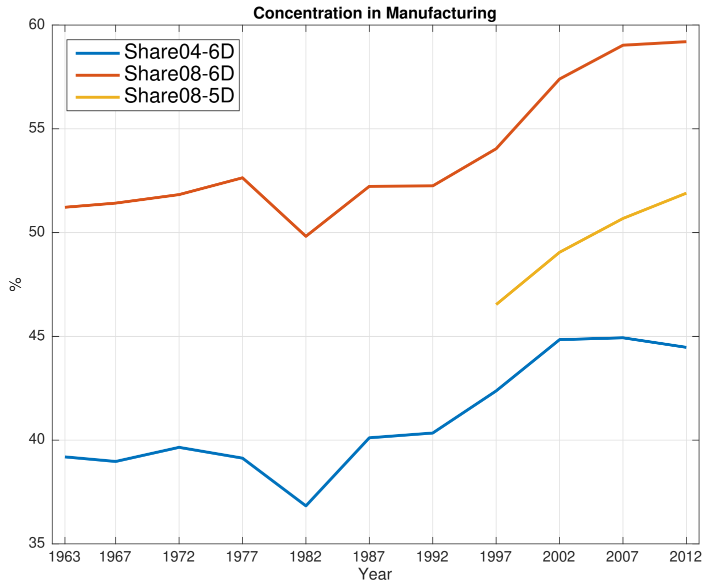
ϕ	20	40	60	80	100	120
C	1.1153	1.4462	2.6202	2.5259	2.4570	2.3904
Y	1.1751	1.4988	2.6446	2.5512	2.4829	2.4172

Figure 6.1: Average markups, 1950-2017



Note: Average markups among public firms, with weights equal to cost of goods sold for the blue line and sales for the red line. *Data source:* Compustat.

Figure 6.2: Concentration in Manufacturing, 1963-2012



Note: The blue (resp. red) line plots the average revenue share of the 4 (resp. 8) largest firms across 6-digit manufacturing sectors; the yellow line is the average revenue share of the 8 largest firms across 5-digit manufacturing sectors. All values are weighted by revenue.

Figure 6.3: Number of Mergers & Acquisitions in the U.S., 1850-2010

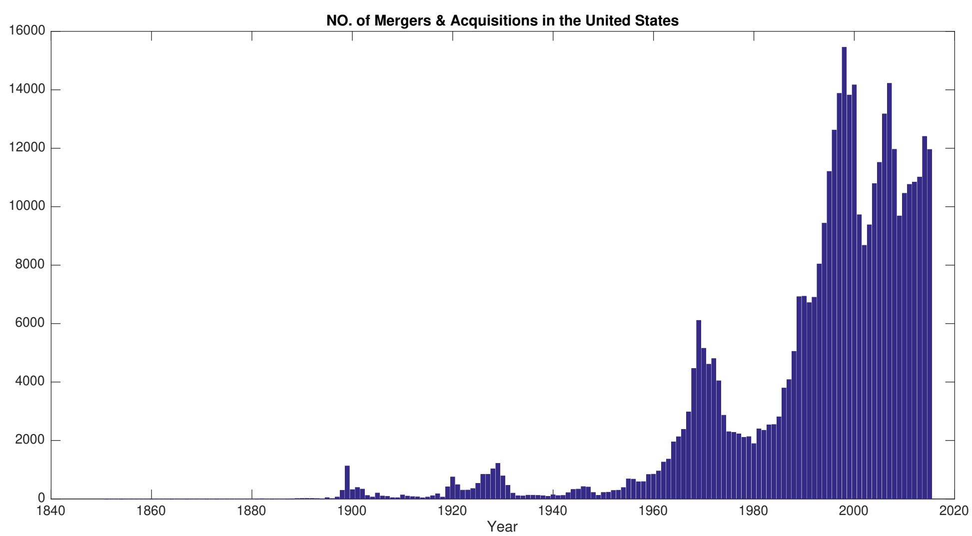
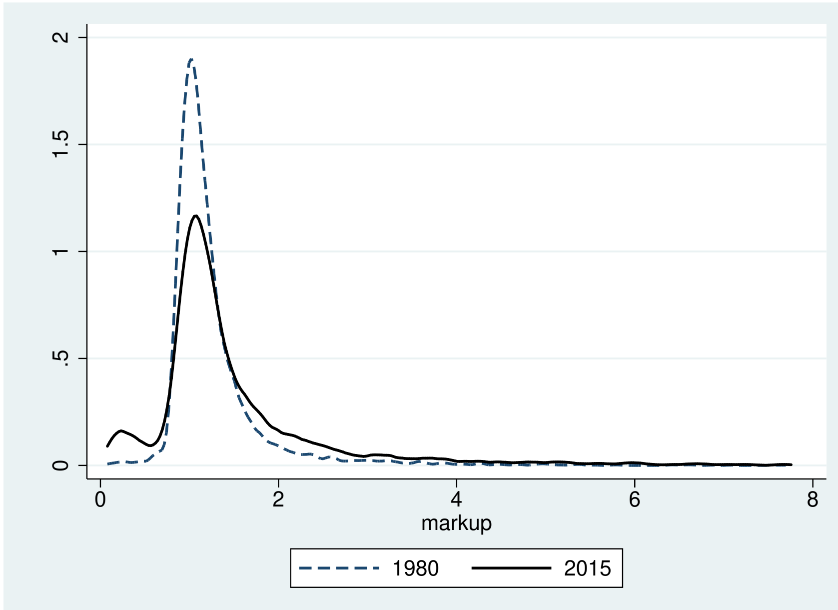


Figure 6.4: Distribution of markups among public firms in 1980 and 2015, 1-99 percentiles



Note: Distribution of markups conditional on markup values between 1 and 99 percentiles of the whole distribution.*Data source:* Compustat.

Anecdotal evidence from court reports Reports from Merger& Acquisition law cases suggest that international competition is an important consideration in antitrust policy implementation. One such case is the Boeing/McDonnell Douglas merger in the 1990s[18]. At that time, Boeing was the largest producer and accounts for about 64% of sales in the world commercial jet aircraft market. The other two producers were Airbus Industries, a European manufacturer which accounts for about 30%, and MaDonnell Douglas from the U.S., with about 5%. Boeing submitted petition to both U.S. and the European Commission. It was approved by the Americans and nearly prohibited by the European Union, which eventually clear the merger after imposing strong conditions.

Both the U.S. Federal Trade Commission (FTC) and the European Commission investigated the case, but they reached very different conclusion. The FTC has concluded that the acquisition of McDonnell Douglass by Boeing would not create a monopoly or substantially lessen competition in the commercial aircraft market. However, the European Commission concluded that the merger would increase Boeing's dominance. In its study, it was found that the McDonnell Douglass' presence led to a reduction of over 7% in the realized price. After the FTC investigation, the Clinton Administration argued to key European official that the merger is not anti-competitive and important to the employment in the United States, and even threatened to retaliate if Europe undermines the merger. The European Commission eventually backed away from a prohibition of the merger, but imposed significant conditions, such as Boeing not to enforce its exclusivity rights under the agreements with big American airline companies.

[18] This case is documented in Eleanor M. Fox (2012).

Entry cost and optimal ϕ We change the entry cost c_e, and see how it affects the optimal ϕ^*, while keeping $\tau = 1$. Table 6.5 presents the results.

Table 6.5: Entry cost and optimal ϕ

c_e	0.5	1	1.5	2	3	4	5	10
ϕ^*	40	60	40	40	40	60	40	40

As the above table shows, ϕ^* doesn't move much as c_e varies. And the direction isn't deterministic. To make sure it's not because of the coarse grid we use, we further narrow it down to be between $[40, 60]$, the issue remains, as shown in Table 6.6.

Table 6.6: Entry cost and optimal ϕ, finer grid

c_e	0.5	1	1.5	2	3	4	5	10
ϕ^*	40	54	43	40	43	54	46	40