

A NEW LOOK AT OLIGOPOLY: IMPLICIT COLLUSION  
THROUGH PORTFOLIO DIVERSIFICATION

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## Abstract

My dissertation is a theoretical and empirical study of the effects of portfolio diversification on oligopolistic industries. The first chapter serves as the introduction, and explains how the prominent role of institutional investors in US stock markets, who tend to own more diversified portfolios than individual households, has increased the relevance of portfolio diversification on market structure.

In the second chapter I develop a model of oligopoly with shareholder voting. Instead of assuming that firms maximize profits, the objective of the firms is decided by majority voting. This implies that portfolio diversification generates tacit collusion. In the limit, when all shareholders are completely diversified, the firms act as if they were owned by a single monopolist.

The third chapter introduces the model in a general equilibrium context. In a model of general equilibrium oligopoly with shareholder voting, higher levels of wealth inequality and/or foreign ownership lead to higher markups and less efficiency.

In the fourth chapter, I study the evolution of shareholder networks for all publicly traded firms in the United States between 2000 and 2011. The most important conclusion of the analysis is that the density of the network has more than doubled over the period, and this is robust to the threshold level chosen.

In the fifth chapter, I study the empirical relationship between common ownership and interlocking directorships. Firm pairs with higher levels of common ownership are more likely to share directors, and their distance in the network of directors is smaller on average. The evidence presented in this chapter suggests that institutional investors play an active role in corporate governance. In particular, it supports the hypothesis that institutional shareholders have influence on the board of directors.

In the sixth chapter, I study empirically the relationship between networks of common ownership and market power. Industries with higher levels of common ownership have higher markups on average.

The last chapter concludes with a discussion of policy implications and potential directions for further research. Based on the theory, I propose a new Herfindahl index adjusted for portfolio diversification.

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# Chapter 1

## Introduction

What is the effect of ownership structure on market structure? Models of oligopoly generally abstract from financial structure by assuming that each firm in an industry is owned by a separate agent, whose objective is to maximize the profits of the firm. In these models, any given firm is in direct competition with all the other firms in the industry. In practice, however, ownership of publicly traded companies is dispersed among many shareholders. The shareholders of a firm, in turn, usually hold diversified portfolios, which often contain shares in most of the large players in an industry. This diversification is, of course, what portfolio theory recommends that fund managers should do in order to reduce their exposure to risk. The increasing importance in equity markets of institutional investors, which tend to hold more diversified portfolios than individual households, suggests that diversification has increased through the second half of the twentieth century and the beginning of the twenty-first. Figure 1.1 shows that the fraction of U.S. corporate equities owned by institutional investors increased from less than 10 percent in the early 1950s to more than 60 percent in 2010.<sup>1</sup>

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<sup>1</sup>See also Gompers and Metrick (2001) and Gillan and Starks (2007).



In chapter 2, I develop a model of oligopoly with shareholder voting. The industrial organization literature usually assumes that the objective of the firm is to maximize profits. Thus, it abstracts from ownership structure, and in particular, from other financial interests that the shareholders may have. The finance literature, on the other hand, usually models firms as either simply a random return (Markowitz), or perfectly competitive (Arrow-Debreu), and therefore abstracts from the effect that portfolio decisions may have on market structure. In the theory that I develop, firms are non-atomistic and owned by shareholders with portfolios that may have stakes in several firms. The objective of the firm is derived endogenously through shareholder voting, and therefore the objective will not be independent profit maximization unless firms are separately owned. In this model, portfolio diversification generates tacit collusion.

In chapter 3, I develop a model of general equilibrium oligopoly with shareholder voting. In general equilibrium, firms will also take into account nonprofit objectives of their shareholders. Thus, they will endogenously engage in corporate social responsibility. The level of corporate social responsibility in equilibrium depends on the level of wealth inequality, with more inequality generating less corporate social responsibility and less efficiency.

In chapter 4, I study the evolution of the network of interlocking shareholdings for the United States between 2000 and 2011. A connection is defined as a pair of firms having a common institutional shareholder with more than a threshold percentage ownership in both firms. The density of this network has more than doubled between 2000 and 2011. The reason for this huge increase in density is an increase in the number of blockholdings held by the largest institutional investors throughout the period. While most blockholdings do not last more than a few years, the survival rate for blockholdings of 3% held by the top 5 institutions has increased substantially in recent years, and the “life expectancy” of these holdings

is high. Within-industry network densities are on average higher than the overall density, reflecting the fact that firms in the same industry are more likely to be connected.

In chapter 5, I study the relation between the network of interlocking shareholders and the network of interlocking directors for a large sample of US firms. Having common shareholders increases the likelihood of having common directors substantially, as does being in the same industry. Moreover, there is a positive interaction effect between having common shareholders and being in the same industry. This suggests that institutional investors are playing a more activist role in selecting directors in US companies than previously thought.

In chapter 6, I study the relationship between networks of common ownership and markups at the industry level. The main result is that the industry-level density of shareholder networks is positively associated with average industry markups. A dynamic analysis using Panel Vector Autoregressions shows that industry-level density of shareholder networks is a significant predictor of average markups, but average markups do not have predictive power for industry-level density.

In chapter 7, I discuss potential implication for policy, and directions for further research. Applying the model of oligopoly with shareholder voting to a Cournot setting, I derive an adjusted Herfindahl index that takes into account common ownership between firms in an industry. I also propose a possible measure of common ownership at the firm-pair level based on the theory.

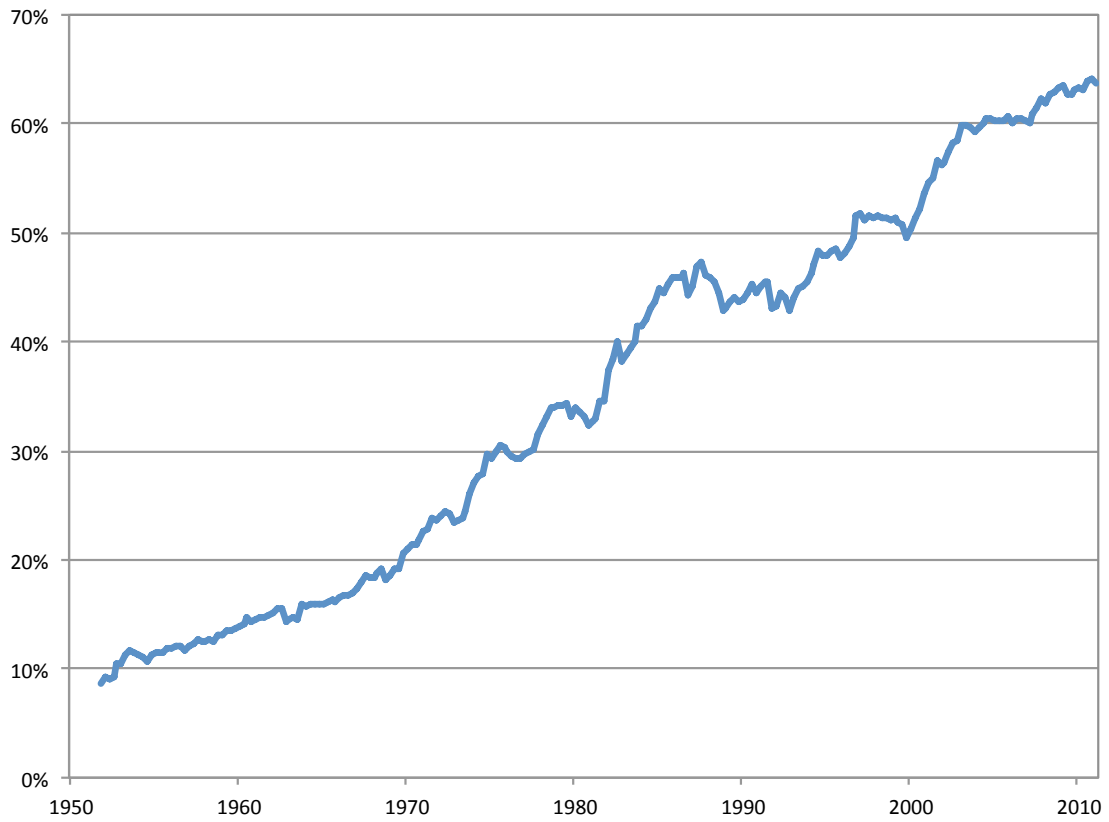


Figure 1.1  
Percentage Ownership of Institutional Investors in U.S. Stock Markets

Source: Federal Reserve Flow of Funds.

# Chapter 2

## Oligopoly with Shareholder Voting

### 2.1 Introduction

Classical models of oligopoly usually abstract from ownership structure by assuming that firms maximize profits. Thus, they assume that each firm is separately owned. At the same time, financial economics shows that it is in the individual interest of investors to hold diversified portfolios. Financial economics usually abstracts from the effect of portfolio diversification on market structure by modeling firms as a random return, as in the case of Markowitz (1952) and the subsequent literature. Even when firms are modeled as productive units, they are usually assumed to be price-takers, as in the case of Arrow-Debreu models of competitive equilibrium. Thus, portfolio diversification in the classical models of financial economics cannot influence market structure by assumption.

In this chapter, I study the implications of portfolio diversification for equilibrium outcomes in oligopolistic industries. The main contribution is the development of a model of oligopoly with shareholder voting. Instead of assuming that firms maximize profits, I model the objective of the firms as determined by the outcome of majority voting by their shareholders. When shareholders vote on the

policies of one company, they take into account the effects of those policies not just on that particular company's profits, but also on the profits of the other companies that they hold stakes in. That is, because the shareholders are the residual claimants in several firms, they internalize the pecuniary externalities that each of these firms generates on the others that they own, as was pointed out by Gordon (1990). This leads to a very different world from the one in which firms compete with each other by maximizing their profits independently, as in classical Cournot or Bertrand models of oligopoly. In the classical models, the actions of each firm generate pecuniary externalities for the other firms, but these are not internalized because each firm is assumed to have a different owner.

Gordon (1990) and Hansen and Lott (1996) argued that, when shareholders are completely diversified, and there is no uncertainty, they agree unanimously on the objective of joint profit maximization. However, in practice shareholders are not completely diversified, and their portfolios are different from each other. Moreover, company profits can be highly uncertain, and shareholders with different degrees of risk aversion will disagree about company policies even if they all hold the same portfolios. The model of oligopoly with shareholder voting developed in this paper, unlike the previous literature, allows for the characterization of the equilibrium in cases in which shareholders disagree about the policies of the firms.

Some new applications that are made possible by a model with shareholder disagreement include (a) the characterization of the equilibrium in the case of complete diversification with uncertainty and risk averse shareholders, (b) comparative statics for different levels of portfolio diversification, (c) the derivation of an adjusted Herfindahl index that incorporates information about common ownership among the firms in an industry, and (d) a model-based measure of common ownership for pairs of firms.

By modeling shareholders as directly voting on the actions of the firms, and having managers care only about expected vote share, I abstract in this paper from the conflict of interest between owners and managers. In practice, shareholders usually do not have a tight control over the companies that they own. Institutional owners usually hold large blocks of equity, and the empirical evidence suggests that they play an active role in corporate governance.<sup>1</sup> The results of the paper should thus be interpreted as showing what the outcome is when shareholders control the managers. From a theoretical point of view, whether agency problems would prevent firms from internalizing externalities that they generate on other portfolio firms depends on the assumptions one makes about managerial preferences. This would only be the case, to some extent, if the utility of managers is higher when they do not internalize the externalities than when they do.

The theory developed in this chapter shows that assessing the potential for market power in an industry by using concentration ratios or the Herfindahl index can be misleading if one does not, in addition, pay attention to the portfolios of the main shareholders of each firm in the industry. This applies to both horizontally and vertically related firms. In the model, diversification acts as a partial form of integration between firms. Antitrust policy usually focuses on mergers and acquisitions, which are all-or-nothing forms of integration. It may be beneficial to pay more attention to the partial integration that is achieved through portfolio diversification.

However, the theory has additional, broader implications for normative analysis. Economists generally consider portfolio diversification, alignment of interest between managers and owners, and competition to be three desirable objectives. In the model developed in this paper, it is not possible to fully attain all three.

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<sup>1</sup>See, for example, Agrawal and Mandelker (1990), Bethel et al. (1998), Kaplan and Minton (1994), Kang and Shivdasani (1995), Bertrand and Mullainathan (2001), and Hartzell and Starks (2003).

Competition and diversification could be attained if shareholders failed to appropriately incentivize the managers of the companies that they own. Competition and maximization of shareholder value are possible if shareholders are not well diversified. And diversification and maximization of shareholder value are fully attainable, but the result is collusive. This trilemma highlights that it is not possible to separate financial policy from competition policy.

## 2.2 Literature Review

In addition to Gordon (1990) and Hansen and Lott (1996), the theory developed in this chapter is related to the work of Reynolds and Snapp (1986), who develop a model of quantity competition in which firms hold partial interests in each other.

This chapter also relates to the literature on aggregation of shareholder preferences, going back at least to the impossibility result of Arrow (1950). Although his 1950 paper does not apply the results to aggregation of differing shareholder preferences, this problem was in the background of the research on the impossibility theorem, as Arrow mentions later (Arrow, 1983, p. 2):

“When in 1946 I began a grandiose and abortive dissertation aimed at improving on John Hicks’s *Value and Capital*, one of the obvious needs for generalization was the theory of the firm. What if it had many owners, instead of the single owner postulated by Hicks? To be sure, it could be assumed that all were seeking to maximize profits; but suppose they had different expectations of the future? They would then have differing preferences over investment projects. I first supposed that they would decide, as the legal framework would imply, by majority voting. In economic analysis we usually have many (in fact, infinitely many) alternative possible plans, so that transitivity quickly became a signif-

icant question. It was immediately clear that majority voting did not necessarily lead to an ordering.”

Milne (1981) explicitly applies Arrow’s result to the shareholders’ preference aggregation problem. Under complete markets and price-taking firms, the Fisher separation theorem applies, and thus all shareholders unanimously agree on the profit maximization objective (see Milne 1974, Milne 1981). With incomplete markets, however, the preference aggregation problem is non-trivial. The literature on incomplete markets has thus studied the outcome of equilibria with shareholder voting. For example, see the work of Diamond (1967), Milne (1981), Dreze (1985), Duffie and Shafer (1986), DeMarzo (1993), Kelsey and Milne (1996), and Dierker et al. (2002). This literature keeps the price-taking assumption, so there is no potential for firms exercising market power.

From a modeling point of view, I rely extensively on insights and results from probabilistic voting theory. For a survey of this literature, see the first chapter of Coughlin (1992). I have also benefited from the exposition of this theory in Acemoglu (2009). These models have been widely used in political economy, but not, to my knowledge, in models of shareholder elections. I also use insights from the work on multiple simultaneous elections by Alesina and Rosenthal (1995), Alesina and Rosenthal (1996), Chari et al. (1997). Ahn and Oliveros (2010) have studied further under what conditions conditional sincerity is obtained as an outcome of strategic voting.

This chapter contributes to the literature on the intersection of corporate finance and industrial organization. The interaction between these two fields has received surprisingly little attention (see Cestone (1999) for a recent survey). The corporate finance literature, since the classic book by Berle and Means (1940), has focused mainly on the conflict of interest between shareholders and managers, rather than on the effects of ownership structure on product markets, while industrial orga-



nization research usually abstracts from issues of ownership to focus on strategic interactions in product markets. It is worth mentioning the seminal contribution of Brander and Lewis (1986), who show that the use of leverage can affect the equilibrium in product markets by inducing oligopolistic firms to behave more aggressively. Fershtman and Judd (1987) study the principal-agent problem faced by owners of firms in Cournot and Bertrand oligopoly games. Poitevin (1989) extends the model of Brander and Lewis (1986) to the case where two firms borrow from the same bank. The bank has an incentive to make firms behave less aggressively in product markets, and can achieve a partially collusive outcome. In a footnote, Brander and Lewis (1986) mention that, although they do not study them in their paper, it would be interesting to consider the possibility that the rival firms are linked through interlocking directorships or through ownership by a common group of shareholders.

Finally, this paper touches on themes that are present in the literature on the history of financial regulation and the origins of antitrust. DeLong (1991) studies the relationship between the financial sector and industry in the U.S. during the late nineteenth and early twentieth century. He documents that representatives of J.P. Morgan and other financial firms sat on the boards of several firms within an industry. He argues that this practice, while helping to align the interests of ownership and control, also led to collusive behavior. Roe (1996) and Becht and DeLong (2005) study the political origins of the US system of corporate governance. In particular, they focus on the weakness of financial institutions with respect to management in the US relative to other countries, especially Germany and Japan. They argue that this weakness can be understood, at least in part, as the outcome of a political process. In the US, populist forces and the antitrust movement achieved their objective of weakening the large financial institutions that in other countries exert a tighter control over managers.

## 2.3 The Basic Model: Oligopoly with Shareholder Voting

An oligopolistic industry consists of  $N$  firms. Firm  $n$ 's profits per share are random and depend both on its own policies  $p_n$  and on the policies of the other firms,  $p_{-n}$ , as well as the state of nature  $\omega \in \Omega$ :

$$\pi_n = \pi_n(p_n, p_{-n}; \omega).$$

Suppose that  $p_n \in S_n \subseteq \mathbb{R}^K$ , so that policies can be multidimensional. The policies of the firm can be prices, quantities, investment decisions, innovation, or in general any decision variable that the firm needs to choose. In principle, the policies could be contingent on the state of nature, but this is not necessary.

There is a continuum  $G$  of shareholders of measure one. Shareholder  $g$  holds  $\theta_n^g$  shares in firm  $n$ . The total number of shares of each firm is normalized to 1. Each firm holds its own elections to choose the board of directors, which controls the firms' policies. In the elections of company  $n$  there is Downsian competition between two parties,  $A_n$  and  $B_n$ . Let  $\xi_{J_n}^g$  denote the probability that shareholder  $g$  votes for party  $J_n$  in company  $n$ 's elections, where  $J_n \in A_n, B_n$ . The expected vote share of party  $J_n$  in firm  $n$ 's elections is

$$\bar{\xi}_{J_n} = \int_{g \in G} \theta_n^g \xi_{J_n}^g dg.$$

Shareholders get utility from income—which is the sum of profits from all their shares—and from a random component that depends on what party is in power in each of the firms. The utility of shareholder  $g$  when the policy of firm  $n$  is  $p_n$ , the

policies of the other firms are  $p_{-n}$ , and the vector of elected parties is  $\{J_n\}_{n=1}^N$  is

$$\tilde{U}^g \left( p_n, p_{-n}, \{J_s\}_{s=1}^N \right) = U^g(p_n, p_{-n}) + \sum_{s=1}^N \tilde{\sigma}_s^g(J_s),$$

where  $U^g(p_n, p_{-n}) = \mathbb{E} \left[ u^g \left( \sum_{s=1}^N \theta_s^g \pi_s(p_s, p_{-s}; \omega) \right) \right]$ . The utility function  $u^g$  of each group is increasing in income, with non-increasing marginal utility. The  $\tilde{\sigma}_n^g(J_n)$  terms represent the random utility that shareholder  $g$  obtains if party  $J_n$  controls the board of company  $n$ . The random utility terms are independent across firms and shareholders, and independent of the state of nature  $\omega$ . As a normalization, let  $\tilde{\sigma}_n^g(A_n) = 0$ . I assume that, given  $p_{-n}$ , there is an interior  $p_n$  that maximizes  $U^g(p_n, p_{-n})$ .

Let  $p_{A_n}$  denote the platform of party  $A_n$  and  $p_{B_n}$  that of party  $B_n$ .

**Assumption 1.** (Conditional Sincerity) *Voters are conditionally sincere. That is, in each firm's election they vote for the party whose policies maximize their utilities, given the equilibrium policies in all the other firms. In case of indifference between the two parties, a voter randomizes.*

Conditional sincerity is a natural assumption as a starting point in models of multiple elections. Alesina and Rosenthal (1996) obtain it as a result of coalition proof Nash equilibrium in a model of simultaneous presidential and congressional split-ticket elections. A complete characterization of the conditions under which conditional sincerity arises as the outcome of strategic voting is an open problem (for a recent contribution and discussion of the issues, see Ahn and Oliveros 2010). In this paper, I will treat conditional sincerity as a plausible behavioral assumption, which, while natural as a starting point, does not necessarily hold in general.

Using Assumption 1, the probability that shareholder  $g$  votes for party  $A_n$  is

$$\zeta_{A_n}^g = P \left[ \tilde{\sigma}_n^g(B_n) < U^g(p_{A_n}, p_{-n}) - U^g(p_{B_n}, p_{-n}) \right].$$

Let us assume that the marginal distribution of  $\tilde{\sigma}_{n,i}^g(B_n)$  is uniform with support  $[-m_n^g, m_n^g]$ . Denote its cumulative distribution function  $H_n^g$ . The vote share of party  $A_n$  is

$$\xi_{A_n} = \int_{g \in G} \theta_n^g H_n^g [U^g(p_{A_n}, p_{-n}) - U^g(p_{B_n}, p_{-n})] dg. \quad (2.1)$$

Both parties choose their platforms to maximize their expected vote shares.

**Assumption 2.** (Differentiability and Concavity of Vote Shares) *For all firms  $n = 1, \dots, N$ , the vote share of party  $A_n$  is differentiable and strictly concave as a function of  $p_n$  given the policies of the other firms  $p_{-n}$  and the platform of party  $B_n$ . The vote share is continuous as a function of  $p_{-n}$ . Analogous conditions hold for the vote share of party  $B_n$ .*

Elections for all companies are held simultaneously, and the two parties in each company announce their platforms simultaneously as well. A pure-strategy Nash equilibrium for the industry is a set of platforms  $\{p_{A_n}, p_{B_n}\}_{n=1}^N$  such that, given the platform of the other party in the firm, and the winning policies in all the other firms, a party chooses its platform to maximize its vote share. The first-order condition for party  $A_n$  is

$$\int_{g \in G} \frac{1}{2m_n^g} \theta_n^g \frac{\partial U^g(p_{A_n}, p_{-n})}{\partial p_{A_n}} dg = 0, \quad (2.2)$$

where

$$\frac{\partial U^g(p_n, p_{-n})}{\partial p_{A_n}} = \left( \frac{\partial U^g(p_{A_n}, p_{-n})}{\partial p_{A_n}^1}, \dots, \frac{\partial U^g(p_{A_n}, p_{-n})}{\partial p_{A_n}^K} \right).$$

In the latter expression,  $p_{A_n}^k$  is the  $k$ th component of the policy vector  $p_{A_n}$ . The derivatives in terms of the profit functions are

$$\frac{\partial U^g(p_n, p_{-n})}{\partial p_{A_n}} = \mathbb{E} \left[ (u^g)' \left( \sum_{s=1}^N \theta_s^g \pi_s(p_s, p_{-s}; \omega) \right) \sum_{s=1}^N \theta_s^g \frac{\partial \pi_s(p_s, p_{-s})}{\partial p_n} \right].$$

The maximization problem for party  $B_n$  is symmetric. Because the individual utility functions have an interior maximum, the problem of maximizing vote shares given the policies of the other firms will also have an interior solution.

To ensure that an equilibrium in the industry exists, we need an additional technical assumption.

**Assumption 3.** *The strategy spaces  $S_n$  are nonempty compact convex subsets of  $\mathbb{R}^K$ .*

**Theorem 1.** *Suppose that Assumptions 1, 2, and 3 hold. Then, a pure-strategy equilibrium of the voting game exists. The equilibrium is symmetric in the sense that  $p_{A_n} = p_{B_n} = p_n^*$  for all  $n$ . The equilibrium policies solve the system of  $N \times K$  equations in  $N \times K$  unknowns*

$$\int_{g \in G} \frac{1}{2m_n^g} \theta_n^g \frac{\partial U^g(p_n^*, p_{-n}^*)}{\partial p_n} dg = 0 \text{ for } n = 1, \dots, N. \quad (2.3)$$

*Proof.* Consider the election at firm  $n$ , given that the policies of the other firms are equal to  $p_{-n}$ . Given the conditional sincerity assumption, the vote share of party  $A_n$  is as in equation (2.1), and a similar expression holds for the vote share of party  $B_n$ . As we have already noted, each party's maximization problem has an interior solution conditional on  $p_{-n}$ . The first-order conditions for each party are the same, and thus the best responses for both parties are the same. We can think of the equilibrium at firm  $n$ 's election given the policies of the other firms as establishing a reaction function for the firm,  $p_n(p_{-n})$ . These reaction functions are nonempty, upper-hemicontinuous, and convex-valued. Thus, we can apply Kakutani's fixed point theorem to show that an equilibrium exists, in a way that is analogous to that of existence of Nash equilibrium in games with continuous payoffs.  $\square$

The system of equations in (2.3) corresponds to the solution to the maximization of the following utility functions

$$\int_{g \in G} \chi_n^g \theta_n^g U^g(p_n, p_{-n}) dg \text{ for } n = 1, \dots, N, \quad (2.4)$$

where the  $n$ th function is maximized with respect to  $p_n$ , and where  $\chi_n^g \equiv \frac{1}{2m_n^g}$ . Thus, the equilibrium for each firm's election is characterized by the maximization of a weighted average of the utilities of its shareholders. The weight that each shareholder gets at each firm depends both on the number of shares held in that firm, and on the dispersion of the random utility component for that firm. Note that the weights in the average of shareholder utilities are different at different firms.

The maximization takes into account the effect of the policies of firm  $n$  on the profits that shareholders get from every firm, not just firm  $n$ . Thus, when the owners of a firm are also the residual claimants for other firms, they internalize some of the pecuniary externalities that the actions of the first firm generate for the other firms that they hold.

## 2.4 The Case of Complete Diversification

We will find it useful to define the following concepts:

**Definition 1.** (*Market Portfolio*) A market portfolio is any portfolio that is proportional to the total number of shares of each firm. Since we have normalized the number of shares of each firm to one, a market portfolio has the same number of shares in every firm.

**Definition 2.** (*Complete Diversification*) We say that a shareholder who holds a market portfolio is completely diversified.

**Definition 3.** (*Uniformly Activist Shareholders*) We say that a shareholder is uniformly activist if the density of the distribution of  $\tilde{\sigma}_n^g(B_n)$  is the same for every firm  $n$ .

Shareholders having a high density of  $\tilde{\sigma}_n^g(B_n)$  have a higher weight in the equilibrium policies of firm  $n$  for a given number of shares. Thus, we can think of

shareholders having high density as being more “activist” when it comes to influencing the decisions of that firm. If all shareholders are uniformly activist, then some shareholders can be more activist than others, but the level of activism for each shareholder is constant across firms.

**Theorem 2.** *Suppose all shareholders are completely diversified, and shareholders are uniformly activist. Then the equilibrium of the voting game yields the same outcome as the one that a monopolist who owned all the firms and maximized a weighted average of the utilities of the shareholders would choose.*

*Proof.* Because of complete diversification, a shareholder  $g$  holds the same number of shares  $\theta^g$  in each firm. The equilibrium now corresponds to the solution of

$$\max_{p_n} \int_{g \in G} \chi_n^g \theta^g U^g(p_n, p_{-n}) dg \text{ for } n = 1, \dots, N.$$

With the assumption that shareholders are uniformly activist,  $\chi_n^g$  is the same for every firm, and thus the objective function is the same for all  $n$ . The problem can thus be rewritten as

$$\max_{\{p_n\}_{n=1}^N} \int_{g \in G} \chi^g \theta^g U^g(p_n, p_{-n}) dg.$$

This is the problem that a monopolist would solve, if her utility function was a weighted average of the utilities of the shareholders. The weight of shareholder  $g$  is equal to  $\chi^g \theta^g$ . □

Note that, although all the shareholders hold proportional portfolios, there is still a conflict of interest between them. This is due to the fact that there is uncertainty and shareholders, unless they are risk neutral, care about the distribution of joint profits, not just the expected value. For example, they may have different degrees of risk aversion, both because some may be wealthier than others (i.e. hold a bigger share of the market portfolio), or because their utility functions differ. Thus,

although all shareholders are fully internalizing the pecuniary externalities that the actions of each firm generates on the profits of the other firms, some may want the firms to take on more risks, and some may want less risky actions. Thus, there is still a non-trivial preference aggregation problem. In what follows, I will show that when shareholders are risk neutral, or when there is no uncertainty, then there is no conflict of interest between shareholders: they all want the firms to implement the same policies.

We will now show that, when all shareholders are completely diversified and risk neutral, the solution can be characterized as that of a profit-maximizing monopolist. In this case, we do not need the condition that  $\chi_n^g$  is independent of  $n$ . In fact, in this case, there is no conflict of interest between shareholders, since they uniformly agree on the objective of expected profit maximization. Thus, this result is likely to hold in much more general environments than the probabilistic voting model of this paper.

**Theorem 3.** *Suppose all shareholders are completely diversified, and their preferences are risk neutral. Then the equilibrium of the voting game yields the same outcome as the one that a monopolist who owned all the firms and maximized their joint expected profits would choose.*

*Proof.* Let the utility function of shareholder  $g$  be  $u^g(y) = a^g + b^g y$ . Then the equilibrium is characterized by the solution of

$$\max_{p_n} \int_{g \in G} \chi_n^g \theta^g \left\{ a^g + b^g \mathbb{E} \left[ \sum_{s=1}^N \theta^s \pi_s(p_s, p_{-s}; \omega) \right] \right\} dg \text{ for } n = 1, \dots, N,$$

which can be rewritten as

$$\max_{p_n} k_{0,n} + k_{1,n} \mathbb{E} \left[ \sum_{s=1}^N \pi_s(p_s, p_{-s}; \omega) \right] \text{ for } n = 1, \dots, N,$$



with  $k_{0,n} = \int_{g \in G} \chi_n^g \theta^g a^g dg$  and  $k_{1,n} = \int_{g \in G} \chi_n^g (\theta^g)^2 b^g dg$ . Since  $k_{1,n}$  is positive, this is the same as maximizing

$$\mathbb{E} \left[ \sum_{s=1}^N \pi_s(p_s, p_{-s}; \omega) \right],$$

which is the expected sum of profits of all the firms in the industry. Since the objective function is the same for every firm, we can rewrite this as

$$\max_{\{p_n\}_{n=1}^N} \mathbb{E} \left[ \sum_{s=1}^N \pi_s(p_s, p_{-s}; \omega) \right].$$

□

The intuition behind this result is simple. When shareholders are completely diversified, their portfolios are identical, up to a constant of proportionality. Without risk neutrality, shareholders care not just about expected profits, but about the whole distribution of joint profits. With risk neutrality, however, shareholders only care about joint expected profits, and thus the conflict of interest between shareholders disappears. The result is that they unanimously want maximization of the joint expected profits, and the aggregation problem becomes trivial.

Finally, let us consider the case of no uncertainty. In this case, when shareholders are completely diversified there is also no conflict of interest between them, and they unanimously want the maximization of joint profits. This is similar to the case of risk neutrality. As in that case, because preferences are unanimous the result is likely to hold under much more general conditions.

**Theorem 4.** *Suppose all shareholders are completely diversified, and there is no uncertainty. Then the equilibrium of the voting game yields the same outcome as the one that a monopolist who owned all the firms and maximized their joint profits would choose.*

*Proof.* To see why this is the case, note that the outcome of the voting equilibrium is characterized by the solution to

$$\max_{p_n} \int_{g \in G} \chi_n^g \theta^g u^g \left( \theta^g \sum_{s=1}^N \pi_s(p_s, p_{-s}) \right) dg \text{ for } n = 1, \dots, N.$$

We can rewrite this as

$$\max_{p_n} f_n \left( \sum_{s=1}^N \pi_s(p_s, p_{-s}) \right) \text{ for } n = 1, \dots, N,$$

where

$$f_n(z) = \int_{g \in G} \chi_n^g \theta^g u^g (\theta^g z) dg.$$

Since  $f_n(z)$  is monotonically increasing, the solution to is equivalent to

$$\max_{p_n} \sum_{s=1}^N \pi_s(p_s, p_{-s}) \text{ for } n = 1, \dots, N.$$

Because the objective function is the same for all firms, we can rewrite this as

$$\max_{\{p_n\}_{n=1}^N} \sum_{s=1}^N \pi_s(p_s, p_{-s}).$$

□

The intuition is similar to that of Theorem 3: when all shareholders are completely diversified and there is no uncertainty, then there is no conflict of interest among them, and the aggregation problem becomes trivial. Thus, in the special case of complete diversification and either risk-neutral shareholders or certainty, shareholders are unanimous in their support for joint profit maximization as the objective of the firm, as argued by Hansen and Lott (1996).

## 2.5 An Example: Quantity and Price Competition

In this section, I illustrate the previous results by applying the general model to the classical oligopoly models of Cournot and Bertrand with linear demands and constant marginal costs. I consider both the homogeneous goods and the differentiated goods variants of these models. For the case of differentiated goods, I use the model of demand developed by Dixit (1979) and Singh and Vives (1984), and extended to the case of an arbitrary number of firms by Häckner (2000).

There is no uncertainty in these models, and I will assume that agents are risk neutral. I will also assume that the  $\tilde{\sigma}_{s,i}^g(J_s)$  are uniformly distributed between  $-\frac{1}{2}$  and  $\frac{1}{2}$  for all firms and all shareholders. Thus, the cumulative distribution function  $H_n^g(x)$  is given by

$$H_n^g(x) = \begin{cases} 0 & \text{if } x \leq -\frac{1}{2} \\ x + \frac{1}{2} & \text{if } -\frac{1}{2} < x \leq \frac{1}{2} \\ 1 & \text{if } x \geq \frac{1}{2} \end{cases}.$$

### 2.5.1 Homogeneous Goods

#### Homogeneous Goods Cournot

The inverse demand for a homogeneous good is  $P = \alpha - \beta Q$ . In the Cournot model, firms set quantities given the quantities of other firms. The marginal cost is constant and equal to  $m$ . Each firm's profit function, given the quantities of other firms is

$$\pi_n(q_n, q_{-n}) = [\alpha - \beta(q_n + q_{-n}) - m] q_n.$$

The vote share of party  $A_n$  when the policies of both parties are close to each other is

$$\xi_{A_n} = \int_{g \in G} \theta_n^g \left\{ \frac{1}{2} + [U^g(q_{A_n}, q_{-n}) - U^g(q_{B_n}, q_{-n})] \right\} dg, \quad (2.5)$$

where  $U^g(q_n, q_{-n}) = \sum_{s=1}^N \theta_s^g [\alpha - \beta(q_s + q_{-s}) - m] q_s$ . The vote share is strictly concave as a function of  $q_{A_n}$ , and thus the maximization problem for party  $A_n$  has an interior solution. The maximization problem for party  $B_n$  is symmetric. Thus, we can apply Theorem 1 to obtain the following result:

**Proposition 1.** *In the homogeneous goods Cournot model with shareholder voting as described above, a symmetric equilibrium exists. The equilibrium quantities in the industry solve the following linear system of  $N$  equations and  $N$  unknowns:*

$$\int_{g \in G} \theta_n^g \left[ \theta_n^g (\alpha - 2\beta q_n - \beta q_{-n} - m) + \sum_{s \neq n} \theta_s^g (-\beta q_s) \right] dg = 0 \text{ for } n = 1, \dots, N. \quad (2.6)$$

To visualize the behavior of the equilibria for different levels of diversification, I will parameterize the latter as follows. Shareholders are divided in  $N$  groups, each with mass  $1/N$ . The portfolios can be organized in a square matrix, where the element of row  $j$  and column  $n$  is  $\theta_n^j$ . Thus, row  $j$  of the matrix represents the portfolio holdings of a shareholder in group  $j$ . When this matrix is diagonal with each element of the diagonal equal to  $N$ , shareholders in group  $n$  owns all the shares of firm  $n$ , and has no stakes in any other firm. Call this matrix of portfolios  $\Theta_0$ :

$$\Theta_0 = \begin{bmatrix} N & 0 & \dots & 0 \\ 0 & N & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & N \end{bmatrix}.$$

In the other extreme, when each fund holds the market portfolio, each element of the matrix is equal to 1. Call this matrix  $\Theta_1$ :

$$\Theta_1 = \begin{bmatrix} 1 & 1 & \cdots & 1 \\ 1 & 1 & \cdots & 1 \\ \vdots & \vdots & \ddots & \vdots \\ 1 & 1 & \cdots & 1 \end{bmatrix}.$$

I will parameterize intermediate cases of diversification by considering convex combinations of these two:

$$\Theta_\phi = (1 - \phi)\Theta_0 + \phi\Theta_1,$$

where  $\phi \in [0, 1]$ . Thus, when  $\phi = 0$ , we are in the classical oligopoly model in which each firm is owned independently. When  $\phi = 1$  the firms are held by perfectly diversified shareholders, each holding the market portfolio.

Figure 2.1 shows the equilibrium prices and total quantities of the Cournot model with homogeneous goods for different levels of diversification and different numbers of firms. The parameters are  $\alpha = \beta = 1$  and  $m = 0$ . It can be seen that, as portfolios become closer to the market portfolio, the equilibrium prices and quantities tend to the monopoly outcome. This does not depend on the number of firms in the industry.

### **Homogeneous Goods Bertrand**

The case of price competition with homogeneous goods is interesting because the profit functions are discontinuous, and the parties' maximization problems do not have interior solutions. Thus, we cannot use the equations of Theorem 1 to solve for the equilibrium. However, by studying the vote shares of the parties, we can

show that symmetric equilibria exist, and lead to a result similar to the Bertrand paradox. When portfolios are completely diversified, any price between marginal cost and the monopoly price can be sustained in equilibrium. However, any deviation from the market portfolio by a group of investors, no matter how small, leads to undercutting, and thus the only possible equilibrium is price equal to marginal cost.

The demand for the homogeneous good is  $Q = a - bP$ , where  $a = \frac{\alpha}{\beta}$  and  $b = \frac{1}{\beta}$ . The firm with the lowest price attracts all the market demand. At equal prices, the market splits in equal parts. When a firm's price  $p_n$  is the lowest in the market, it gets profits equal to  $(p_n - m)(a - bp_n)$ . If a firm's price is tied with  $M - 1$  other firms, its profits are  $\frac{1}{M}(p_n - m)(a - bp_n)$ .

It will be useful to define the profits that a firm setting a price  $p$  would make if it attracted all the market demand at that price:

$$\tilde{\pi}(p) \equiv (p - m)(a - bp).$$

The vote share of party  $A_n$  when the policies of both parties are close to each other is

$$\zeta_{A_n} = \int_{g \in G} \theta_n^g \left\{ \frac{1}{2} + [U^g(p_{A_n}, p_{-n}) - U^g(p_{B_n}, p_{-n})] \right\} dg, \quad (2.7)$$

where  $U^g(p_n, p_{-n}) = \sum_{s=1}^N \theta_s^g \pi(p_s, p_{-s})$ . Note that the profit function is discontinuous, and thus, as already mentioned, we cannot use Theorem 1 to ensure the existence and characterize the equilibrium. However, equilibria do exist, and we can show the following result:

**Proposition 2.** *In the homogeneous goods Bertrand model with shareholder voting described above, symmetric equilibria exist. When all shareholders hold the market portfolio (except for a set of shareholders of measure zero), any price between the marginal cost and the monopoly price can be sustained as an equilibrium. If a set of shareholders with positive*

measure is incompletely diversified, the only equilibrium is when all firms set prices equal to the marginal cost.

*Proof.* First, it will be useful to define the following. The average of the holdings for shareholder  $g$  is

$$\bar{\theta}^g \equiv \frac{1}{N} \sum_{n=1}^N \theta_n^g.$$

The average of the squares of the holdings for shareholder  $g$  is

$$\overline{(\theta^g)^2} \equiv \frac{1}{N} \sum_{n=1}^N (\theta_n^g)^2.$$

Let us begin with the case of all shareholders holding the market portfolio. In this case,  $\theta_n^g = \bar{\theta}^g$  for all  $n$ . Consider the situation of party  $A_n$ . Suppose all other firms, and party  $B_n$  have set a price  $p^* \in [m, p^M]$ , where  $p^M$  is the monopoly price. Maximizing the vote share of party  $A_n$  is equivalent to maximizing

$$\int_{g \in G} \bar{\theta}^g \left( \sum_{s=1}^N \bar{\theta}^g \pi(p_s, p_{-s}) \right) dg = \left( \sum_{s=1}^N \pi(p_s, p_{-s}) \right) \int_{g \in G} \bar{\theta}^{g^2} dg,$$

which is a constant times the sum of profits for all firms. Thus, to maximize its vote share, party  $A_n$  will choose the price that maximizes the joint profits of all firms, given that the other firms have set prices equal to  $p^*$ . Setting a price equal to  $p^*$  maximizes joint profits, as does any price above it. Any price below  $p^*$  would reduce joint profits, and thus there is no incentive to undercut. Therefore, all parties in all firms choosing  $p^*$  as a platform is a symmetric equilibrium, for any  $p^* \in [m, p^M]$ .

Now, let's consider the case of incomplete diversification. It is easy to show that all firms setting price equal to  $m$  is an equilibrium, since there is no incentive to undercut. I will now show that firms setting prices above  $m$  can't be an equilibrium. Suppose that there is an equilibrium with all firms setting the same price

$p^* \in (m, p^M]$ . Maximizing vote share for any of the parties at firm  $n$  is equivalent to maximizing

$$\int_{g \in G} \theta_n^g \left( \sum_{s=1}^N \theta_s^g \pi(p_s, p_{-s}) \right) dg.$$

If firm  $n$  charges  $p^*$ , the profits of each firm are  $\frac{1}{N} \pi(p^*)$ . If firm  $n$  undercuts, that is, if it charges a price equal to  $p^* - \epsilon$ , then the profits of all the other firms are driven to zero, and its own profits are  $\pi(p^* - \epsilon)$ , which can be made arbitrarily close to  $\pi(p^*)$ .

Thus, firm  $n$  will not undercut if and only if

$$\int_{g \in G} \theta_n^g \left( \sum_{s=1}^N \theta_s^g \frac{\pi(p^*)}{N} \right) dg \geq \int_{g \in G} (\theta_n^g)^2 \pi(p^*) dg.$$

We can simplify this inequality to obtain the following condition:

$$\int_{g \in G} \theta_n^g (\bar{\theta}^g - \theta_n^g) dg \geq 0.$$

We can show by contradiction that at least one firm will undercut. Suppose not. Then the above inequality holds for all  $n$ . Adding across firms yields

$$\sum_{n=1}^N \int_{g \in G} \theta_n^g (\bar{\theta}^g - \theta_n^g) dg \geq 0.$$

Exchanging the order of summation and integration, we obtain

$$\int_{g \in G} \sum_{n=1}^N \theta_n^g (\bar{\theta}^g - \theta_n^g) dg \geq 0.$$



But each term  $\sum_{n=1}^N \theta_n^g (\bar{\theta}^g - \theta_n^g)$  is negative, since

$$\begin{aligned}
\sum_{n=1}^N \theta_n^g (\bar{\theta}^g - \theta_n^g) &= \sum_{n=1}^N \theta_n^g (\bar{\theta}^g - \theta_n^g) \\
&= \left( N(\bar{\theta}^g)^2 - N\overline{(\theta^g)^2} \right) \\
&= -N \left( \overline{(\theta^g)^2} - (\bar{\theta}^g)^2 \right) \\
&= -N \frac{1}{N} \sum_{n=1}^N (\theta_n^g - \bar{\theta}^g)^2 \\
&\leq 0.
\end{aligned}$$

Equality holds if and only if  $\frac{1}{N} \sum_{n=1}^N (\theta_n^g - \bar{\theta}^g)^2 = 0$ , which only happens when shareholders are completely diversified, except for a set of measure zero. To avoid a contradiction, all the terms would have to be zero. This only happens when all shareholders are completely diversified except for a set of measure zero, which contradicts the hypothesis. Thus, when diversification is incomplete, at least one firm will undercut. The only possible equilibrium in the case of incomplete diversification is with all firms setting price equal to marginal cost.  $\square$

## 2.5.2 Differentiated Goods

In this section, I apply the voting model to the case of price and quantity competition with differentiated goods. I use the demand model of Häckner (2000), and in particular the symmetric specification described in detail in Ledvina and Sircar (2010). The utility function in this model is

$$U(q) = \alpha \sum_{n=1}^N q_n - \frac{1}{2} \left( \beta \sum_{n=1}^N q_n^2 + 2\gamma \sum_{s \neq n} q_n q_s \right).$$

The representative consumer maximizes  $U(q) - \sum p_n q_n$ . The first-order conditions with respect to  $q_n$  is

$$\frac{\partial U}{\partial q_n} = \alpha - \beta q_n - \gamma \sum_{s \neq n} q_s - p_n = 0.$$

### Differentiated Goods Cournot

The inverse demand curve for firm  $n$  is

$$p_n(q_n, q_{-n}) = \alpha - \beta q_n - \gamma \sum_{s \neq n} q_s.$$

The profit function for firm  $n$  is

$$\pi_n(q_n, q_{-n}) = \left( \alpha - \beta q_n - \gamma \sum_{s \neq n} q_s - m \right) q_n.$$

The vote share of party  $A_n$  is as in equation (2.7), with the utility of shareholder  $g$  being

$$U^g(q_n, q_{-n}) = \sum_{s=1}^N \theta_s^g \left( \alpha - \beta q_s - \gamma \sum_{j \neq s} q_j - m \right) q_s.$$

As in the homogeneous goods case, the vote share is strictly concave as a function of  $q_{A_n}$ , and thus the maximization problem for party  $A_n$  has an interior solution. The maximization problem for party  $B_n$  is symmetric. Thus, we can apply Theorem 1 to obtain the following result:

**Proposition 3.** *In the differentiated goods Cournot model with shareholder voting as described above, a symmetric equilibrium exists. The equilibrium quantities in the industry solve the following linear system of  $N$  equations and  $N$  unknowns:*

$$\int_{g \in G} \theta_n^g \left[ \theta_n^g (\alpha - 2\beta q_n - \gamma \sum_{s \neq n} q_s - m) + \sum_{s \neq n} \theta_s^g (-\gamma q_s) \right] dg = 0 \text{ for } n = 1, \dots, N. \quad (2.8)$$

## Differentiated Goods Bertrand

As in Ledvina and Sircar (2010), the demand system can be inverted to obtain the demands

$$q_n(p_n, p_{-n}) = a_N - b_N p_n + c_N \sum_{s \neq n} p_s \text{ for } n = 1, \dots, N,$$

where, for  $1 \leq n \leq N$ , and defining

$$a_n = \frac{\alpha}{\beta + (n-1)\gamma},$$

$$b_n = \frac{\beta + (n-2)\gamma}{(\beta + (n-1)\gamma)(\beta - \gamma)},$$

$$c_n = \frac{\gamma}{(\beta + (n-1)\gamma)(\beta - \gamma)}.$$

The profits of firm  $n$  are

$$\pi_n(p_n, p_{-n}) = (p_n - m) \left( a_N - b_N p_n + c_N \sum_{s \neq n} p_s \right).$$

The vote share of party  $A_n$  is as in (2.7), with the utility of shareholder  $g$  being

$$U^g(p_n, p_{-n}) = \sum_{s=1}^N \theta_s^g (p_s - m) \left( a_N - b_N p_s + c_N \sum_{j \neq s} p_j \right).$$

The vote share is strictly concave as a function of  $p_{A_n}$ , and thus the maximization problem for party  $A_n$  has an interior solution. The maximization problem for party  $B_n$  is symmetric. Thus, we can apply Theorem 1 to obtain the following result:

**Proposition 4.** *In the differentiated goods Bertrand model with shareholder voting as described above, a symmetric equilibrium exists. The equilibrium quantities in the industry*

solve the following linear system of  $N$  equations and  $N$  unknowns:

$$\int_{g \in G} \theta_n^g \left[ \theta_n^g \left( (a_N - b_N p_n + c_N \sum_{s \neq n} p_s) - b_N (p_n - m) \right) + \sum_{s \neq n} \theta_s^g c_N (p_s - m) \right] dg = 0 \quad (2.9)$$

for  $n = 1, \dots, N$ .

Figure 2.2 shows the equilibrium prices of the differentiated goods Cournot and Bertrand models for different levels of diversification and different numbers of firms. The parameters are  $\alpha = \beta = 1$ ,  $\gamma = \frac{1}{2}$ , and  $m = 0$ . As in the case of Cournot with homogeneous goods, prices go to the monopoly prices as the portfolios go to the market portfolio. As before, this does not depend on the number of firms.<sup>2</sup>

## 2.6 Summary

In this chapter, I have developed a model of oligopoly with shareholder voting. Instead of assuming that firms maximize profits, the objectives of the firms are derived by aggregating the objectives of their owners through majority voting. I have applied this model to classical models of oligopoly. Portfolio diversification increases common ownership, and thus works as a partial form of integration among firms.

The theory developed in this paper has potentially important normative implications. For example, economists usually consider diversification, maximization of value for the shareholders by CEOs and managers, and competition to be desirable objectives. Within the context of the model developed in this paper, it is impossible to completely attain the three. If investors hold diversified portfolios

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<sup>2</sup>In this example, because goods are substitutes, price competition is more intense than quantity competition, and thus prices are lower in the former case. Häckner (2000) showed that, in an asymmetric version of this model, when goods are complements and quality differences are sufficiently high, the prices of some firms may be higher under price competition than under quantity competition.

and managers maximize shareholder value, then it follows that the outcome is collusive. It should be possible in principle to attain any two of the three objectives, or to partially attain each of them. This trilemma poses interesting questions for welfare analysis, since it is not clear how these three objectives should be weighted against each other. For example, how much diversification should we be willing to give up in order to reduce collusion? Should we prioritize maximization of shareholder value over reducing market power or increasing diversification? These issues are beyond the scope of this paper, and would thus be a natural direction for further research.

Market power in an industry is usually assessed by using concentration ratios or the Herfindahl index. This can be misleading if one does not, in addition, study the extent of common ownership in the industry. This applies to both horizontally and vertically related firms. Antitrust policy has thus far focused on mergers and acquisitions. Since common ownership may act as a partial form of integration between firms, it may be useful to pay more attention to the partial integration that can be achieved through portfolio diversification.

In the theory presented in this chapter, I have not modeled agency problems explicitly. Because diversification, all else equal, implies more dispersed ownership, it may increase managerial power relative to the shareholders. The potentially interesting interactions between diversification and agency are also a natural avenue for further research.

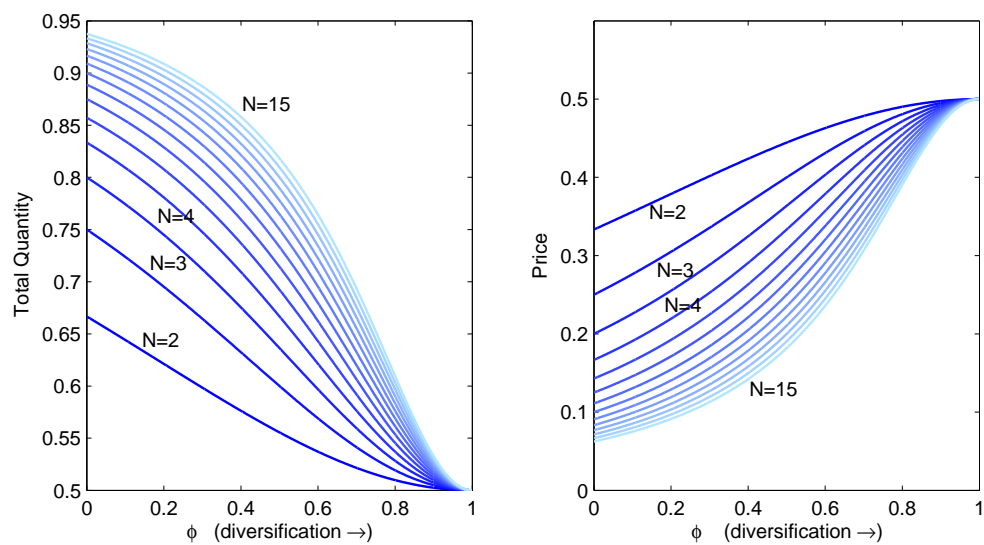


Figure 2.1  
 Equilibrium Quantities and Prices for Different Levels of Portfolio Diversification  
 in a Cournot Oligopoly with Homogeneous Goods

The solution to the model is shown for  $\alpha = \beta = 1$ , and  $m = 0$ . For these parameter values, the competitive equilibrium quantity is 1, and the collusive quantity is .5. The competitive price is zero, and the collusive price is .5.

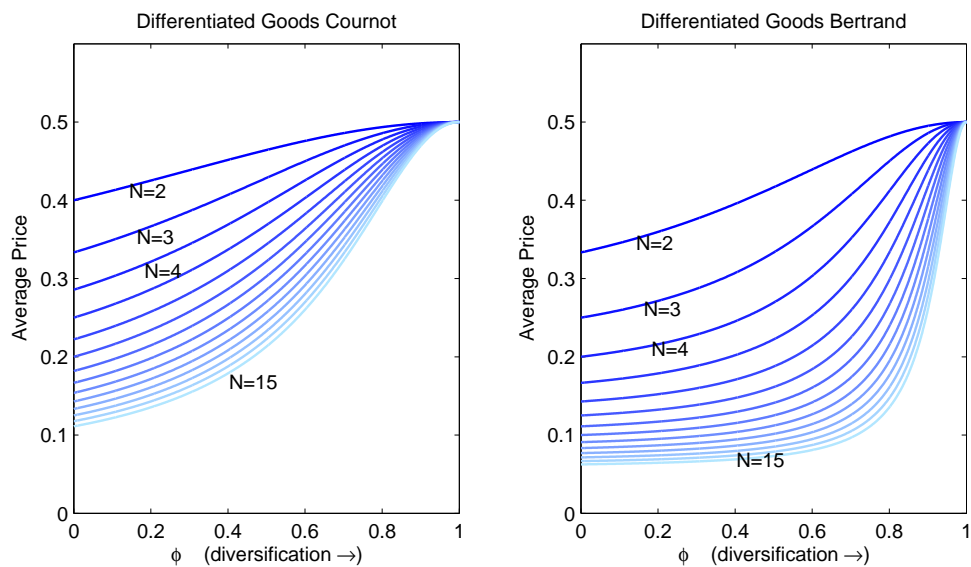


Figure 2.2  
 Equilibrium Prices for Different Levels of Portfolio Diversification in Cournot and  
 Bertrand Oligopoly with Differentiated Goods

The solution to the model is shown for  $\alpha = \beta = 1$ , and  $m = 0$ . For these parameter values, the competitive equilibrium price is zero, and the collusive price is .5.

## Chapter 3

# Oligopoly with Shareholder Voting in General Equilibrium

### 3.1 Introduction

In general equilibrium models with complete markets and perfect competition, the profit maximization assumption is justified by the Fisher separation theorem. The theorem, however, does not apply to models with imperfect competition. The profit maximization assumption could be justified in partial equilibrium models of oligopoly if firms were separately owned, although this is usually an unrealistic scenario. In general equilibrium, because ownership structure is endogenous, the microfoundations for the profit maximization assumption are even shakier, because with uncertainty shareholders have an incentive to diversify their portfolios.

In this section I show how to integrate the model of oligopoly developed in the previous chapter into a simple general equilibrium oligopoly setting. As pointed out by Gordon (1990), shareholders in this context do not care only about profits, but also about how the firms' policies affect them in their role as consumers. Thus,



the firms balance profit and non-profit objectives of the shareholders. In other words, there is corporate social responsibility in equilibrium.

However, the fact that there is some degree of corporate social responsibility in the model does not imply that a socially efficient equilibrium is achieved, *even when the shareholders consume all the output of the firms that they own*. In a quasilinear context, the level of corporate social responsibility depends on the wealth distribution. Wealth inequality and/or foreign ownership lead to lower levels of corporate social responsibility, higher markups, and lower efficiency. When the wealth distribution is completely egalitarian, the equilibrium is Pareto efficient, and price equals marginal cost. When the variance of the wealth distribution goes to infinity, the equilibrium becomes the same as in classical oligopoly or classical monopoly, depending on whether portfolios are diversified.

Thus, the answer to Gordon (1990)'s question "do publicly traded firms act in the public interest?" seems to be, in general, no. Theoretically, publicly traded firms would act in the public interest only in special cases, for example if the wealth distribution was completely egalitarian, and all households consumed the same amount of the oligopolistic good. In this case, the firms would be acting as the cooperatives in the model of Hart and Moore (1996).

It is interesting to note that the key assumption for the Fisher separation theorem that is being relaxed is *competitive perceptions*. Thus, even with a large number of firms, if shareholders are aware of the small pecuniary externalities that each firm generates on each other, and of the pecuniary externalities that they generate on themselves as consumers, the relevant model is oligopoly with shareholder voting. With a continuum of firms, the externalities generated by each firm are zero, but the profits generated are also zero, and thus firms' decision have a zero effect on shareholder utilities. Therefore, the assumption of profit maximization cannot be justified simply by claiming that firms are atomistic. It needs to be de-

rived by combining a model with a finite number of firms and the assumption of competitive perceptions by the shareholders.

## 3.2 Literature Review

A useful textbook treatment of the theory of oligopoly in general equilibrium can be found in Myles (1995), chap. 11. For a recent contribution and a useful discussion of this class of models, see Neary (2002) and Neary (2009).

An important precedent on the objectives of the firm under imperfect competition in general equilibrium is the work of Renstrom and Yalcin (2003), who model the objective of a monopolist whose objective is derived through shareholder voting. They use a median voter model instead of probabilistic voting theory. Their focus is on the effects of productivity differences among consumers, and on the impact of short-selling restrictions on the equilibrium outcome. Although not in a general equilibrium context, Kelsey and Milne (2008) study the objective function of the firm in imperfectly competitive markets when the control group of the firm includes consumers. They assume that an efficient mechanism exists such that firms maximize a weighted average of the utilities of the members of their control groups. The control groups can include shareholders, managers, workers, customers, and members of competitor firms. They show that, in a Cournot oligopoly model, a firm has an incentive to give influence to consumers in its decisions. They also show that in models with strategic complements, such as Bertrand competition, firms have an incentive to give some influence to representatives of competitor firms.

For sample of the literature on the Fisher separation theorem, see Jensen and Long (1972), Ekern and Wilson (1974), Radner (1974), Grossman and Stiglitz (1977), DeAngelo (1981), Milne (1981), and Makowski (1983). In the context of incomplete

markets, the Fisher separation theorem does not apply, and thus the literature has studies models with shareholder voting. For example, see Diamond (1967), Milne (1981), Dreze (1985), Duffie and Shafer (1986), DeMarzo (1993), Kelsey and Milne (1996), and Dierker et al. (2002).

The theoretical relationship between inequality and market power has been explored in the context of monopolistic competition by Foellmi and Zweimuller (2004). They show that, when preferences are nonhomothetic, the distribution of income affects equilibrium markups and equilibrium product diversity. The channel through which this happens in their model is the effect that the income distribution has on the elasticity of demand.

### 3.3 Model Setup

There is a continuum  $G$  of consumer-shareholders of measure one. For simplicity, I will assume that there is no uncertainty, although this can be easily relaxed. Utility is quasilinear:

$$U(x, y) = u(x) + y.$$

To obtain closed form solutions for the oligopolistic industry equilibrium, we will also assume that  $u(x)$  is quadratic:

$$u(x) = \alpha x - \frac{1}{2}\beta x^2.$$

There are  $N$  oligopolistic firms producing good  $x$ . Each unit requires  $m$  labor units to produce. They compete in quantities. There is also a competitive sector which produces good  $y$ , which requires 1 labor unit to produce. Each agent's time endowment is equal to 1 and labor is supplied inelastically. The wage is normal-

ized to 1. As is standard in oligopolistic general equilibrium models, there is no entry.

The agents are born with an endowment of shares in the  $N$  oligopolistic firms (they could also have shares in the competitive sector firms, but this is irrelevant). To simplify the exposition of the initial distribution of wealth, I will assume that the agents are born with a diversified portfolios, but this is not necessary. Their initial wealth  $W^g$  has a cumulative distribution  $F(W^g)$ , where  $W^g$  denotes the percentage of each firm that agent  $g$  is born with. Because in equilibrium the price of all the firms is the same, this can be interpreted as the percentage of the economy's wealth that agent  $g$  initially owns.

There are three stages. In the first stage, agents trade their shares. In the second, they vote over policies. In the third stage they make consumption decisions. Because there is no uncertainty, the agents are indifferent over any portfolio choice. However, adding even an infinitesimal amount of diversifiable uncertainty would lead to complete portfolio diversification, and thus we will assume that, in the case of indifference, the agents choose diversified portfolios. The equilibrium price of a company's stock will be the value of share of the profits that the stock awards the right to. This, of course, wouldn't be the true in the case of uncertainty. The key idea, however, is that asset pricing proceeds as usual: voting power is not incorporated in the price because agents are atomistic. Thus, we are assuming that there is a borrowing constraint, although not a very restrictive one: atomistic agents cannot borrow non-atomistic amounts.

In the second stage, the voting equilibrium will be as in the partial equilibrium case, with the caveat that shareholders now also consume the good that the firms produce. This will lead to an interesting relationship between the wealth distribution and the equilibrium outcome. With a completely egalitarian distribution, the

equilibrium will be Pareto efficient. With wealth inequality, the equilibrium will not be Pareto efficient.

The idea that foreign ownership could affect the objectives of the firm was proposed by Gordon (1990). Blonigen and O’Fallon (2011) present empirical evidence showing that foreign firms are less likely to donate to local charities, but that conditional on donating the amount is higher when the firm is foreign.

### 3.4 Voting Equilibrium with Consumption

I assume that  $\chi_n^g = 1$  for all shareholders and firms. Therefore, in the voting equilibrium each firm will maximize a weighted average of shareholder-consumer utilities, with weights given by their shares in the firm. The voting equilibrium for firm  $n$  given the policies of the other firms is given by:

$$\max_{q_n} \int_{g \in G} \theta_n^g \left\{ \sum_{s=1}^N \theta_s^g \pi_s(q_s, q_{-s}) + v[\alpha - \beta(q_n + q_{-n})] \right\} dg, \quad (3.1)$$

where  $v(P)$  is the indirect utility function from consumption of  $x$  when price is  $P$ :

$$v(P) = \alpha(a - bP) - \frac{1}{2}\beta(a - bP)^2 - P(a - bP),$$

where  $a = \frac{\alpha}{\beta}$  and  $b = \frac{1}{\beta}$ . This expression can be simplified to

$$v(P) = \frac{\beta}{2}(a - bP)^2.$$

When shareholders are completely diversified, the equilibrium will be collusive, and can be solved for by solving the joint maximization of the weighted av-

erage of shareholder-consumer utilities:

$$\max_{\{q_n\}_{n=1}^N} \int_{g \in G} \theta^g \left\{ \sum_{s=1}^N \theta^s \pi_s(q_s, q_{-s}) + v [\alpha - \beta(q_n + q_{-n})] \right\} dg.$$

We can further simplify the problem by rewriting it as

$$\max_Q \int_{g \in G} \theta^g \{ \theta^g \pi(Q) + v [\alpha - \beta Q] \} dg,$$

where  $\pi(Q)$  represents the profit function of a monopolist:

$$\pi(Q) = (\alpha - \beta Q - m)Q.$$

**Definition 4.** (*Completely Egalitarian Wealth Distribution*) We say that the initial wealth distribution is completely egalitarian if and only if  $\theta^g$  is constant, and equal to one for all  $g$ .

**Theorem 5.** *In the oligopolistic general equilibrium model with probabilistic voting and quasilinear and quadratic utility, the outcome is Pareto efficient if and only if the initial wealth distribution is completely egalitarian.*

*Proof.* Let's start by showing that when the distribution is completely egalitarian, the outcome is Pareto efficient. An egalitarian wealth distribution implies that  $\theta^g = 1$  for all  $g$ . Thus, the equilibrium is characterized by

$$\max_Q \pi(Q) + v [\alpha - \beta Q].$$

It is straightforward to check that the solution implies that  $\alpha - \beta Q = m$ . That is, equilibrium price equals marginal cost, which is the condition for Pareto efficiency in this model.

Now let's show that when the outcome is Pareto efficient, the distribution of wealth is not egalitarian. Suppose not. Then there is a wealth distribution such that  $\theta^g \neq 1$  in a set with positive measure. The equilibrium characterization can be rewritten as

$$\max_Q \pi(Q) \int_{g \in G} (\theta^g)^2 dg + v[\alpha - \beta Q].$$

The difference between price and marginal cost in this case can be characterized by

$$P - m = \frac{\phi - 1}{\phi} \beta Q,$$

where

$$\phi \equiv \int_{g \in G} (\theta^g)^2 dg.$$

Thus, price equals marginal cost if and only if either  $Q = 0$  or  $\phi = 1$ . Let us ignore the cases in which quantity equals zero, which are uninteresting. Note that  $\phi - 1$  is equal to the variance of  $\theta^g$ :

$$\sigma_\theta^2 = \int_{g \in G} (\theta^g)^2 dg - \left( \int_{g \in G} \theta^g dg \right)^2 = \phi - 1.$$

Therefore, if the outcome is Pareto efficient, then the variance of the distribution of shares is equal to zero, which is the same as saying that the initial wealth distribution is completely egalitarian.  $\square$

It is also possible to show that there is an increasing and monotonic relationship between the variance of the wealth distribution and the equilibrium markup:

**Theorem 6.** *In the oligopolistic general equilibrium model with probabilistic voting and quasilinear and quadratic utility, equilibrium markups are an increasing function of the variance of the wealth distribution. In the limit, as the variance of the wealth distribution goes to infinity, the equilibrium price is equal to the classic monopoly case.*

*Proof.* We will show that prices are increasing in the variance of  $\theta^g$ . The equilibrium price is characterized by

$$P = \frac{\alpha \frac{\sigma_\theta^2}{\sigma_\theta^2 + 1} + m}{\frac{\sigma_\theta^2}{\sigma_\theta^2 + 1} + 1}.$$

The derivative of this expression with respect to  $\sigma_\theta^2$  is positive when  $\alpha > m$ . Cases with  $\alpha < m$  are degenerate, since the valuation of  $x$  would be less than its marginal cost even at zero units of consumption.

When the variance of the wealth distribution goes to infinity,  $\frac{\sigma_\theta^2}{\sigma_\theta^2 + 1}$  goes to 1, and the expression becomes

$$\lim_{\sigma_\theta^2 \rightarrow \infty} P = \frac{\alpha + m}{2},$$

which is the equilibrium price in the standard monopoly case. □

Because the deadweight loss is increasing in price, the level of inefficiency will be higher for higher levels of wealth inequality. Figure 3.1 illustrates this results for  $\alpha = 1$ ,  $\beta = 1$  and  $m = .5$ .

When interpreting these results, there are several caveats that need to be noted. First, introducing in the model an endogenous labor supply and many periods, the redistribution policies required to achieve an egalitarian distribution of wealth would be distortionary, through the usual channels. Second, the model abstracts from agency issues and, with an egalitarian distribution of wealth, ownership would be extremely dispersed, making the accumulation of managerial power an important issue.

It is clear, however, that the classic trade-off between equality and efficiency does not apply in oligopolistic economies. Given the caveats mentioned in the last paragraph, it is possible that for some regions of the parameter space, and for



some levels of inequality, a reduction in inequality through income or wealth taxes increases economic inefficiency, but the overall picture is more complicated than in the competitive case.

### **3.5 Endogenous Corporate Social Responsibility, Inequality, and Foreign Ownership**

In the model described above, corporate social responsibility arises as an endogenous objective of the firm. Friedman (1970) argued that the only valid objective of the firm is to maximize profits. This is not the case when firms have market power, since the Fisher Separation Theorem does not apply. Since the owners of the firms are part of society, for example as consumers, they will in general want firms to pursue objectives different from profit maximization.

This does not imply that the equilibrium level of corporate social responsibility will be the socially optimal one. In the model described in this section, the socially optimal firm policies are obtained in equilibrium when the wealth distribution is completely egalitarian. In this case, the result is Pareto optimal. Inequality in this case generates inefficiency because the owners of the firms want the latter to use its market power more aggressively to extract monopoly (or oligopoly) rents.

In general, the optimal level of corporate social responsibility will be an equilibrium when ownership is distributed in proportion to how affected each individual in society is by the policies of the oligopolistic firms. In the quasilinear model, because consumption of the oligopolistic good is the same for everyone, optimality is achieved when ownership is egalitarian. This differs, for example, from the results in Renstrom and Yalcin (2003), because in their model (a) preferences are homothetic, and (b) labor income is heterogeneous.

In a model with environmental externalities, these would be internalized to the extent that the owners are affected by them. The optimal level of pollution would be obtained if ownership is proportional to the damage generated by the firms to each member of society, with more affected members having a proportionally larger stake in the firms.

Another interesting implication of the theory is that, to the extent that foreigners do not consume the home country's goods, foreign ownership leads to less corporate social responsibility in equilibrium. This is consistent with the evidence provided by Blonigen and O'Fallon (2011), who show that foreign firms are less likely to donate to local charities.

### 3.6 Solving for the Equilibrium with Incomplete Diversification

Although we have assumed that in case of indifference agents choose diversified portfolios, it is possible to construct equilibria in which agents choose imperfectly diversified portfolios when they are indifferent. In this subsection, I show how the equilibrium varies for different levels of diversification and wealth inequality. For imperfectly diversified cases, we need to solve the system of equations defined by equation 3.1. Rearranging the terms, we obtain

$$\sum_{s=1}^N \left\{ \left[ \int_{g \in G} \beta \theta_n^g (\theta_n^g + \theta_s^g - 1) dg \right] q_s \right\} = \int_{g \in G} (\theta_n^g)^2 (\alpha - m) dg \text{ for } n = 1, \dots, N.$$

This is a linear system, and the coefficients can be calculated by Monte Carlo integration. To do so, we need to specify a wealth distribution. I will use a lognormal wealth distribution, although the model can be solved easily for any distribution that can be sampled from.

Figure 3.2 shows the equilibrium quantity for different values of the  $\sigma$  parameter of the wealth distribution and different values of the diversification parameter  $\phi$ , defined in the same way as in section 5. The parameters of the oligopolistic industry are  $\alpha = \beta = 1$  and  $m = 0$ . The number of firms is set to 3, although it is not difficult to solve for the equilibrium with more firms. The Pareto efficient quantity for these values of the parameters is 1. The classic Cournot quantity is 0.75 and the classic monopoly quantity is 0.5. We can see that, when the distribution of wealth is completely egalitarian, the outcome is Pareto efficient independently of the portfolios. At all positive levels of wealth inequality, diversification reduces the equilibrium quantity. Also, for all levels of diversification, wealth inequality reduces the equilibrium quantity. We can also see that the collusive effect of diversification is greater at higher levels of wealth inequality. For values of  $\sigma$  above 2, at zero diversification the equilibrium quantity is approximately that of classic Cournot, which under the and with complete diversification it is approximately that of classic monopoly.

### 3.7 Relaxing the Quasilinearity Assumption

Suppose that preferences are not quasilinear. Then, the equilibrium under complete diversification is characterized by the solution to

$$\max_p \int_{g \in G} \theta^g v(p, m^g(p)) dg,$$

where  $v(p, m^g(p))$  is the indirect utility function corresponding to the general utility function  $U(x, y)$ . Total income  $m^g$  is the sum of labor income and profits:

$$m^g \equiv wL + \theta^g \pi(p).$$

The first order conditions are:

$$\int_{g \in G} \theta^g \left[ \frac{\partial v(p, m^g)}{\partial p} + \frac{\partial v(p, m^g)}{\partial m^g} \theta^g \frac{\partial \pi}{\partial p} \right] dg = 0.$$

Using Roy's identity, we can rewrite this equation as

$$\int_{g \in G} \theta^g \left[ -x(p, m^g) \frac{\partial v(p, m^g)}{\partial m^g} + \frac{\partial v(p, m^g)}{\partial m^g} \theta^g \frac{\partial \pi}{\partial p} \right] dg = 0.$$

If the wealth distribution is completely egalitarian, the solution is characterized by

$$\frac{\partial \pi}{\partial p} - x(p, m) = 0.$$

It is easy to check that this is the condition for Pareto optimality.

However, with general preferences an egalitarian distribution is not the only case under which the equilibrium is Pareto optimal. For example, if consumption of the oligopolistic good is proportional to ownership of the oligopolistic firms, then the result is also Pareto optimal. That is, the relevant condition is

$$x(p, m^g) = \theta^g x(p).$$

Replacing this condition in the first order conditions, it is immediately clear that the solution is Pareto optimal. Note that, because there is labor income in addition to profit income, this condition does not correspond to homothetic preferences. While the condition is difficult to characterize in terms of the primitives of the model, the intuition is clear. The markup of the oligopolistic good affects agents in proportion to their consumption of that good. The optimal level of corporate social responsibility—in this case applied to the setting of markups—occurs in equilibrium

when ownership is proportional to the level of consumption of the oligopolistic good.

### **3.8 Summary**

In this chapter, I introduced the model of oligopoly with shareholder voting to in a general equilibrium setting. In general equilibrium, oligopolistic firms take into account objectives of their owners that are not related to profits. For example, the shareholders internalize some of the effects that firm policies generate on them as consumers.

The general equilibrium model of oligopoly with voting has implications that may be of interest from a normative point of view. Corporate social responsibility arises in equilibrium as an endogenous objective of the firm. Owners of oligopolistic firms will in general want their firms to pursue objectives beyond profit maximization. Socially optimal outcomes are achieved when the distribution of ownership is proportional to how affected the agents are by the policies of the oligopolistic firms. When consumption of oligopolistic goods increases less than proportionally with wealth, an increase in wealth inequality increases inefficiency. Another implication of the theory is that foreign ownership leads to less corporate social responsibility in equilibrium, which is consistent with evidence that shows that foreign-owned firms are less likely to donate to local charities than locally owned firms.

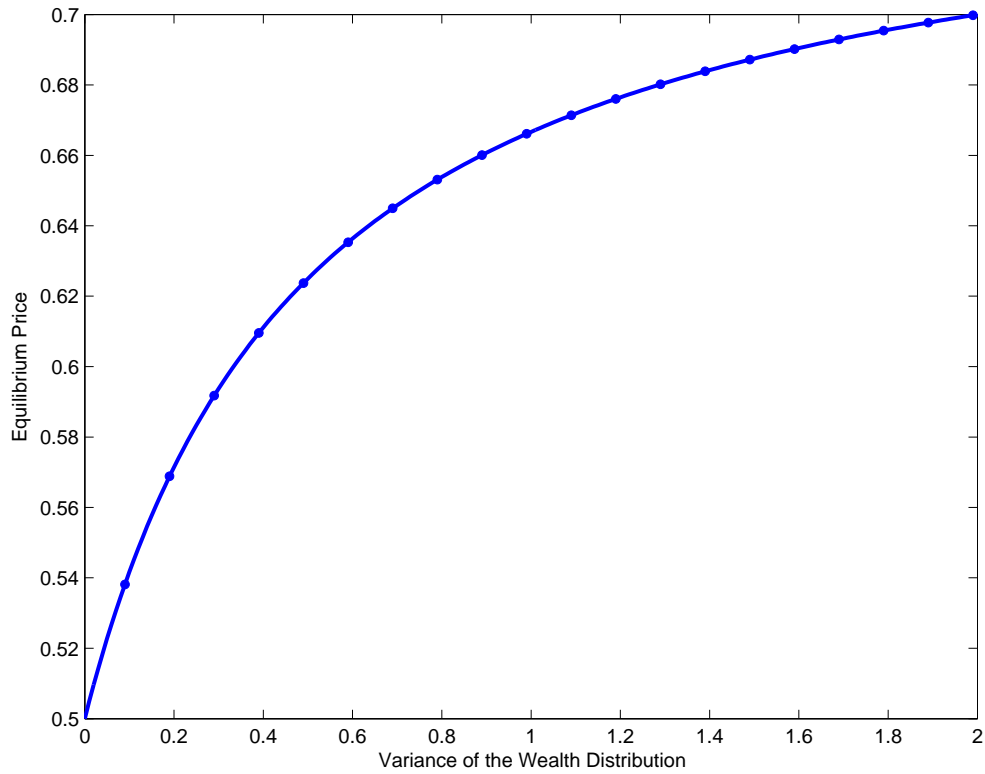


Figure 3.1  
 Equilibrium Prices in the Quasilinear General Equilibrium Model for Different  
 Levels of Initial Wealth Inequality

The solution to the model is shown for  $\alpha = \beta = 1$  and  $m = .5$ . The number of firms does not affect the equilibrium price. For these parameter values, the price consistent with a Pareto optimal quantity of good  $x$  is  $.5$ . The classic monopoly price is  $.75$ .

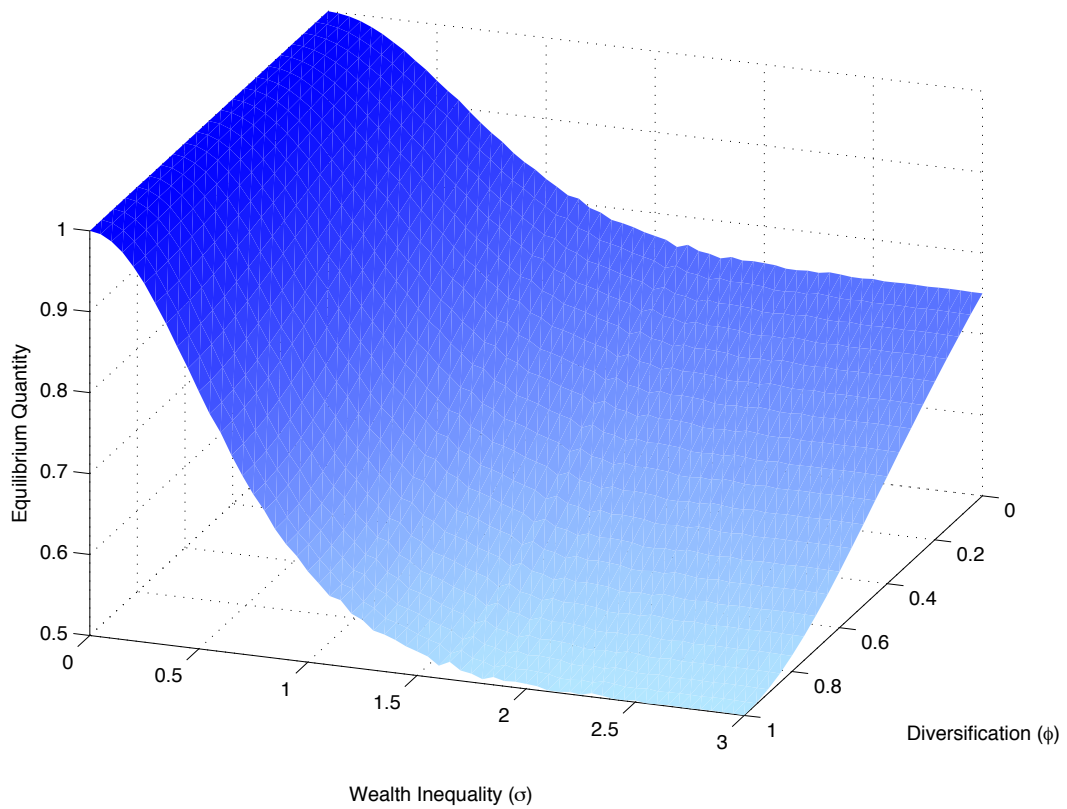


Figure 3.2  
 Equilibrium Quantity of the Oligopolistic Good in the Quasilinear General  
 Equilibrium Model for Different Levels of Wealth Inequality and Diversification  
 (Lognormal Wealth Distribution)

The solution to the model is shown for  $\alpha = \beta = 1$ ,  $m = .5$ , and  $N = 3$ . For these parameter values, the Pareto optimal quantity of good  $x$  is 1. The classic Cournot and classic monopoly quantities are .75 and .5, respectively.

# Chapter 4

## The Evolution of Shareholder Networks in the United States: 2000-2011

### 4.1 Introduction

This chapter studies the evolution of the network of interlocking shareholdings among publicly traded companies in the United States between 2000 and 2011. I focus on interlocking shareholdings generated by institutional investors owning blocks of stock in several firms.

Ownership concentration and shareholder interlocks are known to be widespread in Europe and Asia.<sup>1</sup> Historically, however, ownership has been less concentrated in the United States.<sup>2</sup> The main finding of this chapter is that, due to the increase in institutional ownership in recent decades, large blockholdings of publicly traded companies in the United States are now normal.

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<sup>1</sup>See, for example, Itō (1992), Becht and Röell (1999), Kim (2003), and Allen et al. (2004).

<sup>2</sup>See, for example, Berle and Means (1940), Roe (1996), and Becht and DeLong (2005).



To construct the network of firms connected by institutional investors, I define two firms as connected if there is an institutional investors with an ownership stake above a threshold  $x$ —for example, 5%—in both firms. The main findings are the following. First, the density of the network has more than doubled between 2000 and 2011. This more than doubling of network density holds for network definitions using percentage ownership thresholds of 3%, 5% and 7%, and for the 3% threshold the density has more than tripled over the period.

Second, the vast majority of the connections in the network are generated by a few very large funds, despite the fact that the number of institutions in the sample has increased substantially over the period. In 2011, the top 5 institutional investors ranked by the number of blockholdings generated more than 80% of the connections, independently of the threshold. The fact that the number of blockholdings owned by the top institutions increased significantly over this period helps to explain why measures of network density have increased so rapidly.

Third, larger firms are in general more connected. Focusing on the largest 3000 firms by market capitalization shows that this set of firms is much more connected than the overall network. Moreover, the increase in density between 2000 and 2011 has been steeper among this set of large firms.

Fourth, most blockholdings do not survive more than a few years. However, in recent years blockholdings of 3% held by the top 5 institutional investors have much higher survival rates.

Finally, the densities of within-industry subnetworks are on average higher than the overall network density. Thus, firms are more likely to be connected if they are in the same industry.

## 4.2 Data Description

I use data from Thomson Reuters on institutional ownership for stocks listed in stock exchanges in the United States. These data are based on the holdings reported in Form 13F that is required by the Securities and Exchange Commission to be filed quarterly by institutional investors owning shares listed in US stock exchanges. The Thomson Reuters dataset includes information on the portfolios of a large number of institutional investors, including the number of shares held, the share price, number of shares outstanding, and the industrial sector of the company. I will focus on the period starting on the second quarter of 2000 until the third quarter of 2011.<sup>3</sup>

Table 4.1 shows summary statistics for this dataset, in particular the number of firms per quarter, the number of institutional investors, the total number of holdings, and the number of blockholdings at 3%, 5%, and 7%. The sample consists of all common stock for domestic firms listed in any exchange in the United States with nonmissing data for share price, shares outstanding, shares held. The number of firms declined from more than 8,000 in the year to around 6,000 in 2011. The number of institutions, on the other hand, has increased, from less than 2,000 at the start of the sample to almost 3,000 at the end. The number of holdings has also increased. The total number of blockholdings in the sample has increased over time at the 3% and 5% thresholds, but not at 7%.

## 4.3 The Increase in Shareholder Network Density

We can think of a group of firms as the nodes in a network. Institutional investors generate links between them by creating relations of common-ownership. For sim-

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<sup>3</sup>The reason I start the sample in the second quarter of 2000 and not the first is that the number of observations in the first quarter was extremely low.

plicity, I will define two firms as being connected through common owners if there is an institutional shareholder with an ownership stake of more than  $x$  percent in both. Figure 4.1 shows the network at the end 2010 for a random sample of 1000 companies using a threshold of 5%. The size of each circle is proportional to the logarithm of market capitalization. The color represents the number of connections, with colors closer to red representing more connections, and colors closer to blue representing less connections.

How pervasive are relations of common ownership among a group of firms? A useful statistic that captures the average level of connections in a network is the network density. The density of a network is defined as the total number of connections divided by the total number of possible connections. The formula for the density of a network, given its adjacency matrix  $Y$ , is

$$Density = \frac{\sum_{i=1}^n \sum_{j<i} y_{ij}}{n(n-1)/2},$$

where  $n$  is the number of nodes in the network and  $y_{ij}$  is equal to 1 if node  $i$  and node  $j$  are connected, and zero otherwise (by convention, a node is not considered to be connected to itself, and thus the adjacency matrix has zeros in its diagonal). Thus, it is a measure of the average level of “connectedness” among its nodes. It can be interpreted as the probability that a pair of nodes selected at random is connected.

Figure 4.2 shows the evolution of the network density measures for all the firms in the dataset, at the 3%, 5%, and 7% thresholds. The density has more than doubled at all thresholds. Using a threshold of 3%, density increased from 7.8% in 2000Q2 to 23.5% in 2011Q3. That is, the probability that a randomly selected pair of firms was connected in 2000Q2 was 7.8%, and it was 23.5% in 2011Q3. For a thresh-

old of 5%, network density increased from 2.9% in 2000Q2 to 7.9% in 2011Q3. For a threshold of 7%, density increased from .8% to 1.8% over the same period.

Figure 4.3 shows the evolution of density for the largest 3000 firms in terms of market capitalization. The density for this set of firms is significantly higher than the density for the whole sample, at all thresholds. At a threshold of 3%, the network density increased from 15% in 2000Q2 to 60.2% in 2011Q3, implying that almost two thirds of all firm pairs were connected. For thresholds of 5% and 7%, density over this period increased from 4.7% to 20.1% and from 1.7% to 4.3%, respectively.

Thus, larger firms are in general more connected. Focusing on the largest 500 firms however, the picture is more complicated. Figure 4.4 shows the evolution of density for the largest 500 firms in terms of market capitalization. The subnetwork formed by these firms does have a higher density than the overall network at all thresholds. It is also more connected than the network of the largest 3000 firms when using a 3% threshold, with a density of more than 75% in 2011. However, at thresholds of 5% and 7% these firms are less connected than the largest 3000, and density has declined over the period.

The reason for this nonmonotonic relationship between density and firm size is that the largest firms are less likely to have a blockholder with 5% or more. This can be seen by comparing the fraction of firms with blockholders at different thresholds for the whole sample, the largest 3000 firms, and the largest 500 firms, shown in Figures 4.5, 4.6, and 4.7.

In summary, the data shows a huge increase in the density of interlocking shareholder networks at all thresholds. For the largest 3000 firms, both the level and the increase are higher than for the overall sample. For the largest 500 firms, density is higher at the 3% threshold, but lower at the 5% and 7% thresholds, and the reason is that blockholdings of 5% and 7% are less frequent for the largest firms. The

density at 3% for the largest 500 firms is remarkably high, with more than 75% of firm pairs being connected.

## 4.4 Increasing Concentration of Ownership Among Institutional Investors

In addition to the total number of blockholdings, the density of the network of interlocking shareholdings is determined by their concentration. An institution that has a portfolio with blockholdings in  $k$  firms generates  $\frac{k(k-1)}{2}$  connections in the network. Thus, an ownership structure with few blockholdings held by a small number of institutions can result in firms being more connected than one with many blockholdings but in which a large number of institutions hold few companies each. In this section, I show evidence that the number of blockholdings held by the largest institutions has increased significantly.

First, it is interesting to note that most connections in the network are generated by a handful of institutions. Figure 4.8 shows that, for every period and at all thresholds, more than 70% of the connections were generated by just 5 institutional investors, and currently the fraction is more than 80%. This is surprising, given that the number of institutional investors in the dataset has increased substantially over the period.

Tables 4.2, 4.3, and 4.4 show rankings of institutional investors by the number of blockholdings that they held at the end of 2001, 2004, 2007, and 2010, at 3%, 5%, and 7% thresholds. The number of blockholdings held by the top institutions has increased significantly. For example, in 2001 the top institution in terms of 3% blockholdings was Dimensional, with 1,586. These generated  $\frac{1,586 \times 1,585}{2} = 1,256,905$  connections in the network. At the end of 2010, the top institution in terms of 3% blockholdings was BlackRock, with 2,501. These gener-

ated  $\frac{2,501 \times 2,500}{2} = 3,126,250$  connections, more than twice as many. This illustrates the fact that an increase in blockholdings by the largest institutions increases the density of the network more than proportionally.

Figures 4.9, 4.10, and 4.11 show that the fraction of firms in which the top 1, top 5, top 10, and top 20 institutions hold blockholdings has increased over the period at all thresholds. The fraction of the largest 3000 firms in terms of market capitalization in which they have blockholdings is much higher, as shown in figures 4.12, 4.13, and 4.14. The top 20 institutions have blockholdings of more than 3% in almost 90% of the largest 3000 firms.

What is behind the increase in the number of blockholdings held by the largest institutions has increased is an increasing concentration of the ownership of the US stock market among the largest asset managers over this period of time. This is confirmed by the evidence shown in Figure 4.15, which shows the cumulative distribution function for the portfolio values of institutional investors as a fraction of total market capitalization. Portfolio values follow approximately a power law. The fraction of market capitalization held has declined between 2000 and 2010 at all percentiles below .35%. The fraction of market capitalization held by institutions between the .35% and .14% percentiles has remained roughly constant. The fraction held by the top .14% of institutions has increased significantly.

## 4.5 How Long Do Blockholdings Last?

How long does the typical blockholding last? This question is important because institutions that hold large blocks for a long period of time are more likely to take on an active role in corporate governance. In this section, I present evidence showing that most blockholdings do not last very long. However, the survival rate for blockholdings of 3% held by the top institutions has increased in recent years, and

in 2011 it was such that the great majority of blockholdings would survive for more than three years.

To calculate survival rates, I use, for each period, the firms and institutions which are observed at least one more period. For these institutions and firms, I calculate the fraction of blockholdings that survives until the next period. This way, I avoid counting blockholdings as dying just before the institution did not report its holdings for one period, or because the firm exited the sample. This procedure overestimates survival rates only to the extent that there was an institution that lost all of its blockholdings that period, which seems unlikely.

Figure 4.16 shows the fraction of blockholdings surviving each period. The fraction surviving has changed somewhat over time, declining during the recession, and then returning to levels comparable to those at the start of the sample. In 2011, around 90% of blockholdings at 3%, around 88% of blockholdings at 5%, and around 86% of blockholdings at 7% survived each quarter. A survival rate of 90% per quarter implies a three-year survival rate of  $.9^{12}$ , approximately 28%. Thus, most blockholdings do not last for more than three years. The temporal evolution of survival rates is similar for blockholdings of different sizes.

For the top 5 institutions, the behavior is different. Figure 4.17 shows the evolution of survival rates for blockholdings held by the top 5 largest institutions. The survival rate has increased substantially for blockholdings of 3%, has remained relatively stable for blockholdings of 5%, and has declined for blockholdings of 7%. At the end of the period, the quarterly survival rate for blockholdings of 3% held by the top 5 institutions was more than 96%, implying a three-year survival rate of more than 61%. If these survival rates are sustained, most blockholdings of 3% held by the top 5 institutions will survive for more than three years.

## 4.6 Evolution of the Degree Distributions

Figure 4.18 shows the change in the degree distribution between 2000 and 2011. At every threshold, the distribution of degrees is very far from a power law, indicating that the network is very far from being scale-free. In 2011 it is even further away from a power law distribution than in 2000. This is particularly pronounced for the 3% threshold network, whose degree distribution in 2011 practically forms a 90-degree angle, suggesting that, with few exceptions, a firm is either connected to most firms or is completely disconnected.

## 4.7 Density of Subnetworks by Industrial Sector

An important question is whether firms that are in the same industry are more likely to have common institutional shareholders than firms that are in different sectors of the economy. In this section, I show evidence that this is actually the case by measuring the density of subnetworks by industrial sector.

Figures 4.19, 4.20, and 4.21 show the density of the subnetwork for the 37 industry classifications in the Thomson Reuters database, plus the density for the overall network (“All Industries”). At the 3% threshold, the most connected industries are Textiles and Apparel, Transportation, and Airlines, and the least connected (without counting Unknown and Miscellaneous) are Metals and Mining, Banks and Savings Institutions, and Financial Services. At the 5% threshold, the most connected industries are Paper and Forestry Products, Airlines, and Textiles and Apparel. The least connected are Metals and Mining, Financial Services, and Real Estate. At the 7% threshold, the most connected industries are Airlines, Construction and Engineering, and Food and Restaurants, and the least connected are Tobacco, Packaging, and Financial Services.



At all thresholds, the average density of the sectoral subnetworks was higher than the density for the overall network. Thus, it is more likely that two firms will be connected if they are in the same industry.

## **4.8 Summary**

In this chapter, I have presented evidence on the evolution of networks of interlocking shareholdings for publicly traded US companies between 2000 and 2011. The most important conclusion of the analysis is that the density of the network has more than doubled over the period, and this is robust to the threshold level chosen.

The immediate cause of this increase in density is the increase in the number of blockholdings by the largest institutional investors during the period. The top 5 institutions ranked by the number of blockholdings have blockholdings in hundreds of companies at the 7% level, and in thousands at the 5% and 3% levels. This means that a few institutions own blocks of stock in a large fraction of the publicly traded companies in the United States. Thus, the evidence contradicts the accepted view that, unlike in Europe and Japan, blockholdings are scarce in the United States. Large blockholdings are, in fact, quite common among publicly traded US companies.

Date	Firms	Institutions	Holdings	Blockholdings (3%)	Blockholdings (5%)	Blockholdings (7%)
April 1, 2000	8,118	1,757	488,396	16,388	8,488	4,983
July 1, 2000	8,332	1,779	506,758	16,703	8,757	5,308
October 1, 2000	8,040	1,915	505,736	16,336	8,537	5,150
January 1, 2001	8,024	1,873	526,412	16,247	8,456	5,077
April 1, 2001	7,700	1,871	501,859	16,201	8,366	4,964
July 1, 2001	7,828	1,867	511,072	16,393	8,430	5,144
October 1, 2001	7,594	1,767	472,712	16,157	8,235	4,898
January 1, 2002	7,583	1,923	509,381	16,447	8,300	5,039
April 1, 2002	7,456	1,875	482,324	16,576	8,217	4,887
July 1, 2002	7,424	1,892	501,838	17,008	8,382	5,090
October 1, 2002	7,193	1,923	475,466	16,398	8,207	4,787
January 1, 2003	7,001	1,913	495,350	16,765	8,310	4,780
April 1, 2003	7,000	1,938	496,298	16,824	8,189	4,676
July 1, 2003	6,631	1,935	530,227	17,240	8,176	4,999
October 1, 2003	6,610	2,033	527,135	15,676	7,830	4,538
January 1, 2004	7,164	2,087	569,847	18,516	8,620	4,777
April 1, 2004	7,116	2,092	587,641	19,076	8,863	4,957
July 1, 2004	7,070	2,068	562,031	19,256	9,058	5,147
October 1, 2004	7,103	2,246	591,607	19,670	9,273	5,487
January 1, 2005	7,138	2,278	596,810	20,372	9,503	5,423
April 1, 2005	7,062	2,305	623,381	20,237	9,526	5,555
July 1, 2005	7,066	2,246	589,322	20,723	9,774	5,648
October 1, 2005	7,067	2,419	589,298	21,467	10,210	5,907
January 1, 2006	7,127	2,459	610,385	21,663	10,273	5,924
April 1, 2006	6,922	2,477	601,785	22,489	10,499	5,967
July 1, 2006	7,125	2,477	630,200	22,255	10,617	6,151
October 1, 2006	7,231	2,657	656,895	23,103	11,051	6,324
January 1, 2007	7,259	2,693	636,161	23,489	11,138	6,407
April 1, 2007	7,656	2,713	659,758	24,323	11,528	6,614
July 1, 2007	7,130	2,701	646,494	25,612	12,465	7,690
October 1, 2007	7,114	2,922	643,308	25,044	12,059	6,955
January 1, 2008	7,287	2,921	643,135	25,598	12,269	7,166
April 1, 2008	7,269	2,940	651,428	25,357	12,117	7,045
July 1, 2008	7,152	2,908	651,974	24,953	12,110	7,155
October 1, 2008	7,005	2,868	615,764	23,629	11,667	6,998
January 1, 2009	6,739	2,807	569,507	22,543	10,892	6,318
April 1, 2009	6,628	2,818	594,556	21,747	10,136	5,718
July 1, 2009	6,631	2,769	621,866	21,950	10,358	6,700
October 1, 2009	6,634	2,802	619,582	22,034	10,247	6,289
January 1, 2010	6,641	2,798	621,990	19,950	9,233	5,857
April 1, 2010	6,566	2,786	619,562	19,128	8,760	5,138
July 1, 2010	6,489	2,768	601,750	22,147	10,194	5,636
October 1, 2010	6,463	2,986	648,182	21,915	10,402	5,816
January 1, 2011	6,136	2,983	629,493	21,167	9,796	5,317
April 1, 2011	5,822	2,980	619,633	20,898	9,730	5,084
July 1, 2011	5,591	2,945	573,517	20,231	9,484	4,800
Total	325,937	110,180	26,607,826	927,901	446,732	260,290

Table 4.1  
Summary Statistics

Source: SEC through Thomson Reuters.

Ranking	2001	2004	2007	2010
1	Dimensional (1586)	Barclays (1959)	Barclays (2204)	BlackRock (2501)
2	Fidelity (1017)	Fidelity (1175)	Fidelity (1115)	Vanguard (2097)
3	Barclays (805)	Dimensional (863)	Dimensional (961)	Fidelity (1016)
4	Wellington (591)	Wellington (651)	Vanguard (890)	Dimensional (876)
5	Price T. Rowe (394)	Price T. Rowe (510)	Wellington (654)	State Street (719)

Table 4.2  
Top 5 Institutional Investors by Number of Blockholdings (3% Threshold)

This table shows the top 5 institutional investors in terms of the number of firms in which they held ownership stakes of at least 3% (blockholdings), for the last quarter of 2001, 2004, 2007 and 2010. The numbers in parentheses below each institution's name indicate the number of blockholdings.

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Ranking	2001	2004	2007	2010
1	Dimensional (947)	Fidelity (847)	Fidelity (853)	BlackRock (1311)
2	Fidelity (719)	Barclays (611)	Barclays (751)	Fidelity (759)
3	Wellington (365)	Dimensional (513)	Dimensional (600)	Morgan Stanely (532)
4	Price T. Rowe (265)	Wellington (397)	Wellington (401)	Dimensional (480)
5	Capital Res. & Mgmt. (200)	Price T. Rowe (340)	Price T. Rowe (391)	Vanguard (420)

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Table 4.3  
Top 5 Institutional Investors by Number of Blockholdings (5% Threshold)

This table shows the top 5 institutional investors in terms of the number of firms in which they held ownership stakes of at least 5% (blockholdings), for the last quarter of 2001, 2004, 2007 and 2010. The numbers in parentheses below each institution's name indicate the number of blockholdings.

Ranking	2001	2004	2007	2010
1	Fidelity (522)	Fidelity (635)	Fidelity (655)	Fidelity (584)
2	Dimensional (428)	Barclays (247)	Dimensional (367)	BlackRock (477)
3	Wellington (243)	Wellington (242)	Price T. Rowe (256)	Morgan Stanely (414)
4	Price T. Rowe (173)	Price T. Rowe (231)	Wellington (255)	Price T. Rowe (247)
5	Franklin Resources (106)	Dimensional (217)	Barclays (197)	Dimensional (229)

Table 4.4  
Top 5 Institutional Investors by Number of Blockholdings (7% Threshold)

This table shows the top 5 institutional investors in terms of the number of firms in which they held ownership stakes of at least 7% (blockholdings), for the last quarter of 2001, 2004, 2007 and 2010. The numbers in parentheses below each institution's name indicate the number of blockholdings.

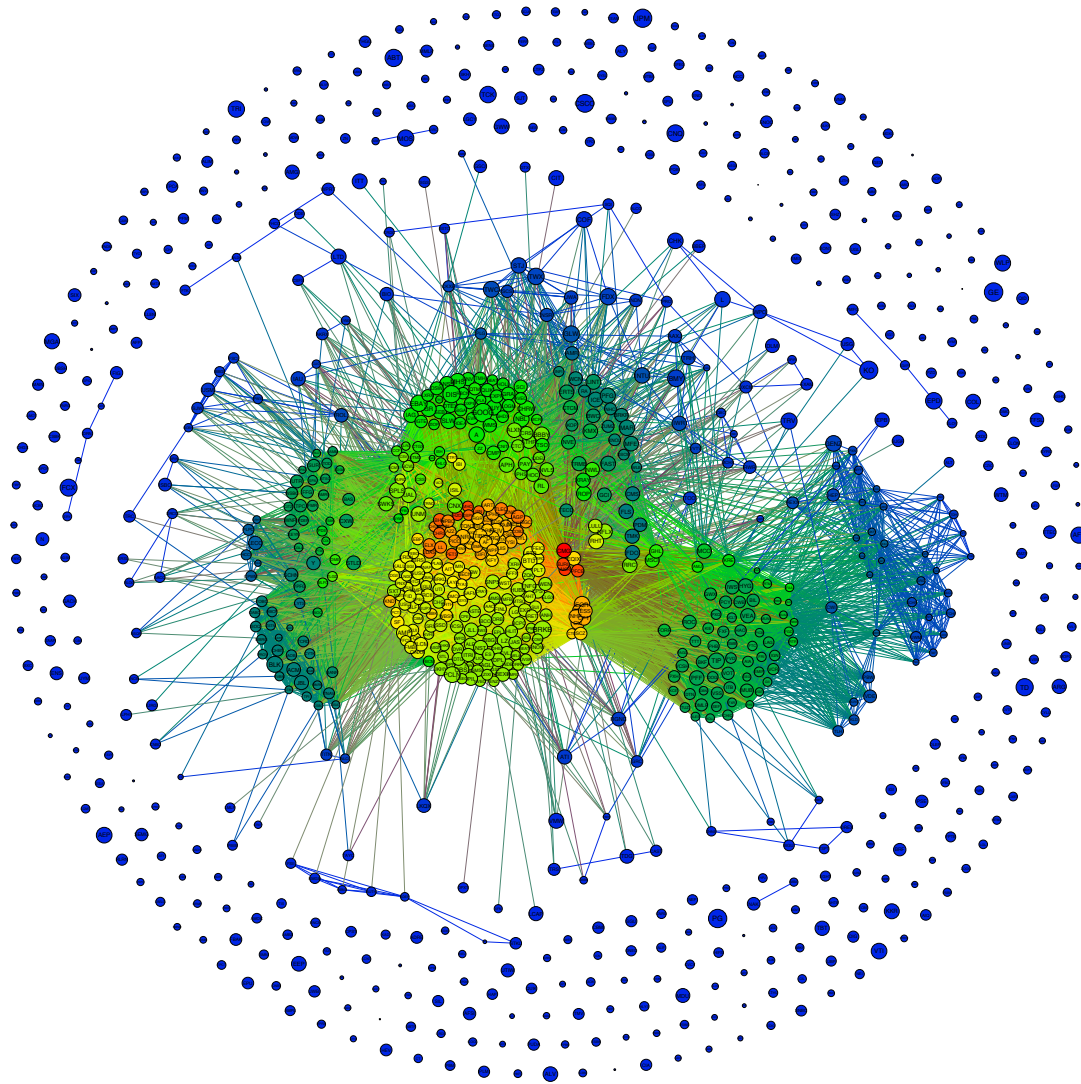


Figure 4.1  
Shareholder Network (Random Sample of 1000 Companies in 2010Q4)

This figure shows a plot of a sample of 1000 companies in the network of firms in 2010Q4. The edges are generated by common institutional shareholders with ownership stakes of at least 5% in a pair of firms. The layout of the network is calculated using a Fruchterman-Reingold algorithm. The size of the circles is proportional to the logarithm of a company's market capitalization. The color represents the number of connections of the company, with colors closer to blue indicating less connections, and colors closer to red indicating more connections.

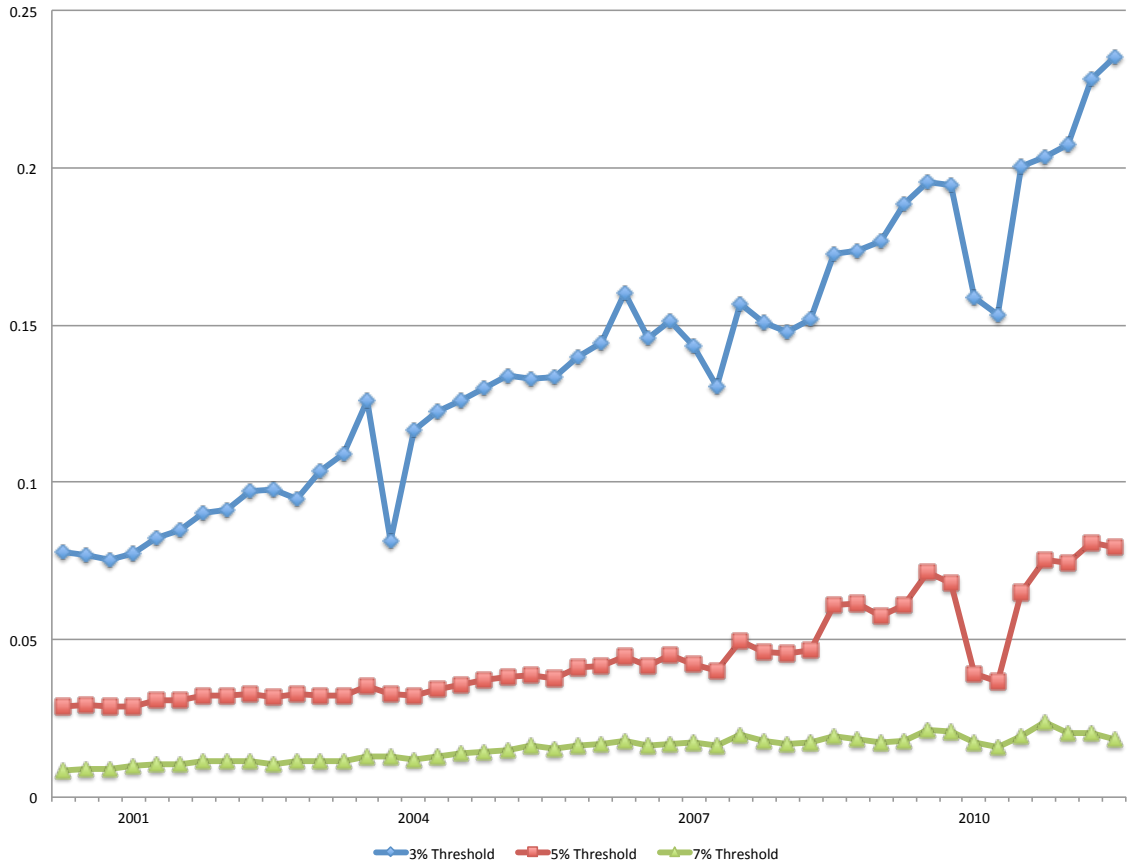


Figure 4.2  
 Evolution of the Density of the Network of Interlocking Shareholdings: All Firms

Source: SEC through Thomson Reuters and author's calculations.

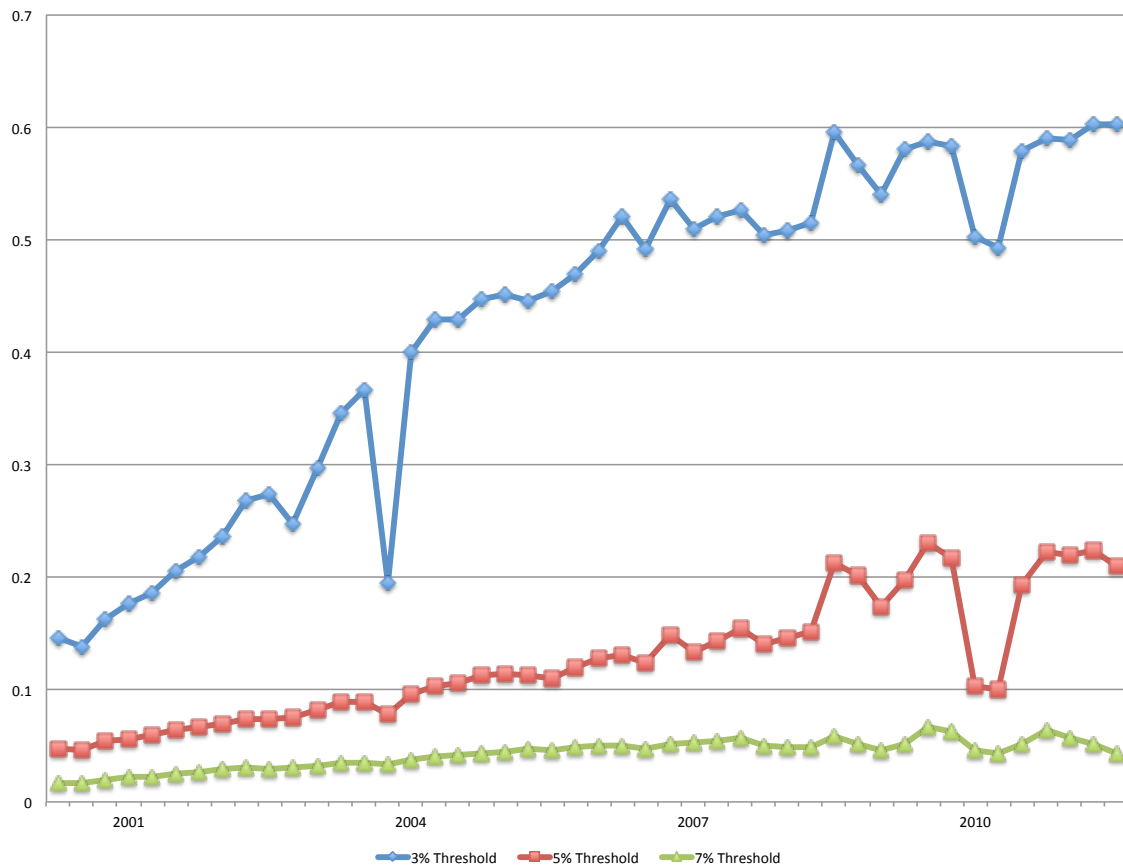


Figure 4.3  
 Evolution of the Density of the Network of Interlocking Shareholdings: Largest 3000 Firms

Source: SEC through Thomson Reuters and author's calculations.



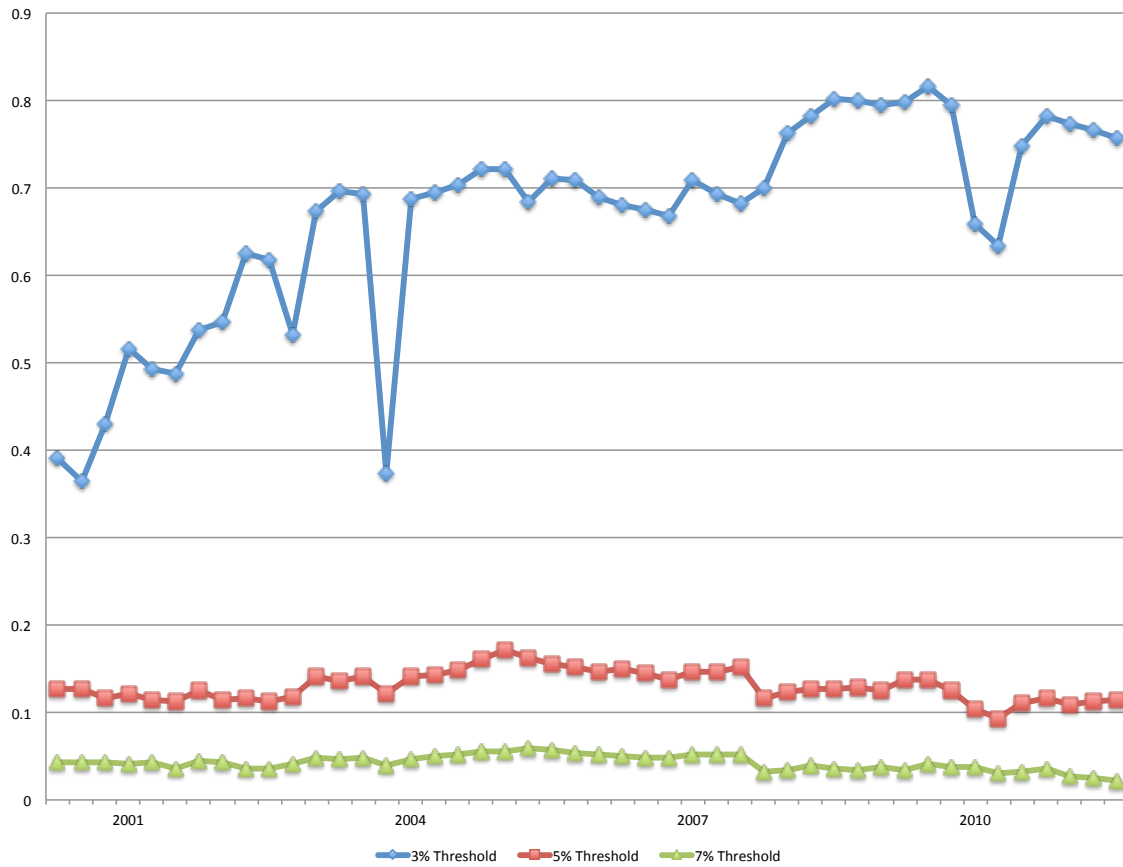


Figure 4.4  
 Evolution of the Density of the Network of Interlocking Shareholdings: Largest 500 Firms

Source: SEC through Thomson Reuters and author's calculations.

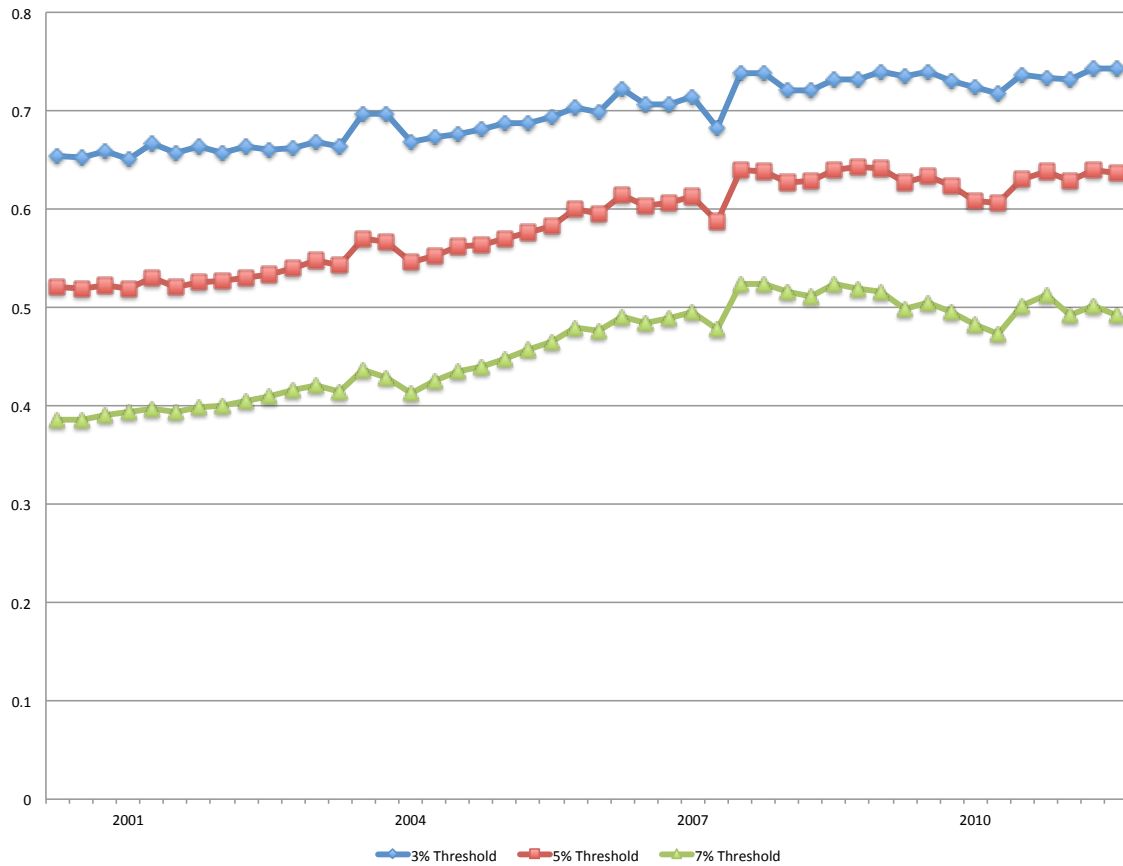


Figure 4.5  
 Fraction of Firms with At Least one Blockholder: All Firms

Source: SEC through Thomson Reuters and author's calculations.

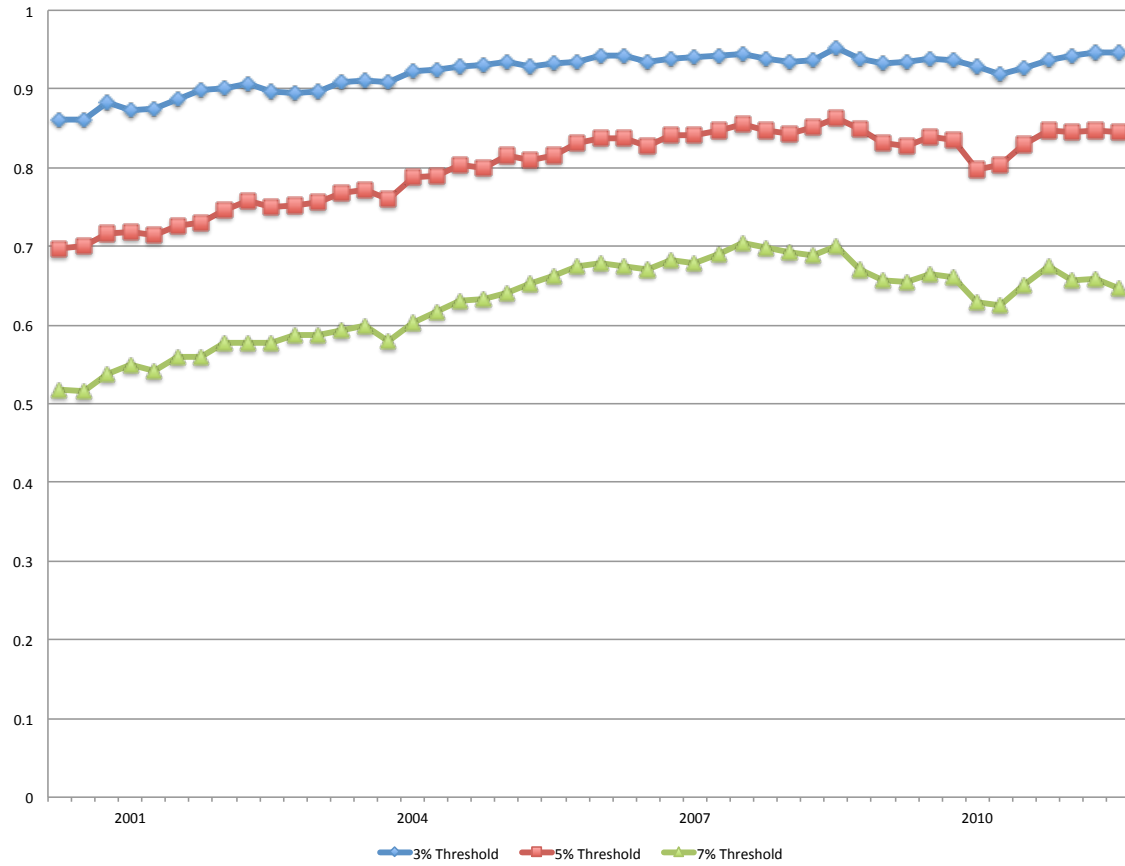


Figure 4.6  
 Fraction of Firms with At Least one Blockholder: Largest 3000 Firms

Source: SEC through Thomson Reuters and author's calculations.

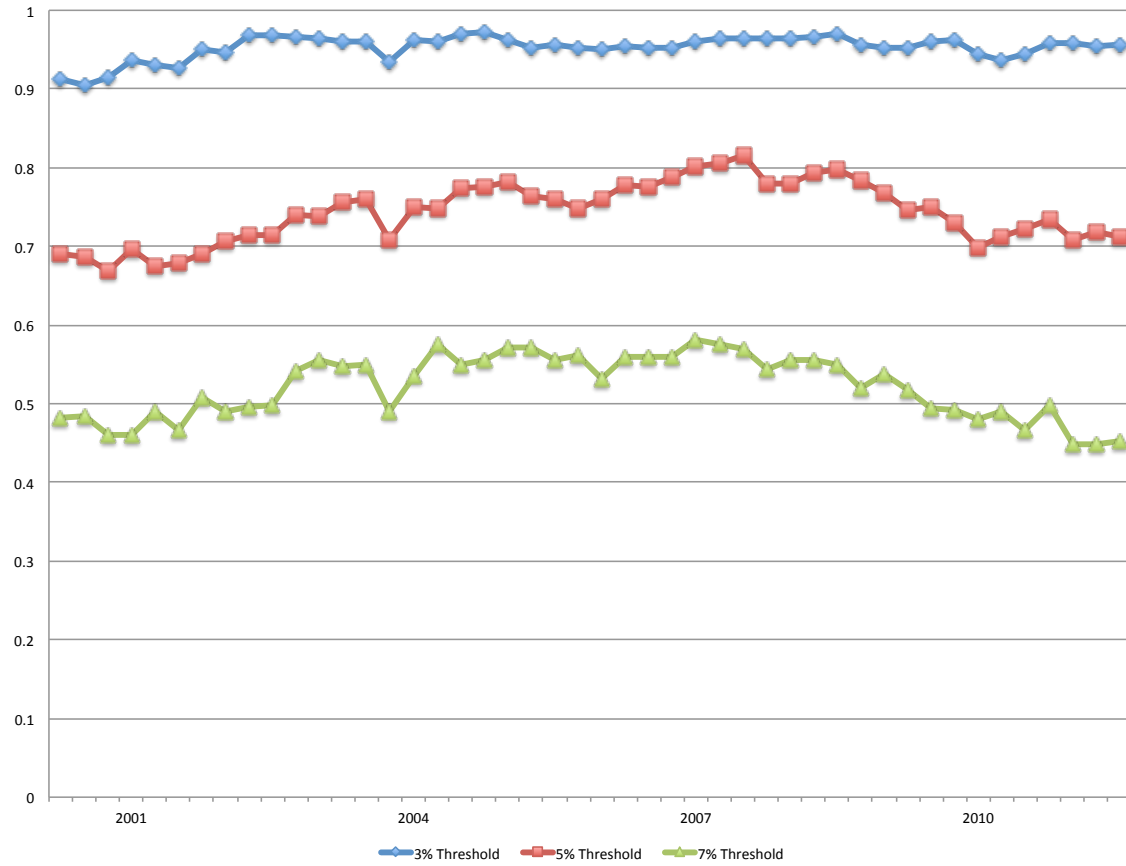


Figure 4.7  
 Fraction of Firms with At Least one Blockholder: Largest 500 Firms

Source: SEC through Thomson Reuters and author's calculations.

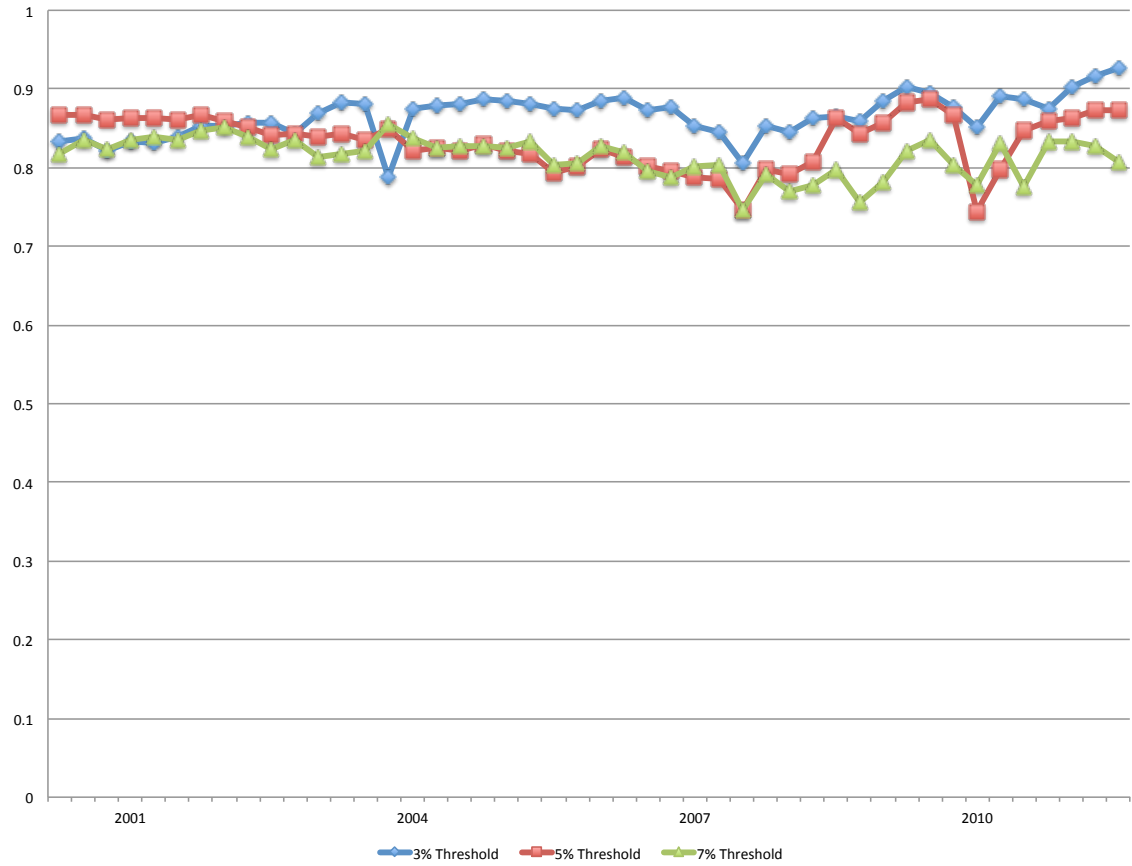


Figure 4.8  
 Fraction of Connections Generated by the Top 5 Institutional Investors

Source: SEC through Thomson Reuters and author's calculations.

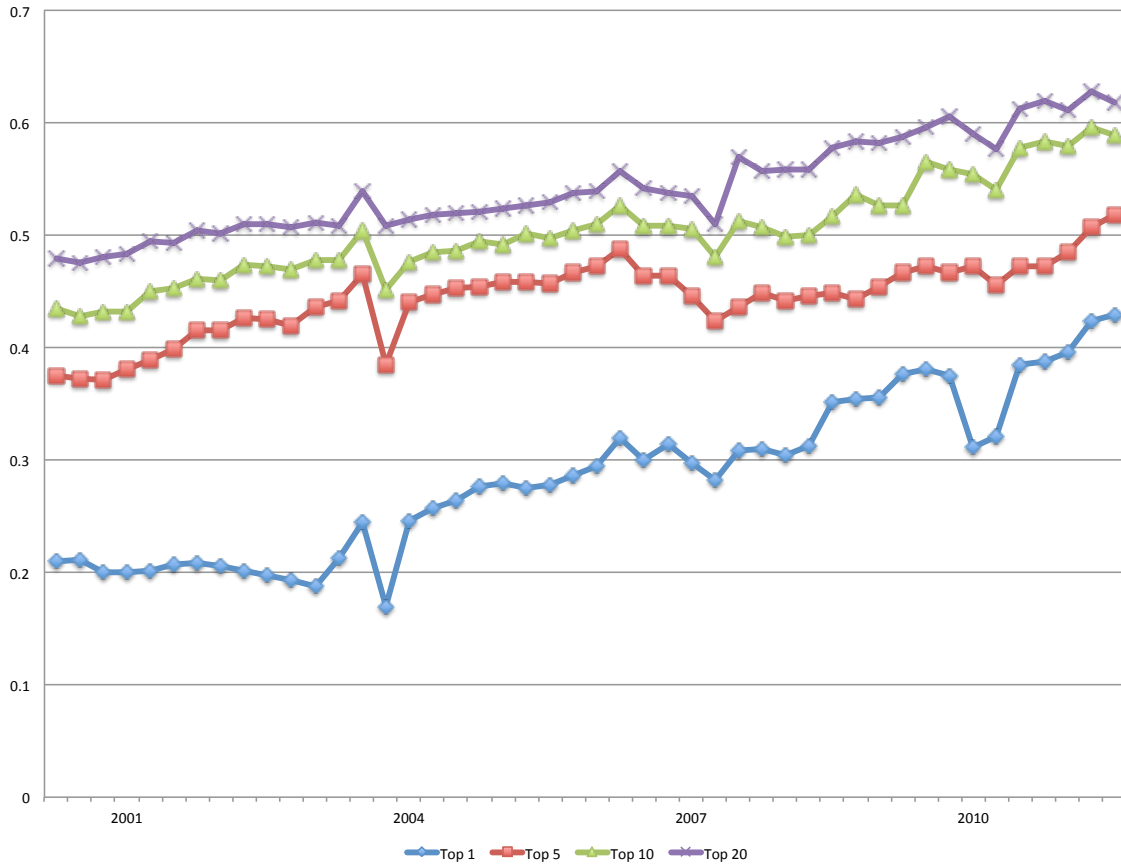


Figure 4.9  
 Fraction of Firms Owned by the Top  $x$  Institutional Investors: 3% Threshold

Source: SEC through Thomson Reuters and author's calculations.

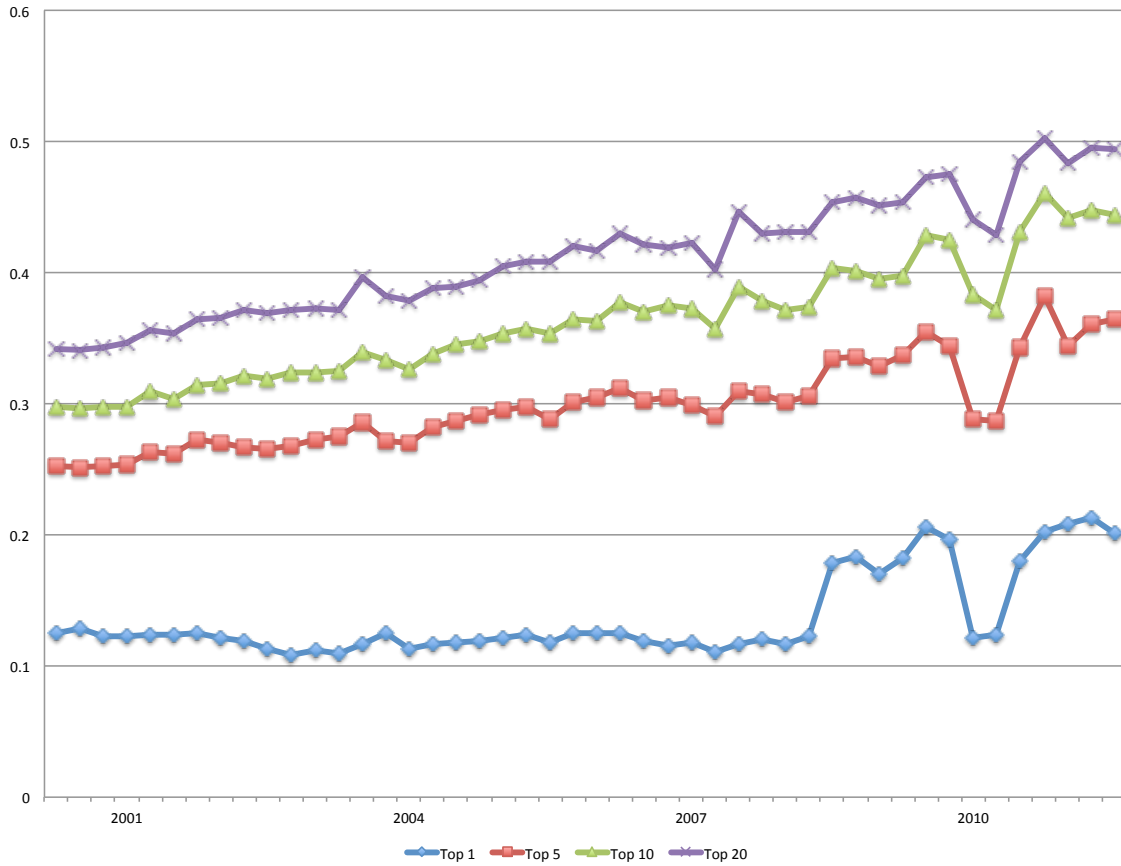


Figure 4.10  
 Fraction of Firms Owned by the Top  $x$  Institutional Investors: 5% Threshold

Source: SEC through Thomson Reuters and author's calculations.

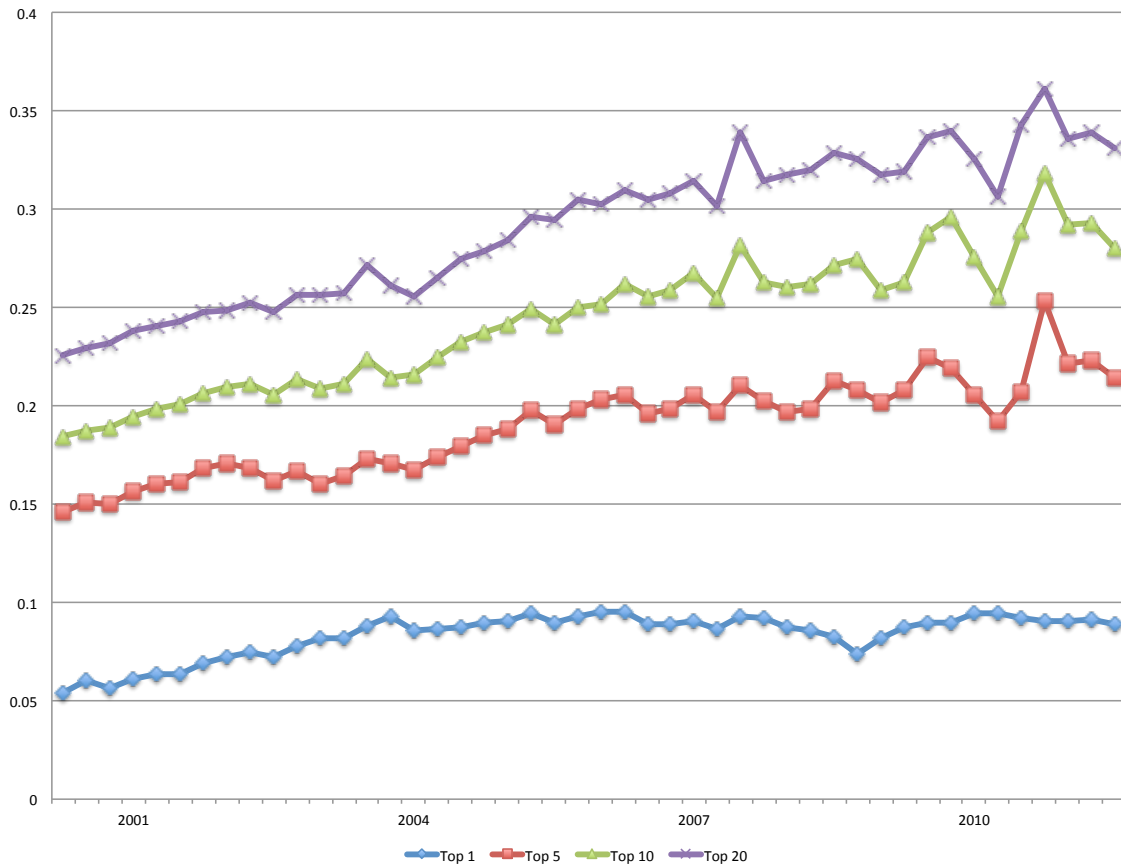


Figure 4.11  
 Fraction of Firms Owned by the Top  $x$  Institutional Investors: 7% Threshold

Source: SEC through Thomson Reuters and author's calculations.



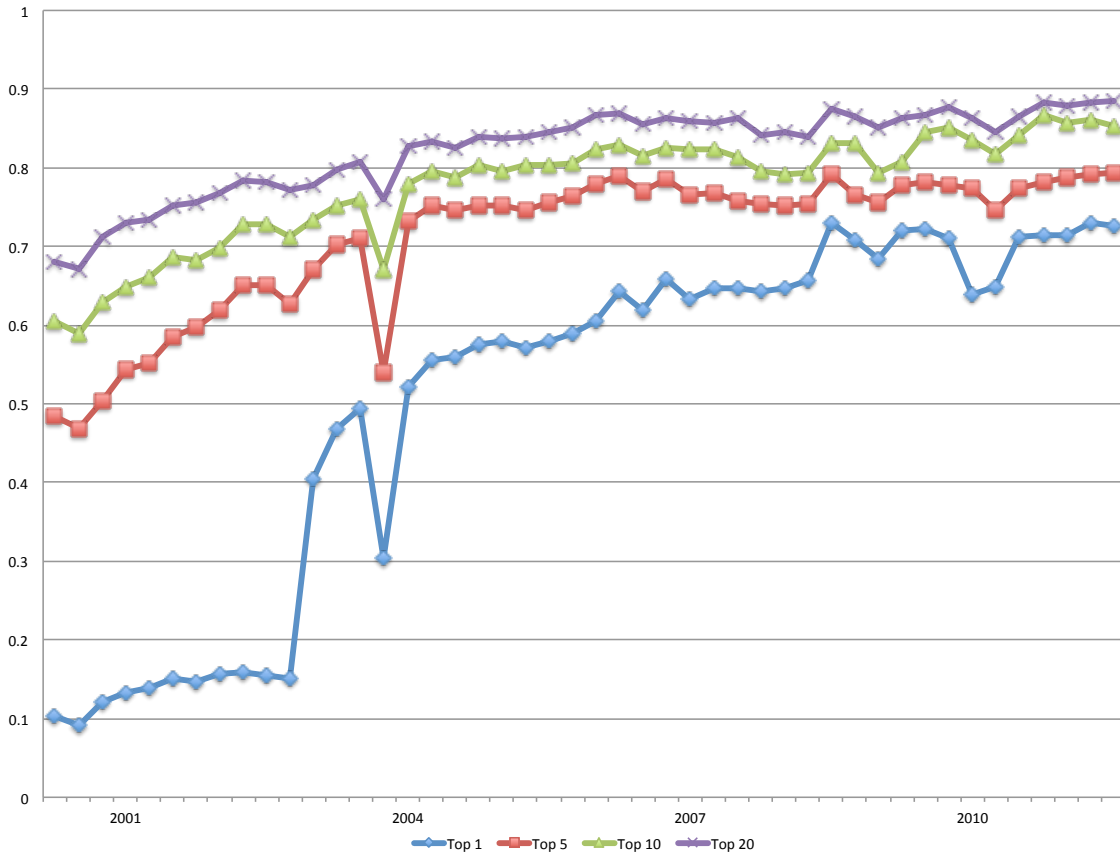


Figure 4.12  
 Fraction of Firms Owned by the Top  $x$  Institutional Investors: 3% Threshold,  
 Largest 3000 Firms

Source: SEC through Thomson Reuters and author's calculations.

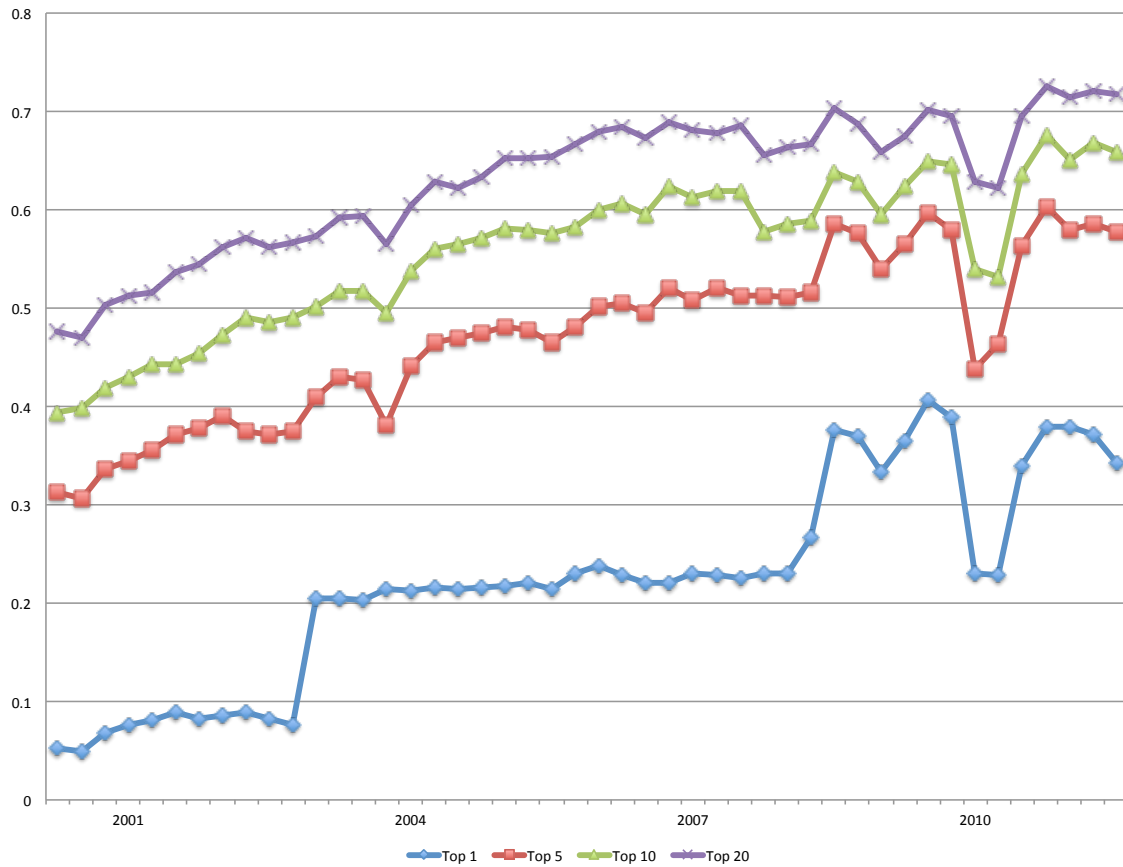


Figure 4.13  
 Fraction of Firms Owned by the Top  $x$  Institutional Investors: 5% Threshold,  
 Largest 3000 Firms

Source: SEC through Thomson Reuters and author's calculations.

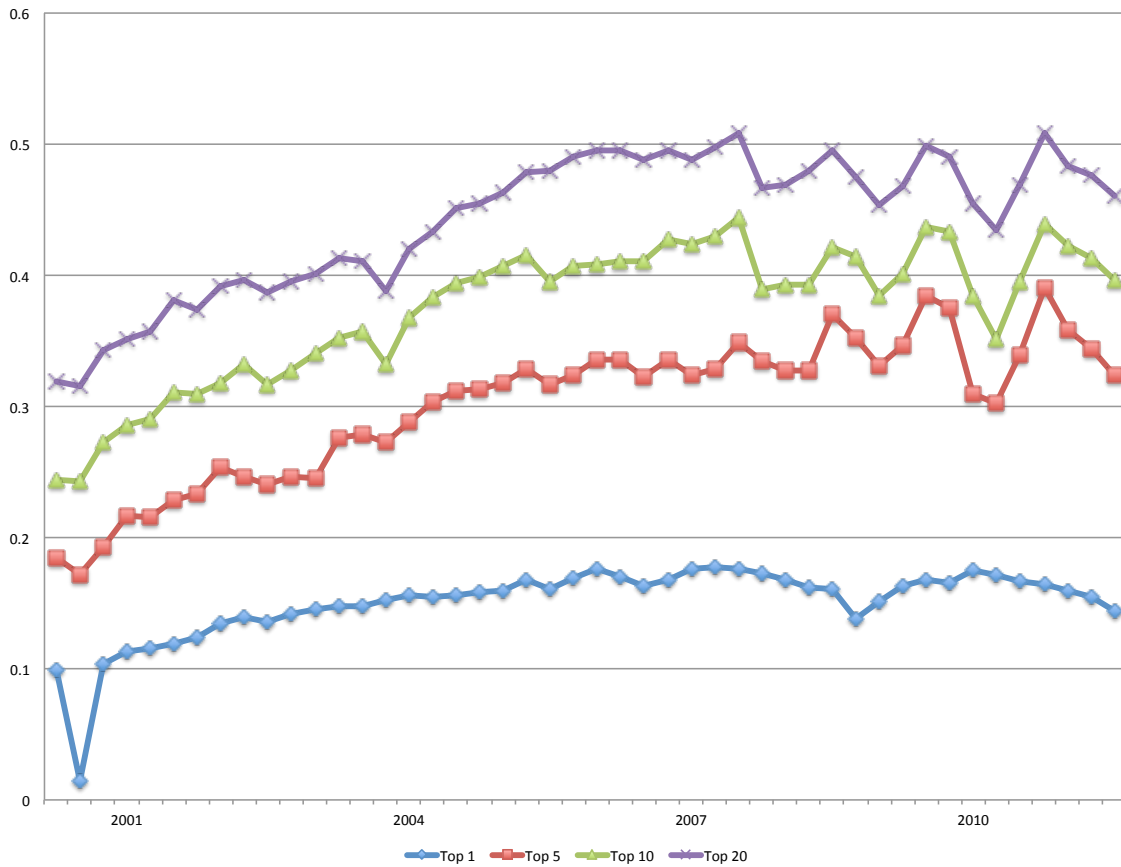


Figure 4.14  
 Fraction of Firms Owned by the Top  $x$  Institutional Investors: 7% Threshold,  
 Largest 3000 Firms

Source: SEC through Thomson Reuters and author's calculations.

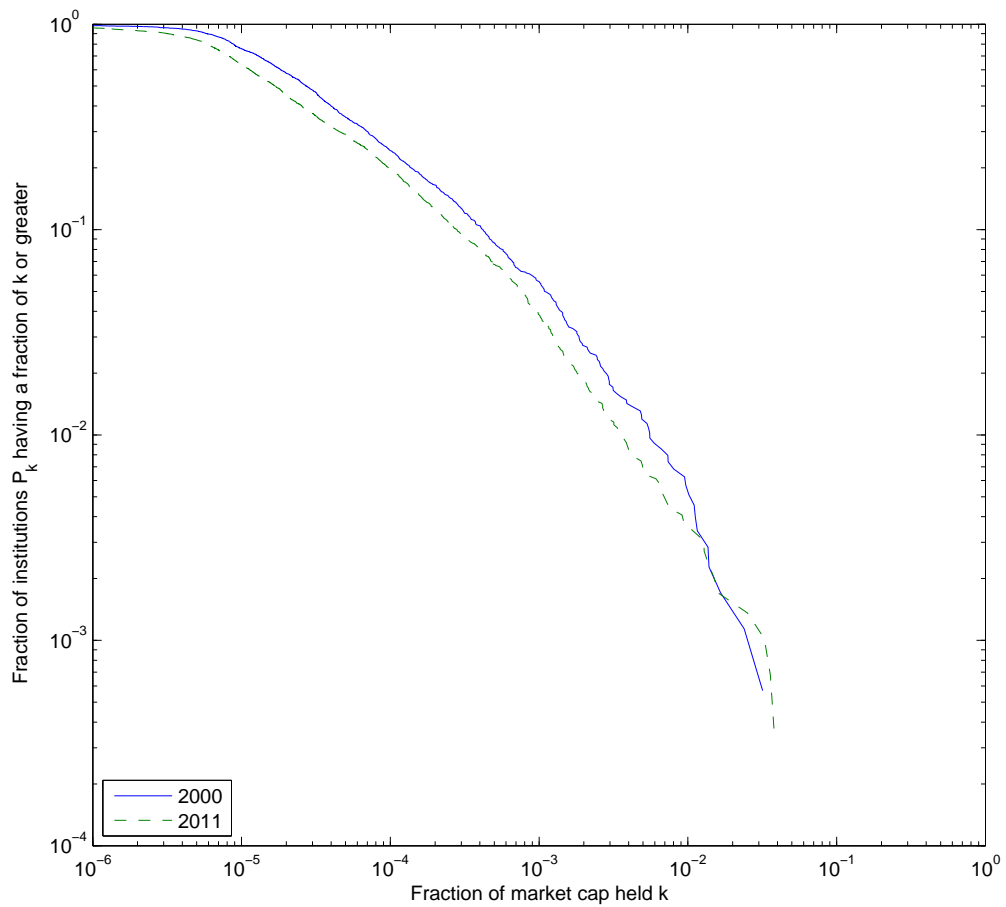


Figure 4.15  
 Cumulative Distribution Function for the Value of the Portfolios of Institutional Investors as a Share of Total Market Capitalization: 2000 and 2011

Source: SEC through Thomson Reuters and author's calculations.

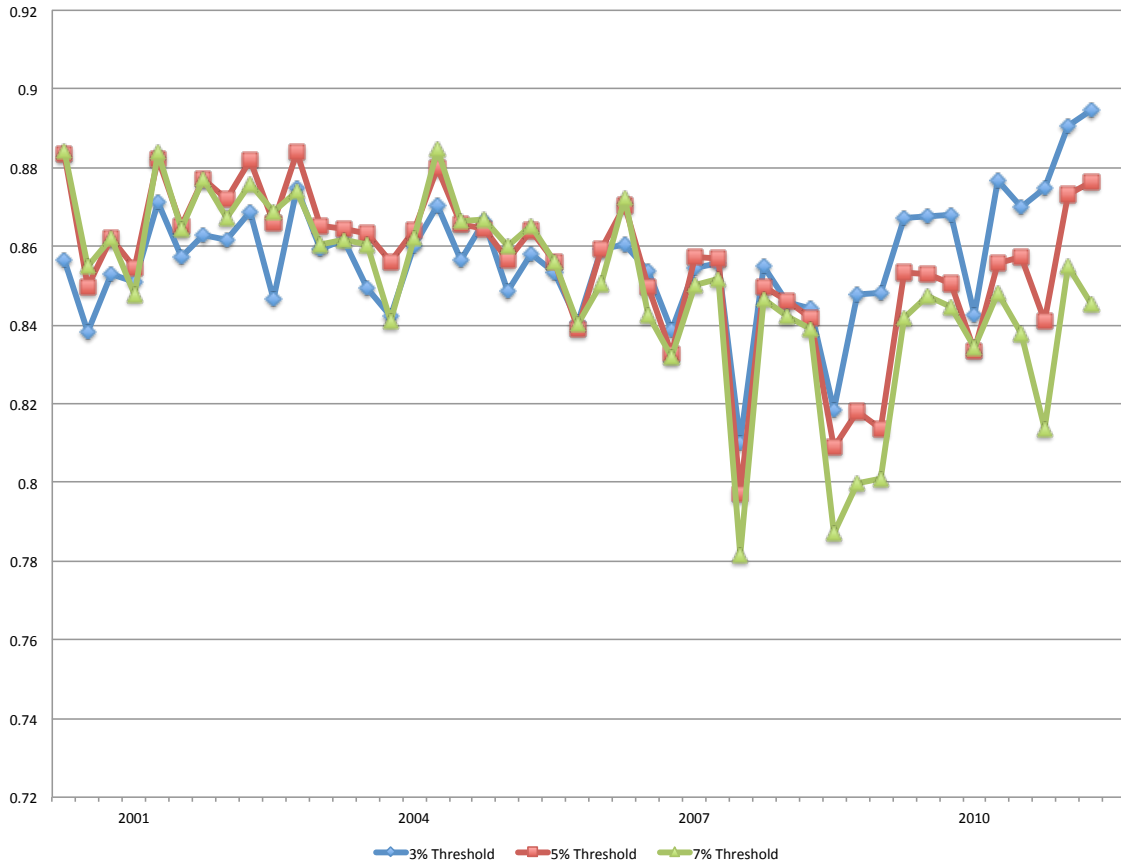


Figure 4.16  
 Fraction of Blockholdings Surviving Until Next Quarter

Source: SEC through Thomson Reuters and author's calculations.

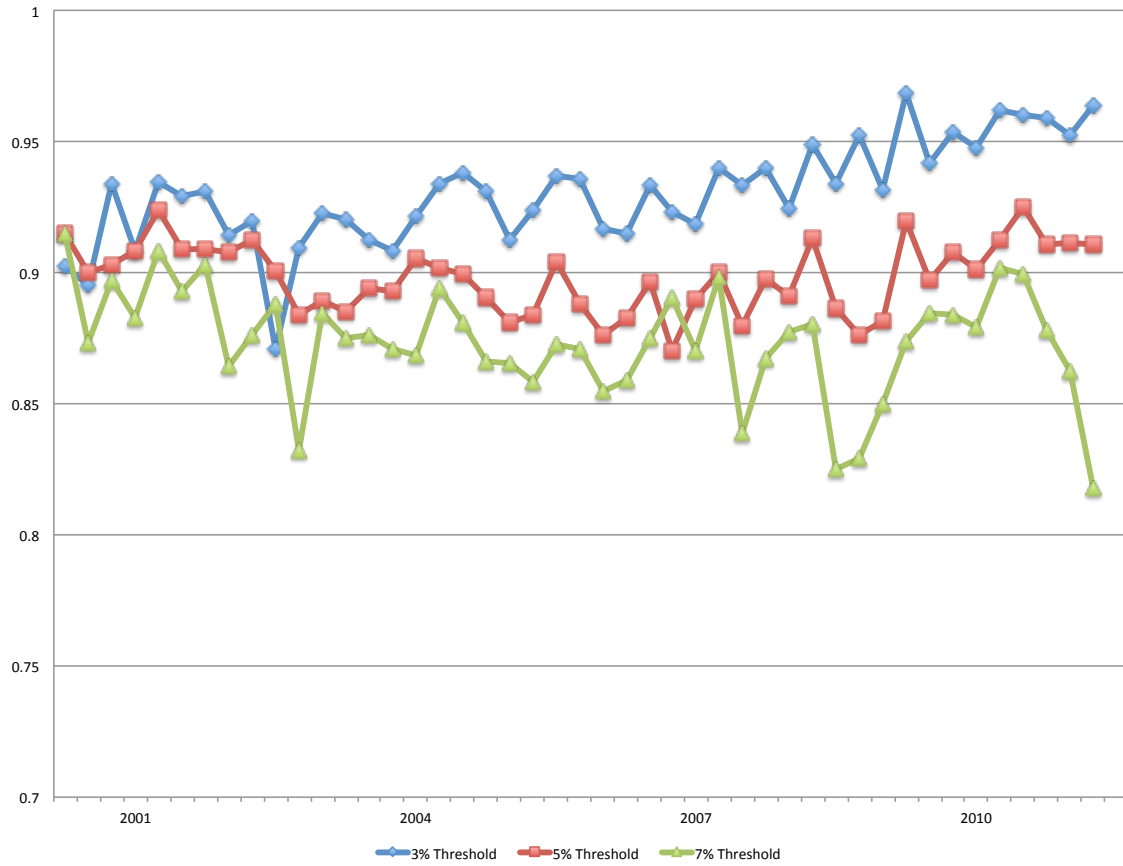
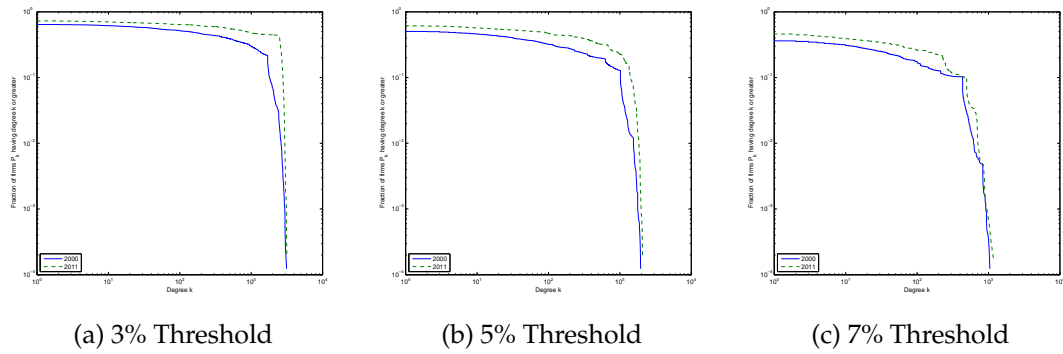


Figure 4.17  
 Fraction of Blockholdings Surviving Until Next Quarter (Top 5 Institutions)

Source: SEC through Thomson Reuters and author's calculations.



(a) 3% Threshold                      (b) 5% Threshold                      (c) 7% Threshold

**Figure 4.18**  
**Cumulative Distribution Functions for the Degrees of the Shareholder Network at  
Different Thresholds: 2000 and 2011**

Source: SEC through Thomson Reuters and author's calculations.

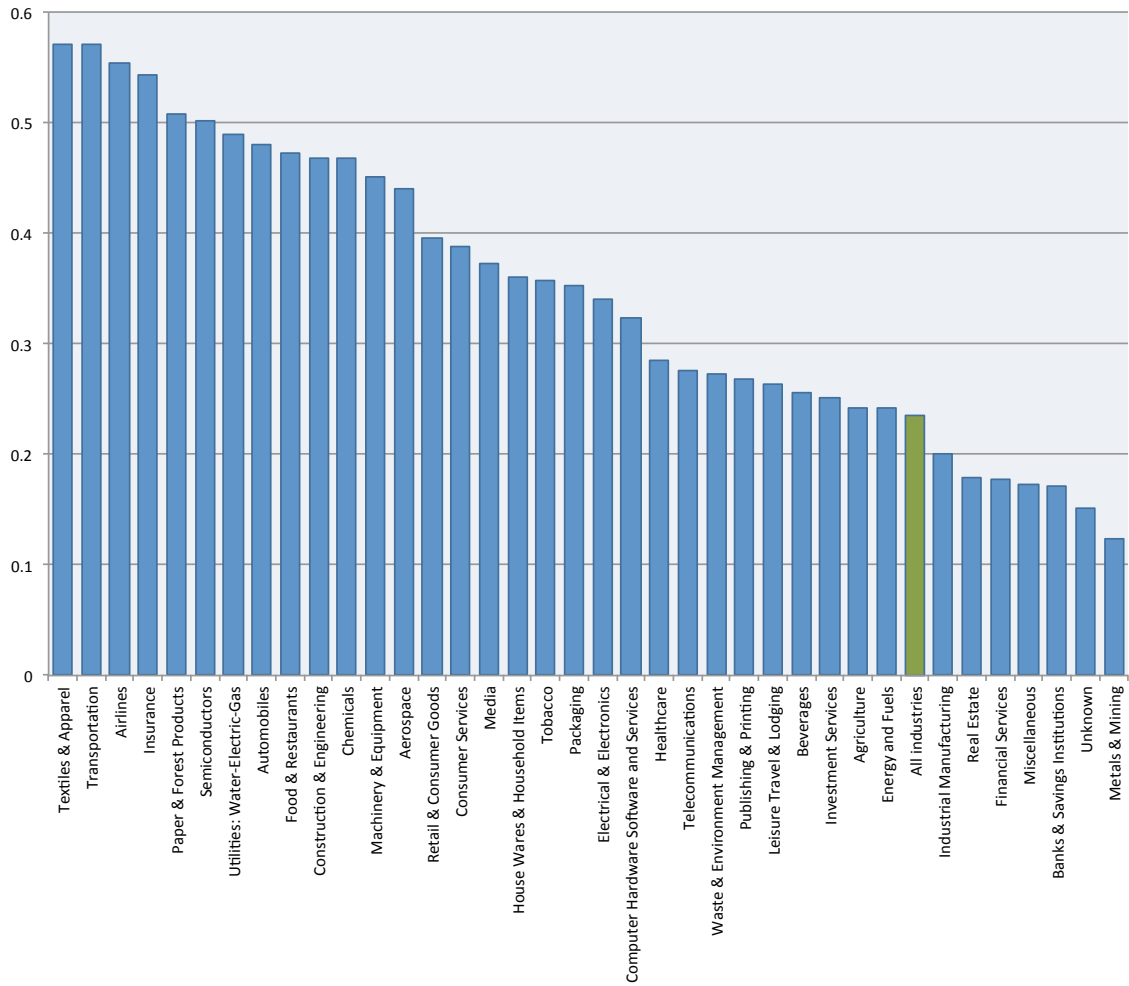


Figure 4.19  
Industry Sub-Network Densities in 2011: 3% Threshold

Source: SEC through Thomson Reuters and author's calculations.



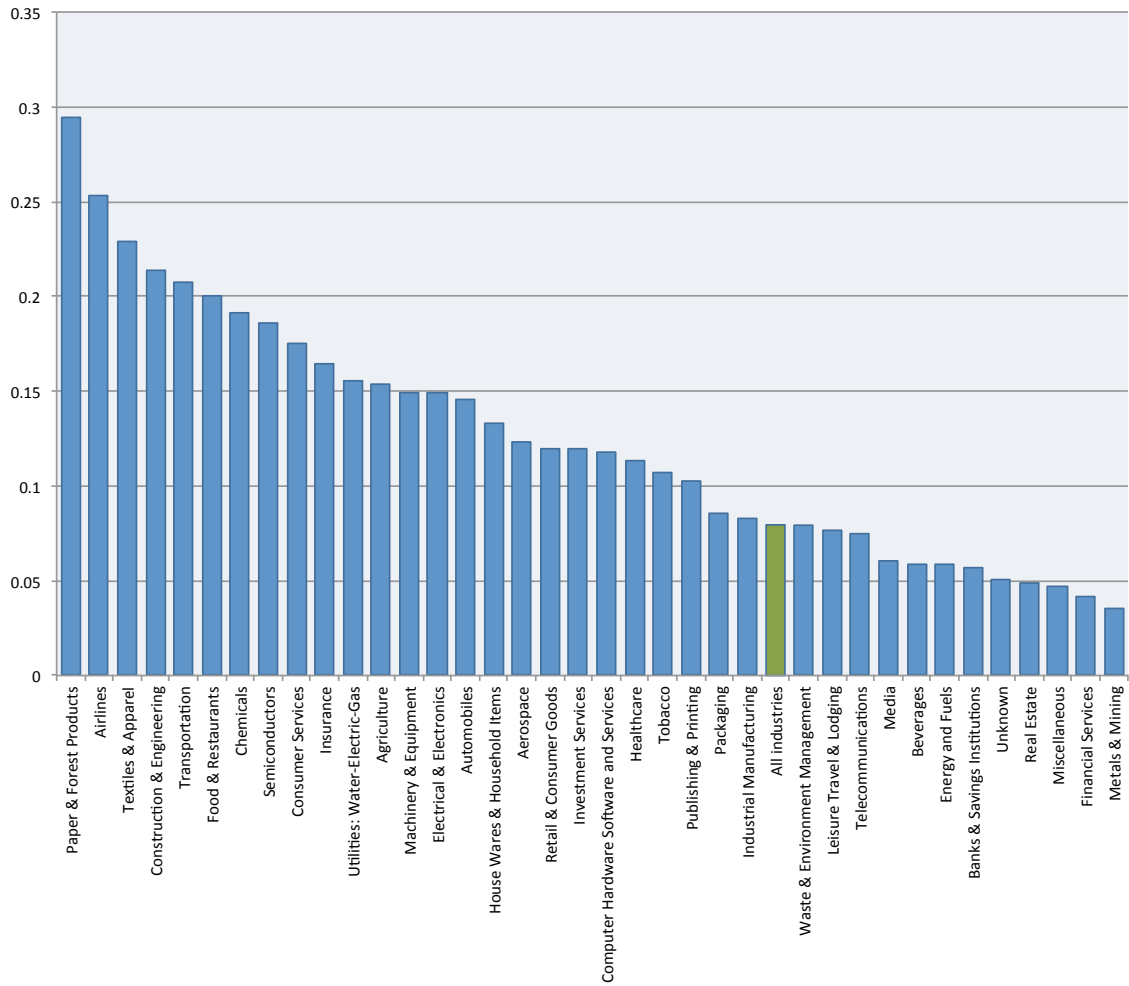


Figure 4.20  
 Industry Sub-Network Densities in 2011: 5% Threshold

Source: SEC through Thomson Reuters and author's calculations.

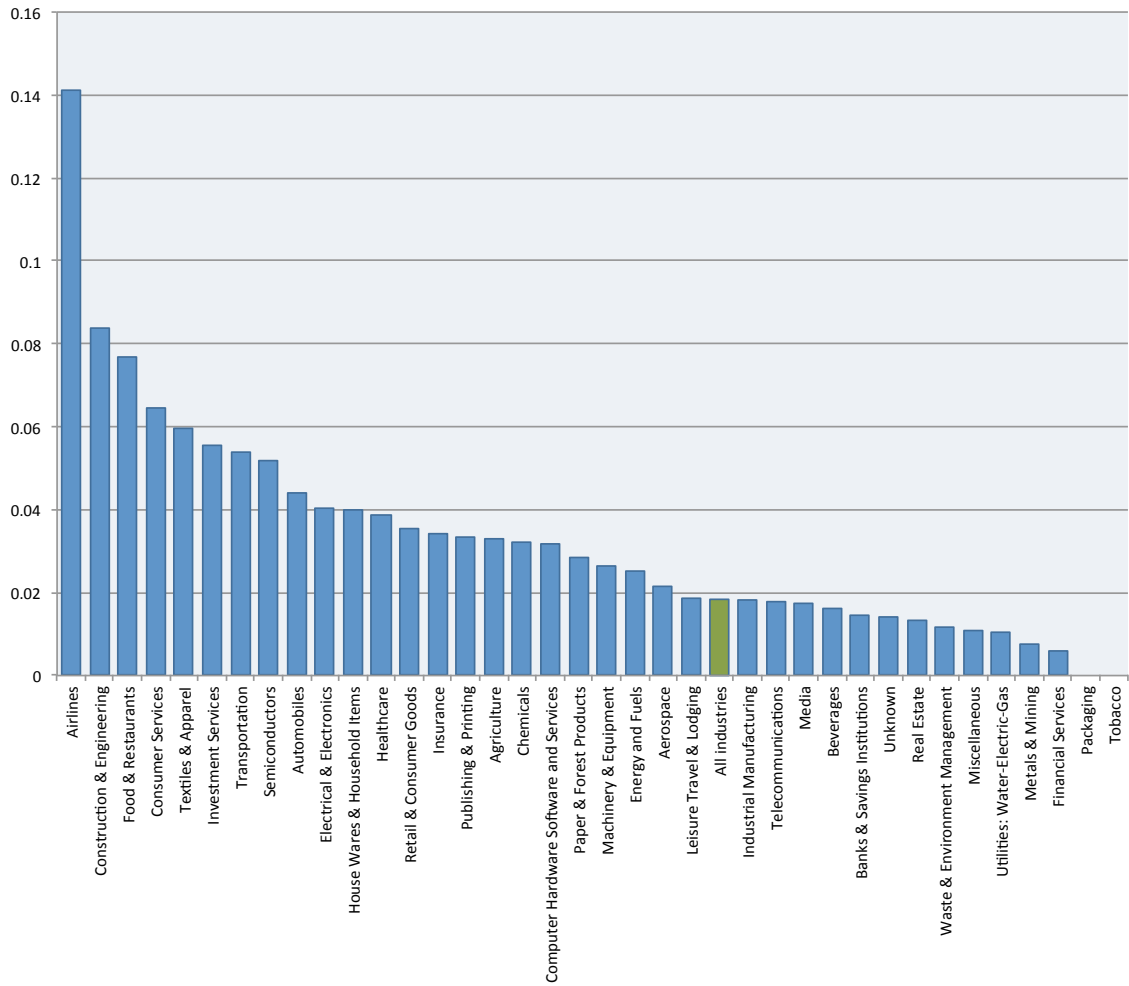


Figure 4.21  
 Industry Sub-Network Densities in 2011: 7% Threshold

Source: SEC through Thomson Reuters and author's calculations.

# Chapter 5

## Common Shareholders and Interlocking Directorships

### 5.1 Introduction

In this chapter, I study the empirical relationship between common ownership and interlocking directorships. I estimate a gravity equation model for the probability that a pair of firms will have a common director, as a function of the geographic distance between the firms, their sizes, and a set of covariates, including measures of common ownership between the firms. The main finding is that, robustly across several measures of common ownership, firm pairs with higher levels of common ownership are more likely to share directors. Also, their distance in the network of directors is smaller on average. Consistent with the “gravity” interpretation, larger firms are more likely to share directors, and firms that are geographically more distant are less likely to share directors.

While past work has studied networks of interlocking directorships, this chapter is the first to study the determinants of interlocks at the firm-pair level using a gravity equation.<sup>1</sup>

The evidence presented in this chapter suggests that institutional investors play an active role in corporate governance. In particular, it supports the hypothesis that institutional shareholders have influence on the board of directors. Other studies have also found evidence that institutional investors play an active role in governance and can influence, among other things, executive pay and turnover.<sup>2</sup> Recent papers have studied the effect of common ownership by institutional investors on merger and acquisition decisions.<sup>3</sup>

## 5.2 Data Description

Data on boards of directors for US firms is available from the Corporate Library. The frequency of the data is yearly, and the data start in 2001 and 2010. The data on institutional ownership and market capitalization, as in Chapter 3, is from Thomson Reuters. To convert the quarterly ownership data to a yearly frequency, I use the observations from the last quarter of each year. Data on zip codes, which are necessary to calculate the geographic distance between firms, and for SIC industry codes, is available from Compustat.

Table 5.1 shows summary statistics for the merged dataset. The number of firms with available data for director interlocks has increased substantially over time. In 2001, only 1,049 firms had data for directors, institutional shareholders,

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<sup>1</sup>For a sample of the literature on interlocking directors in sociology, see Domhoff (1967) and Mizruchi (1996). There has been some recent interest in the finance literature on the relationship between director interlocks and corporate finance decisions, such as the work of Stuart and Yim (2010), Cai and Sevilir (2011), and Cukurova (2011).

<sup>2</sup>See, for example, Agrawal and Mandelker (1990), Kaplan and Minton (1994), Hartzell and Starks (2003), and Kaplan and Minton (2008).

<sup>3</sup>See Matvos and Ostrovsky (2008) and Harford et al. (2011).

market capitalization, industry, and zip codes. For 2010, the number was 2,597. The number of directors represented in the sample increased from 9,907 to 39,991. Thus, the average number of directors per firm has increased. The same is true for blockholdings, which throughout the chapter are defined as holdings above the 5% threshold. The number increased from 1,866 in 2001 to 6,804 in 2010, an increase more than proportional to the increase in the number of firms.

For a pair of firms, a director interlock is generated if there is at least one director that sits on the boards of both firms. The number of director interlocks in the sample increased from 1,999 to 12,939. A shareholder interlock for a pair of firms is generated if there is an institutional shareholder who owns at least 5% in both firms. The number of shareholder interlocks increased from 55,963 to 1,071,738. The large increases in interlocks, both in the directors and shareholder sampled networks, should by themselves not be too surprising, since the number of interlocks is expected to grow more than proportionally as the sample size increases.

Figure 5.1 shows a plot of the network of interlocking directors in 2010. The size of the circle is proportional to the log of market capitalization. The color varies with the number of connections of the firm, with colors closer to blue indicating less connections, and colors closer to red indicating more connections. The layout of the plot is calculated using a Fruchterman-Rheingold algorithm. There is a clear relationship between firm size and number of connections, which should not be surprising given that larger firms tend to have more directors, and therefore more possibilities for interlocks. Thus, large firms tend to be at the center of the network. Unlike the network of interlocking shareholders, whose plot was shown in Chapter 3 (Figure 3.1), there are no salient clusters in the network of interlocking directors.

Figure 5.2 shows the cumulative distribution of degrees for the network of interlocking directors in 2001 and 2010. The degrees in the sample have increased,

but this is not surprising given the increase in the number of firms in the sample. There is no evidence of fat tails in the degree distribution for either period.

### 5.2.1 Weighted Measures of Common Ownership

Defining two firms as having common owners if there is an institutional shareholder having more than  $x$  percent in both has the advantage of conceptual simplicity. However, it leaves out large amounts of useful information. For example, if a shareholder has 20% in two firms, the 5%-threshold measure is the same as if the shareholder only had exactly 5% in each firm, despite the fact that having a shareholder with 20% in two firms clearly represents a higher level of common ownership for that pair of firms. Conversely, if there is a shareholder having 4.99% in both firms—and all the other shareholders have less than 5% in both firms—then the measure will be zero, the same as if the firms had completely separate owners. In this chapter, I will argue in favor of three new measures of common ownership that can take a continuum of values. Thus, each of these measures defines a weighted network of interlocking shareholdings.

#### Maximin

The first new weighted measure of common ownership for a pair of firms  $\{i, j\}$  that I propose to use is the “Maximin”, defined as

$$Maximin_{ij} = \max_{g \in G} \{ \min [s_{gi}, s_{gj}] \},$$

where  $G$  is the set of shareholders of both firms, and  $s_{gi}$  is the percentage of firm  $i$  owned by shareholder  $g$ .

Thus, if a shareholder has 20% of firm  $i$  and 20% of firm  $j$ , and all the other shareholders do not have shares in both firms, the Maximin for that pair is .2. If

instead the common shareholder had 5% in both firms, the Maximin would be .05. If the common shareholder had 4.99%, the Maximin would be .0499. Thus, this measure solves two problems of the common shareholder dummy measure: common ownership not increasing for stakes above 5%, and falling to zero for common stakes just below 5%.

Intuitively, the Maximin is the largest threshold  $x$  for which the common ownership dummy would be equal to one. That is, suppose the maximin is .08. Then a common ownership dummy with a threshold of  $x$  percent would equal one for  $x \leq .08$  and zero for  $x > .08$ .

Thus, the Maximin has several benefits as a measure of common ownership. It is almost as intuitive as the common shareholder dummy. It avoids the arbitrariness of setting a threshold for common ownership. It avoids the discontinuity at the threshold. And, finally, it assigns a higher level of common ownership to firm pairs with shareholders that hold larger blocks of both firms.

### **Sum of Mins**

While an improvement with respect to the common ownership dummy, the Maximin measure of common ownership still has drawbacks. For example, consider a pair of firms  $\{i, j\}$  has one common shareholder with 5% in both firms. Now consider another pair of firms,  $\{k, l\}$ , with four common shareholders, each owning 5% of both firms. The Maximin measure would be .05 for both pairs of firms, even though the total amount of stock that is commonly owned for the second pair is four times higher than for the first pair. The reason is that the Maximin only focuses on the shareholder with the largest block of stock in the pair of firms, while throwing out information from all the other shareholders.

A second new measure of common ownership that includes information on all the common shareholders, is the “Sum of Mins”, defined as

$$\text{Sum of Mins}_{ij} = \sum_{g \in G} \min [s_{gi}, s_{gj}].$$

One way to think about this measure is the following. One can think of a pair of firms  $\{i, j\}$  as having several common ownership links, each generated by a different shareholder. The intensity of the link generated by shareholder  $g$  can be captured by the  $\min [s_{gi}, s_{gj}]$ . The Sum of Mins summarizes all of these links by adding them. For the example above, the Sum of Mins would be .05 for the pair of firms  $\{i, j\}$ , and .2 for the pair of firms  $\{k, l\}$ .

Thus, the Sum of Mins also provides an intuitive weighted measure of common ownership, and addresses a potential problem with the Maximin measure. However, the strength of the Sum of Mins in terms of capturing the links generated by all the shareholders can also be a drawback in some applications, in particular if one would want the measure to penalize for a low concentration of ownership. With the Sum of Mins, the measure is the same if there is one owner having 100% in both firms or 100 owners each having 1% in both firms. The Maximin, on the other hand, imposes a very high penalty for lack of ownership concentration: it ignores all shareholders except the one that generates the connection with the highest weight.

### **Inner Product**

A third measure that imposes a penalty for lower concentration that is lower than the Maximin but higher than the Sum of Mins is the (unnormalized) “Inner Product”:

$$\text{Inner Product}_{ij} = \sum_{g \in G} s_{gi}s_{gj}.$$



Like the Sum of Mins, the inner product sums the weights of the connections generated by all the common shareholders, but in this case the weight is defined by the product of the percentage ownership stakes rather than the minimum. The product yields values that are more than proportionally higher for more concentrated ownership stakes. Thus, the Inner Product measure “rewards” ownership concentration, while the Sum of Mins does not. For example, consider a pair of firms  $\{i, j\}$  such that one shareholder owns 100% of both firms. Both the Sum of Mins and the Inner Product are equal to one. Now consider another pair  $\{k, l\}$  such that two shareholders each have portfolios with 50% of both firms. The Sum of Mins for  $\{k, l\}$  is still equal to one, even though the ownership is less concentrated. The Inner Product, however, equals  $.5^2 + .5^2 = .5$ . If, instead the pair were owned by four shareholders each owning 25% of both firms, the Sum of Mins would still be one, while the Inner Product would be  $4 \times .25^2 = .25$ . Thus, for a pair of firms completely held by the same owners, splitting the ownership stakes in half, which reduces ownership concentration without changing the fact that firms are commonly owned, also halves the Inner Product measure of common ownership, while having no effect on the Sum of Mins.

For example, if a shareholder owns 5 percent of firm  $i$  and 5 percent of firm  $j$ , then the weight of the connection generated by that shareholder is 0.0025. If a shareholder owns 10 percent in both firms, the weight of the connection is .01, which is four times higher. In this sense,

The inner product of a firms with respect to itself is actually the Herfindahl measure for ownership concentration. If one defines the matrix  $S$  containing  $s_{gi}$  in row  $g$  and column  $i$ , then the ownership concentration Herfindahl’s will be the diagonal elements of  $S'S$ , and the common ownership Inner Product measures will be the off-diagonal terms.

## 5.2.2 Firm-Pair Level Variables

Table 5.2 shows summary statistics for the variables at the firm-pair level that will be used in the econometric analysis. There are 21,008,282 firm pair-year observations.

The common director dummy, already described, has a mean of .003427, indicating that .34% of firm pairs (pooling all years together) have a director interlock. The distance in the network of directors is the shortest path between two firms, and is calculated using a Breadth-First Search algorithm. The average distance is slightly above 4. The number of observations for distance is somewhat smaller than the total because for some pairs the observed distance is infinite.

The common ownership variables were described in the previous section. For the purposes of calculating the weighted measures of common ownership I restrict the sample to holdings of at least 1% of outstanding stock. Approximately 22.6% of the pairs in the sample have a common shareholder at the 5% threshold. The average Maximin is 3.9%, the average Sum of Mins is 10.6%, and the average Inner Product is .00572.

To control for the average size of a pair of firms, I use the the logarithm of the product of the market capitalizations, in millions of 2001 dollars. The average of the log of the product of market capitalizations is approximately 13.8. Combining the zip codes with data on latitude and longitude I calculate the geographic distance between two firms using a Haversine algorithm. The average distance of the firms in the sample is 929.18km, with a minimum distance of zero and a maximum distance of 4,727.88km. I also calculate a dummy for whether two firms are in the same industry at the SIC 3-digit level, and a dummy for whether they are both in the S&P500. Approximately 2.16% of the firm pairs are in the same industry, and 4.24% of the pairs are both in the S&P500.

Table 5.3 shows the correlation between the different measures of common ownership. All the measures are highly correlated with each other. The measure that is most highly correlated with the common shareholder dummy is the Maximin, with a correlation coefficient of 73%. The measure that is least correlated with the common shareholder dummy is the Sum of Mins, with a correlation coefficient of 58%. All the correlations between the Maximin, Sum of Mins, and Inner Product are above 80%. The highest correlation is between the Inner Product and the Sum of Mins, with a correlation coefficient of more than 88%. The Inner Product is more highly correlated with the Sum of Mins or the Maximin than the last two are with each other, supporting the idea that the Inner Product is an “intermediate” measure in terms of how much it rewards ownership concentration.

### 5.3 A Gravity Equation for Director and Shareholder Interlocks

In this section, I estimate “gravity” equations for the probability of director interlocks, distance in the directors’ network, and for measures of common ownership, modeling these variables in terms of the product of the sizes of the firms in the pair, their geographic distance, and other covariates. The basic specification for the zero-one variables is

$$P(Y_{ij,t} = 1) = \Lambda(\beta_0 + \beta_1 \text{Log}(\text{MarketCap}_{i,t} \times \text{MarketCap}_{j,t}) + \beta_2 \text{GeographicDistance}_{ij,t} + \gamma X_{ij,t}),$$

where  $Y_{ij,t}$  represents either a dummy for common directors or for common shareholders,  $X_{ij,t}$  is a vector of controls, and  $\Lambda$  is the logistic function. For the continuous variables (i.e. distance in the network, and the weighted measures of common

ownership), the basic specification is

$$Y_{ij,t} = \beta_0 + \beta_1 \text{Log}(\text{MarketCap}_{i,t} \times \text{MarketCap}_{j,t}) + \beta_2 \text{GeographicDistance}_{ij,t} + \gamma X_{ij,t} + \epsilon_{ij,t}.$$

Table 5.4 shows the results of Logit regressions with the common director dummy and common shareholder dummy as dependent variables. Larger firms have a significantly higher probability of having a common director, and a significantly lower probability of having a common institutional shareholder at the 5% threshold. Firms that are geographically more distant have a significantly lower probability of having a common director, and a significantly higher probability of having a common institutional shareholder. Firms that are in the same Industry at the SIC 3-digit level have significantly higher probabilities of both having a common director and a common institutional shareholder. Firms that are both in the S&P500 have a higher probability of interlocking directors. When controlling for the log product of firm sizes using only a linear term, firms that are both in the S&P500 have a lower probability of interlocking shareholders. However, when including a cubic b-spline in the log product of firm sizes, the effect of both firms being in the S&P500 is positive. The b-spline used in all the regressions in this chapter has five knots: at the 10th, 25th, 50th, 75th, and 90th percentiles.

Figure 5.3 shows the estimated probability of interlocking directorships as a function of the log product of market capitalizations, from regression (3) in Table 5.4. The other regressors are fixed at their mean values, and the year is set to 2010. The effect of firm size on the probability of director interlocks is approximately zero for small firms, and is larger for large values of  $\text{Log}(\text{MarketCap}_{i,t} \times \text{MarketCap}_{j,t})$  than for values near the mean.

Figure 5.4 shows the estimated probability of interlocking shareholders at the 5% threshold as a function of the log product of market capitalizations, from regression (4) in Table 5.4. The effect is nonmonotonic: the probability increases as  $\text{Log}(\text{MarketCap}_{i,t} \times \text{MarketCap}_{j,t})$  increases up to approximately 12.5, and decreases for higher values.

Table 5.5 shows the results of linear regressions with the log of network distance and weighted measures of common ownership as dependent variables. Standard errors are clustered at the firm-pair level. Larger pairs of firms are closer in the network of interlocking directors. When using the weighted measures of common ownership, the effect of the log product of firm sizes is positive, however, whereas the effect of size when using the common shareholder dummy was negative. Geographic distance has a positive effect on network distance, and it also increases all measures of common ownership. Being in the same industry at the SIC 3-digit level reduces expected network distance, and increases the expected value for all measures of common ownership. Both firms being in the S&P500 reduces expected network distance, and increases the expected value for all measures of common ownership.

Figure 5.5 shows network distance as a function of  $\text{Log}(\text{MarketCap}_{i,t} \times \text{MarketCap}_{j,t})$ . The other regressors are fixed at their mean values, and the year is set to 2010. To obtain network distance I take the exponential of the predicted value for the log of network distance. Network distance falls monotonically as a function of the product of firm sizes. The fall is somewhat less steep at the lower range of  $\text{Log}(\text{MarketCap}_{i,t} \times \text{MarketCap}_{j,t})$ .

Figure 5.6 shows the expected Maximin as a function of  $\text{Log}(\text{MarketCap}_{i,t} \times \text{MarketCap}_{j,t})$ . The effect of size is non-monotonic. The expected maximin increases up to the log of the product of firm sizes equal to 13.8, which is close to the mean, and then decreases for further increases in the log of the product of firm

sizes. However, the decrease is much less pronounced than in the case of the common shareholder dummy.

Figure 5.7 shows the expected Sum of Mins as a function of  $\text{Log}(\text{MarketCap}_{i,t} \times \text{MarketCap}_{j,t})$ . The effect of size in the case of the Sum of Mins is monotonic. The increase in Sum of Mins is fastest for firm pairs below the mean of log product of sizes. The increase in Sum of Mins becomes very slow, but still positive, for the largest firm pairs.

Figure 5.8 shows the expected Inner Product as a function of  $\text{Log}(\text{MarketCap}_{i,t} \times \text{MarketCap}_{j,t})$ . The effect is non-monotonic. The pattern seems to be an intermediate of the cases of the Maximin and the Sum of Mins, again supporting the idea that the Inner Product is “in between” these measures. The Inner Product increases up to the log of the product of firm sizes equal to 15.6, and then decreases for further increases in the log of the product of firm sizes. The decrease is slower compared to both the case of the common shareholder dummy and the case of the Maximin.

### 5.3.1 Have Director Interlocks Increased?

Has there been an increase in interlocking directorships over the past decade? A naive look at the data would suggest that this is not the case. The solid line in Figure 5.9 shows the raw probability that a randomly selected pair of firms in the sample had an interlocking directorship for each year between 2001 and 2010. This probability has fluctuated over time, but there is no clear trend. However, because the number of firms with data for boards in directors from Compustat has increased over time, and, in particular, smaller firms are more highly represented in later years, it is necessary to control the probabilities for firm size. The dashed line shows the predicted probabilities using the gravity equation for director interlocks, setting the log product of firm sizes, as well as other regressors, equal to their

means. The only variable that varies over time are the year dummies. This shows that for the average pair of firms the probability of a director interlock increased during the period, almost doubling from .13% in 2001 to .23% in 2010. Note that the predicted probability for the average firm pair is smaller than the raw probability at all periods. This is not surprising, since connections are much more likely for very large pairs of firms compared to pairs of average log product of size.

## 5.4 Common Ownership and Interlocking Directorships

Are pairs of firms with higher levels of common ownership more likely to have interlocking directorships? Are they closer together in the network of directors? We can address these questions by introducing measures of common ownership as explanatory variables in the gravity equation for director interlocks and for log network distance.

Table 5.6 shows the results for the gravity equations using the common shareholder dummy as the measure of common ownership. Column (1) shows the result of a Logit model for the probability of interlocking directorships with a common shareholder dummy at the 5% threshold,  $\text{Log}(\text{MarketCap}_{i,t} \times \text{MarketCap}_{j,t})$ , geographic distance, a dummy for the firms in the pair being in the same industry at the SIC 3-digit level, a dummy for both firms being in the S&P500, and year dummies. Having a common institutional shareholder has a positive and highly significant effect on the probability that the firm pair has interlocking directors.

Column (2) shows the results of a similar regression, but adding interaction terms for the common shareholder dummy and the same industry dummy, and for the common shareholder dummy and the S&P500 dummy. The effect of common

ownership is larger for pairs that are in the same industry, and it is smaller for pairs that are in the S&P500.

Column (3) shows the results of a regression similar to that in Column (2), but adding a cubic spline in  $\text{Log}(\text{MarketCap}_{i,t} \times \text{MarketCap}_{j,t})$ . The direction of the results is unchanged, and the magnitude of the effect of common shareholders on director interlocks is similar.

Column (4) shows the results of a Logit regression with firm-pair fixed effects. Geographic distance, the same industry and S&P500 dummies, and the interaction effects are dropped due to lack of within variation. The effect of common shareholders on common directors is positive but not significant at 5% (the p-value is approximately 12%).

Columns (5) to (8) show the results of analogous specification, but for linear regressions with the log of distance in the network of interlocking directors as the dependent variable, instead of a common director dummy. It should be noted that the log of distance for the sampled network is an upwardly biased estimator of the actual distance, since there are potential paths that could be shorter but are not observed because they go through nodes that are outside the sample. The common shareholder dummy has a negative and significant effect at 1% on the distance in the directors' network for all specifications. Being in the same industry makes the effect of common shareholders stronger, while in the S&P500 reverses the sign of the effect.

Table 5.7 shows the results for similar regressions, but using Maximin instead of the common shareholder dummy. The results are similar. However, the positive effect of Maximin on the probability of interlocking directors when using fixed effects is significant at 5% (Column 4). Another difference is that, in the log network distance regressions, being in the same industry weakens the effect of Maximin in Column (6), and is not significant in Column (7).



Table 5.8 shows the results using Sum of Mins as the measure of common ownership. The main results are similar. In this case the positive effect of Sum of Mins on the probability of interlocking directors when using fixed effects is significant at 1% (Column 4). Being in the same industry weakens the effect of common ownership on interlocking directors and on log network distance, as does being in the S&P500.

Table 5.9 shows the results using the Inner Product as the measure of common ownership. The main results, again, are similar. The positive effect of the Inner Product measure of common ownership on the probability of interlocking directors with fixed effects is significant at 5% (Column 4). Being in the same industry makes the effect of common ownership stronger in the common director regressions, and weaker in the log of network distance regressions. Being in the S&P500 weakens the effect both in the common director and in the log of network distance regressions.

Thus, the regression analysis does support the hypothesis that common ownership has an effect on the network on interlocking directors. A plausible explanation is that institutional shareholders have at least some power to influence who will be on the board of the firms in which they hold blocks of stock.

## 5.5 Summary

In this chapter I showed evidence on the relationship between measures of common ownership and interlocking directorships. There is a positive relationship between the level of common ownership for a pair of firms and the probability that the pair has interlocking directors, and a negative relationship between common ownership and distance in the network of directors.

These results are robust across a range of measures of common ownership, including several new weighted measures. The results hold even when controlling for fixed effects. This suggests the presence of a causal relationship, although it does not provide definitive evidence. Thus, the data support the hypothesis that institutional shareholders have an active influence on the board of directors of publicly traded US firms.

Year	Firms	Directors	Blockholdings	Director Interlocks	Shareholder Interlocks
2001	1,049	9,907	1,866	1,999	55,963
2002	1,130	11,098	2,103	2,494	72,629
2003	1,286	13,725	2,256	3,508	87,240
2004	1,507	13,779	3,282	3,295	189,348
2005	1,576	14,407	3,693	3,363	206,140
2006	2,390	30,904	6,210	9,130	535,479
2007	2,557	34,427	7,137	10,785	604,136
2008	2,605	36,996	7,084	11,625	907,527
2009	2,733	40,161	6,681	12,858	1,025,909
2010	2,597	39,991	6,804	12,939	1,071,738

Table 5.1  
Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
<i>Directors Network Variables</i>					
Common Director Dummy	21,008,282	.003427	.0584404	0	1
Distance in the Network	16,244,541	4.096688	1.140737	1	14
<i>Common Ownership Variables</i>					
Common Shareholder Dummy	21,008,282	.2263921	.4184958	0	1
Maximin	21,008,282	.0390907	.0207413	0	.7607495
Sum of Mins	21,008,282	.1061435	.0622078	0	.7607495
Inner Product	21,008,282	.0057231	.0047606	0	.704425
<i>Control Variables</i>					
$\text{Log}(\text{MarketCap}_i \times \text{MarketCap}_j)$	21,008,282	13.79712	2.455084	-1.491559	25.6797
Geographic Distance (km)	21,008,282	929.1822	635.7565	0	4727.881
Same Industry Dummy (SIC3)	21,008,282	.0216108	.1454089	0	1
Both in S&P500 Dummy	21,008,282	.0424458	.201604	0	1

Table 5.2  
Summary Statistics for Variables at the Firm-Pair Level

	Common Shareholder Dummy	Maximin	Sum of Mins	Inner Product
Common Shareholder Dummy	1.0000			
Maximin	0.7366	1.0000		
Sum of Mins	0.5795	0.8056	1.0000	
Inner Product	0.6486	0.8654	0.8821	1.0000

Table 5.3  
Correlation Matrix for Common Ownership Variables

	Common Dir. (1)	Common Sh. (2)	Common Dir. (3)	Common Sh. (4)
$\text{Log}(\text{MarketCap}_i \times \text{MarketCap}_j)$	0.230*** (0.00397)	-0.0457*** (0.000335)		
Geographic Distance	-0.000978*** (2.05e-05)	3.07e-05*** (1.26e-06)	-0.000982*** (2.04e-05)	3.57e-05*** (1.26e-06)
Same Industry	1.346*** (0.0303)	0.221*** (0.00541)	1.330*** (0.0307)	0.245*** (0.00536)
Both in S&P500	1.079*** (0.0250)	-0.0497*** (0.00479)	1.026*** (0.0280)	0.472*** (0.00516)
Constant	-8.349*** (0.0605)	-0.168*** (0.00491)	-8.371*** (1.702)	0.880*** (0.195)
Cubic Spline in $\text{Log}(\text{MarketCap}_i \times \text{MarketCap}_j)$	No	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	21,003,082	21,003,082	21,003,082	21,003,082

Robust standard errors in parentheses

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

Table 5.4  
Gravity Equations for Common Directors and Common Shareholders (Logit)

	Log Network Distance (1)	Maximin (2)	Sum of Mins (3)	Inner Product (4)	Log Network Distance (5)	Maximin (6)	Sum of Mins (7)	Inner Product (8)
$\text{Log}(\text{MarketCap}_i \times \text{MarketCap}_j)$	-0.0438*** (5.54e-05)	0.000678*** (3.31e-06)	0.00637*** (1.03e-05)	0.000279*** (7.84e-07)				
Geographic Distance	3.28e-05*** (1.96e-07)	3.54e-07*** (1.18e-08)	3.66e-07*** (3.69e-08)	4.88e-08*** (2.85e-09)	3.32e-05*** (1.95e-07)	4.09e-07*** (1.16e-08)	5.23e-07*** (3.64e-08)	6.15e-08*** (2.82e-09)
Same Industry	-0.0399*** (0.00106)	0.00224*** (5.79e-05)	0.00829*** (0.000202)	0.000623*** (1.64e-05)	-0.0381*** (0.00105)	0.00249*** (5.66e-05)	0.00898*** (0.000199)	0.000676*** (1.61e-05)
Both in S&P500	-0.137*** (0.000755)	0.00112*** (3.16e-05)	0.0276*** (0.000108)	0.000897*** (9.23e-06)	-0.113*** (0.000800)	0.00601*** (3.35e-05)	0.0416*** (0.000116)	0.00203*** (9.89e-06)
Constant	2.123*** (0.000914)	0.0205*** (5.53e-05)	-0.0233*** (0.000163)	-0.000863*** (1.25e-05)	2.074*** (0.0217)	0.0189*** (0.00165)	0.0387*** (0.00338)	0.00124*** (0.000251)
Cubic Spline in $\text{Log}(\text{MarketCap}_i \times \text{MarketCap}_j)$	No	No	No	No	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	16,239,841	21,003,082	21,003,082	21,003,082	16,239,841	21,003,082	21,003,082	21,003,082
R-squared	0.224	0.044	0.129	0.064	0.228	0.059	0.142	0.075

Robust standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 5.5  
Gravity Equations for Log Network Distance and for Weighted Measures of Common Ownership

	(1)	Common Director			Log of Distance in the Network of Directors			
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
Common Shareholder	0.216*** (0.0132)	0.224*** (0.0149)	0.232*** (0.0148)	0.0648 (0.0409)	-0.00467*** (0.000209)	-0.00500*** (0.000211)	-0.00938*** (0.000211)	-0.00182*** (0.000155)
$\text{Log}(\text{MarketCap}_i \times \text{MarketCap}_j)$	0.235*** (0.00400)	0.235*** (0.00401)			-0.0438*** (5.53e-05)	-0.0438*** (5.53e-05)		
Geographic Distance	-0.000980*** (2.04e-05)	-0.000979*** (2.04e-05)	-0.000983*** (2.04e-05)		3.28e-05*** (1.96e-07)	3.28e-05*** (1.96e-07)	3.32e-05*** (1.95e-07)	
Same Industry	1.333*** (0.0303)	1.216*** (0.0342)	1.193*** (0.0348)		-0.0396*** (0.00106)	-0.0384*** (0.00113)	-0.0359*** (0.00113)	
Both in S&P500	1.071*** (0.0251)	1.110*** (0.0259)	1.042*** (0.0289)	0.472*** (0.110)	-0.137*** (0.000755)	-0.139*** (0.000784)	-0.115*** (0.000826)	-0.00184** (0.000804)
Common Sh. $\times$ Same Industry		0.361*** (0.0461)	0.380*** (0.0465)			-0.00426** (0.00184)	-0.00610*** (0.00183)	
Common Sh. $\times$ Both in S&P500		-0.216*** (0.0357)	-0.163*** (0.0354)			0.0106*** (0.00127)	0.00954*** (0.00126)	
Constant	-8.488*** (0.0612)	-8.490*** (0.0613)	-8.553*** (1.720)		2.124*** (0.000912)	2.124*** (0.000912)	2.077*** (0.0217)	1.211*** (0.0156)
Cubic Spline in $\text{Log}(\text{MarketCap}_i \times \text{MarketCap}_j)$	No	No	Yes	Yes	No	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Pair FE	No	No	No	Yes	No	No	No	Yes
Observations	21,003,082	21,003,082	21,003,082	68,436	16,239,841	16,239,841	16,239,841	16,239,841
R-squared				0.224	0.224	0.224	0.228	0.840

Robust standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 5.6

Gravity Equations for Director Interlocks and Log Network Distance with Common Shareholder Dummy



	Common Director			Log of Distance in the Network of Directors				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Maximin	7.506*** (0.329)	7.694*** (0.356)	8.047*** (0.348)	2.075** (0.947)	-0.298*** (0.00487)	-0.311*** (0.00485)	-0.430*** (0.00485)	-0.0537*** (0.00411)
$\text{Log}(\text{MarketCap}_i \times \text{MarketCap}_j)$	0.233*** (0.00405)	0.232*** (0.00405)			-0.0436*** (5.56e-05)	-0.0436*** (5.56e-05)		
Geographic Distance	-0.000981*** (2.04e-05)	-0.000980*** (2.04e-05)	-0.000984*** (2.03e-05)		3.29e-05*** (1.96e-07)	3.29e-05*** (1.96e-07)	3.33e-05*** (1.95e-07)	
Same Industry	1.320*** (0.0303)	1.153*** (0.0534)	1.123*** (0.0532)		-0.0391*** (0.00106)	-0.0435*** (0.00190)	-0.0391*** (0.00187)	
Both in S&P500	1.053*** (0.0251)	1.252*** (0.0584)	1.122*** (0.0601)	0.470*** (0.110)	-0.137*** (0.000755)	-0.153*** (0.00180)	-0.126*** (0.00181)	-0.00177*** (0.000804)
Maximin $\times$ Same Industry		3.546*** (0.941)	3.789*** (0.927)			0.105*** (0.0401)	0.0513 (0.0394)	
Maximin $\times$ Both in S&P500		-4.611*** (1.237)	-3.284*** (1.213)			0.388*** (0.0397)	0.366*** (0.0393)	
Constant	-8.723*** (0.0634)	-8.723*** (0.0635)	-8.581*** (1.726)		2.130*** (0.000913)	2.131*** (0.000914)	2.077*** (0.0218)	1.211*** (0.0156)
Cubic Spline in $\text{Log}(\text{MarketCap}_i \times \text{MarketCap}_j)$	No	No	Yes	Yes	No	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Pair FE	No	No	No	Yes	No	No	No	Yes
Observations	21,003,082	21,003,082	21,003,082	68,436	16,239,841	16,239,841	16,239,841	16,239,841
R-squared					0.224	0.224	0.229	0.840

Robust standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 5.7  
Gravity Equations for Director Interlocks and Log Network Distance with Maximin

	Common Director			Log of Distance in the Network of Directors				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sum of Mins	3.234*** (0.117)	3.683*** (0.128)	3.947*** (0.128)	1.474*** (0.396)	-0.154*** (0.00178)	-0.164*** (0.00178)	-0.205*** (0.00179)	-0.0331*** (0.00170)
$\text{Log}(\text{MarketCap}_i \times \text{MarketCap}_j)$	0.218*** (0.00413)	0.218*** (0.00413)			-0.0428*** (5.70e-05)	-0.0428*** (5.70e-05)		
Geographic Distance	-0.000981*** (2.04e-05)	-0.000980*** (2.04e-05)	-0.000984*** (2.03e-05)		3.28e-05*** (1.96e-07)	3.28e-05*** (1.96e-07)	3.32e-05*** (1.95e-07)	
Same Industry	1.297*** (0.0304)	1.512*** (0.0543)	1.487*** (0.0538)		-0.0383*** (0.00106)	-0.0614*** (0.00177)	-0.0575*** (0.00175)	
Both in S&P500	0.967*** (0.0255)	1.214*** (0.0520)	1.169*** (0.0545)	0.449*** (0.110)	-0.133*** (0.000755)	-0.153*** (0.00179)	-0.135*** (0.00180)	-0.00128 (0.000803)
Sum of Mins $\times$ Same Industry		-1.495*** (0.346)	-1.468*** (0.343)			0.192*** (0.0131)	0.179*** (0.0131)	
Sum of Mins $\times$ Both in S&P500		-1.597*** (0.286)	-1.869*** (0.293)			0.131*** (0.0108)	0.194*** (0.0107)	
Constant	-8.598*** (0.0621)	-8.658*** (0.0624)	-8.769*** (1.735)		2.122*** (0.000915)	2.123*** (0.000917)	2.080*** (0.0217)	1.212*** (0.0156)
Cubic Spline in $\text{Log}(\text{MarketCap}_i \times \text{MarketCap}_j)$	No	No	Yes	Yes	No	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Pair FE	No	No	No	Yes	No	No	No	Yes
Observations	21,003,082	21,003,082	21,003,082	68,436	16,239,841	16,239,841	16,239,841	16,239,841
R-squared					0.225	0.225	0.229	0.840

Robust standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 5.8  
Gravity Equations for Director Interlocks and Log Network Distance with Sum of Mins

	(1)	Common Director		Log of Distance in the Network of Directors				
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
Inner Product	31.83*** (1.117)	33.48*** (1.207)	34.71*** (1.192)	10.74** (4.371)	-1.815*** (0.0232)	-1.888*** (0.0230)	-2.319*** (0.0225)	-0.176*** (0.0192)
$\text{Log}(\text{MarketCap}_i \times \text{MarketCap}_j)$	0.229*** (0.00406)	0.228*** (0.00406)			-0.0433*** (5.60e-05)	-0.0433*** (5.60e-05)		
Geographic Distance	-0.000980*** (2.04e-05)	-0.000980*** (2.04e-05)	-0.000984*** (2.03e-05)		3.28e-05*** (1.96e-07)	3.28e-05*** (1.96e-07)	3.33e-05*** (1.95e-07)	
Same Industry	1.312*** (0.0303)	1.276*** (0.0395)	1.249*** (0.0396)		-0.0384*** (0.00106)	-0.0439*** (0.00145)	-0.0411*** (0.00136)	
Both in S&P500	1.033*** (0.0251)	1.147*** (0.0395)	1.032*** (0.0405)	0.467*** (0.110)	-0.136*** (0.000754)	-0.144*** (0.00147)	-0.117*** (0.00147)	-0.00168** (0.000804)
Inner Product $\times$ Same Industry		4.237 (3.290)	5.210 (3.248)			0.805*** (0.164)	0.733*** (0.149)	
Inner Product $\times$ Both in S&P500		-14.48*** (3.839)	-9.718*** (3.497)			1.192*** (0.173)	1.141*** (0.167)	
Constant	-8.563*** (0.0620)	-8.565*** (0.0619)	-8.582*** (1.723)		2.123*** (0.000914)	2.124*** (0.000916)	2.074*** (0.0217)	1.211*** (0.0156)
Cubic Spline in $\text{Log}(\text{MarketCap}_i \times \text{MarketCap}_j)$	No	No	Yes	Yes	No	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Pair FE	No	No	Yes	Yes	No	No	No	Yes
Observations	21,003,082	21,003,082	21,003,082	68,436	16,239,841	16,239,841	16,239,841	16,239,841
R-squared					0.224	0.224	0.229	0.840

Robust standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 5.9  
Gravity Equations for Director Interlocks and Log Network Distance with Inner Product

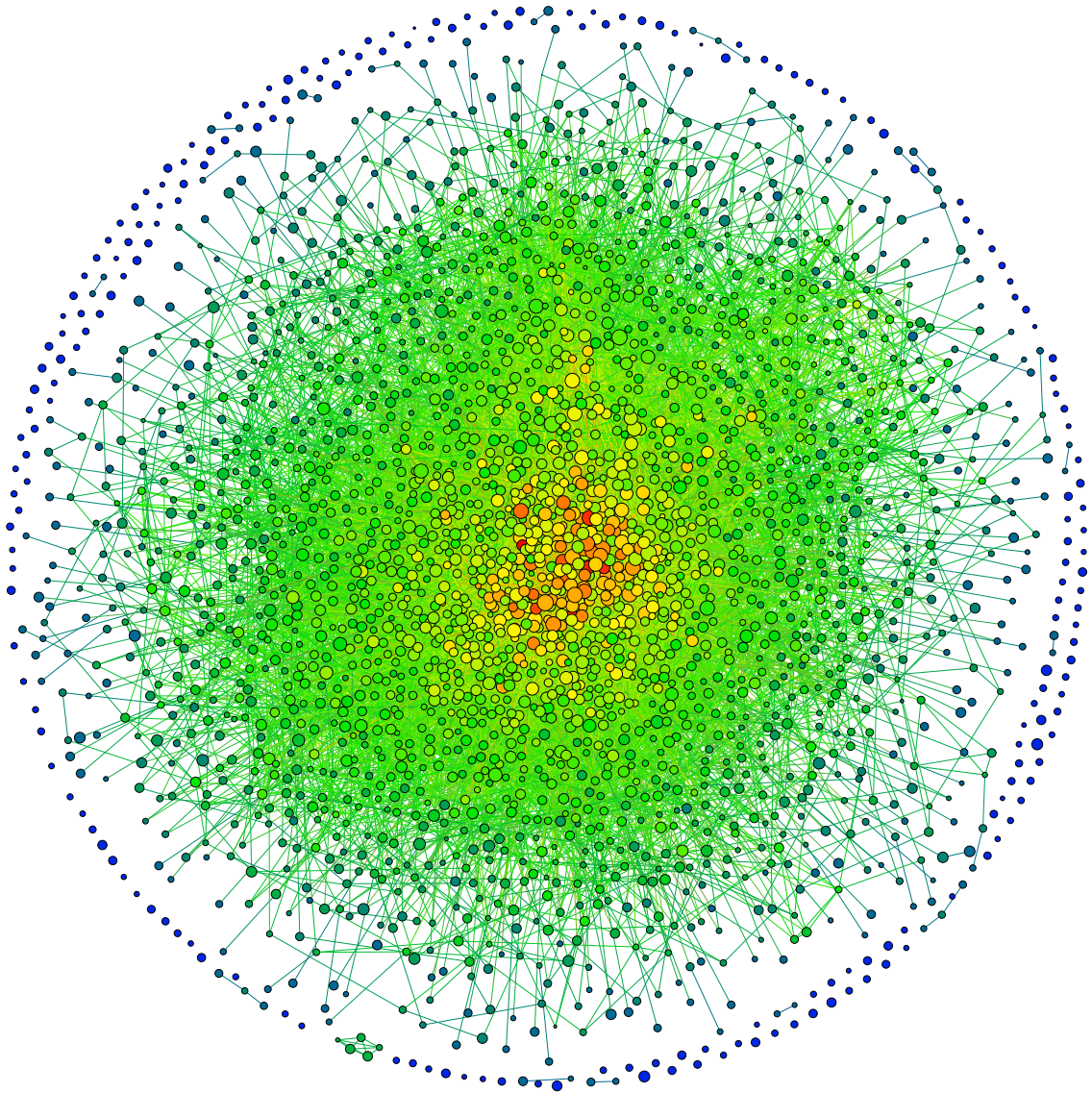


Figure 5.1  
Network of Interlocking Directorships for US Firms: 2010

Source: Corporate Library, Thomson Reuters, and author's calculations.

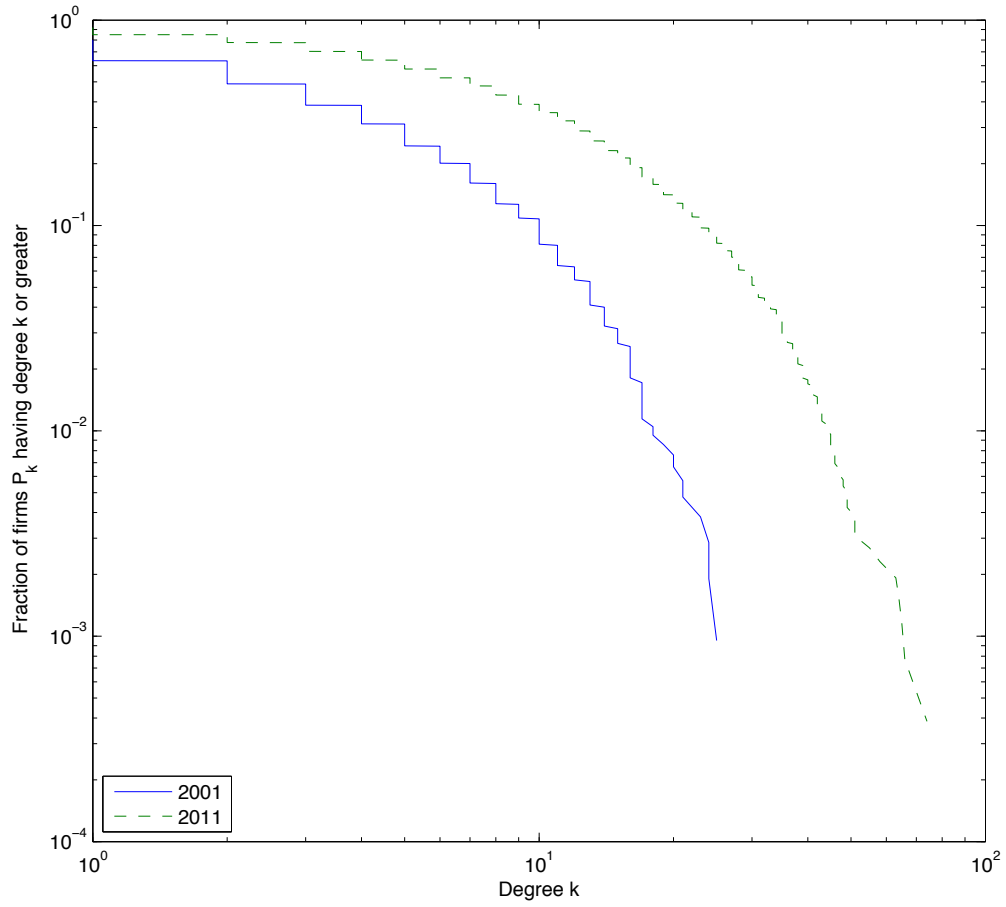


Figure 5.2  
Degree Distribution for the Network of Interlocking Directors: 2001 and 2010

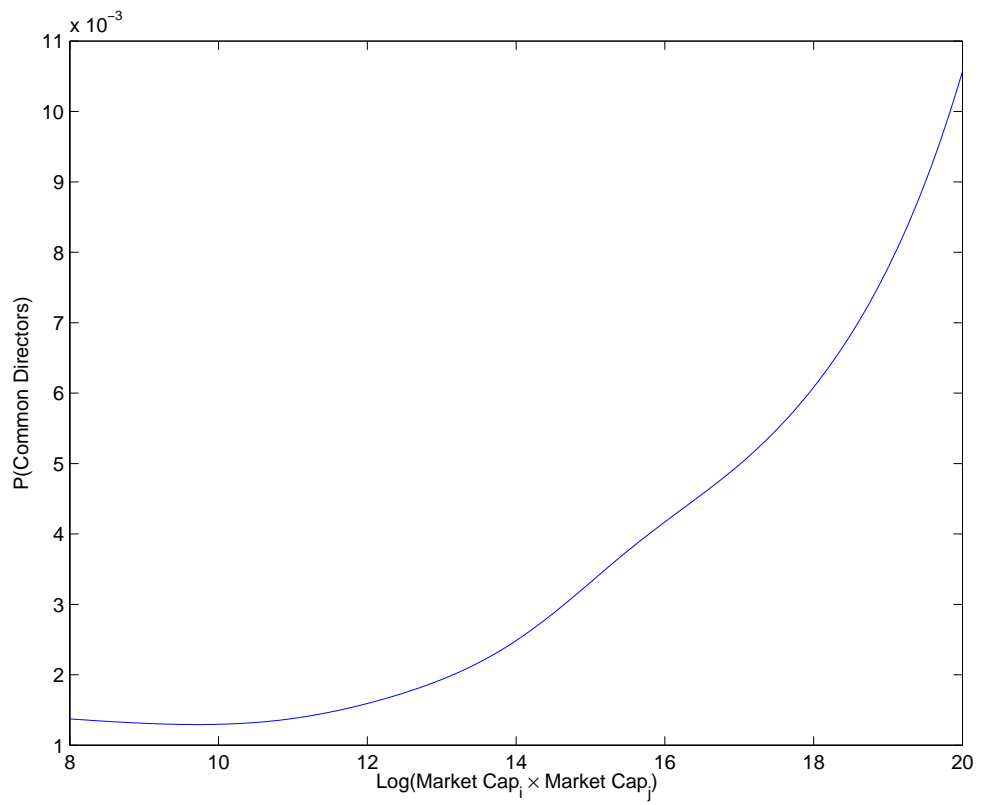


Figure 5.3  
Cubic Spline Polynomial for the Probability of Common Directors as a Function  
of the Log of the Product of Firm Sizes

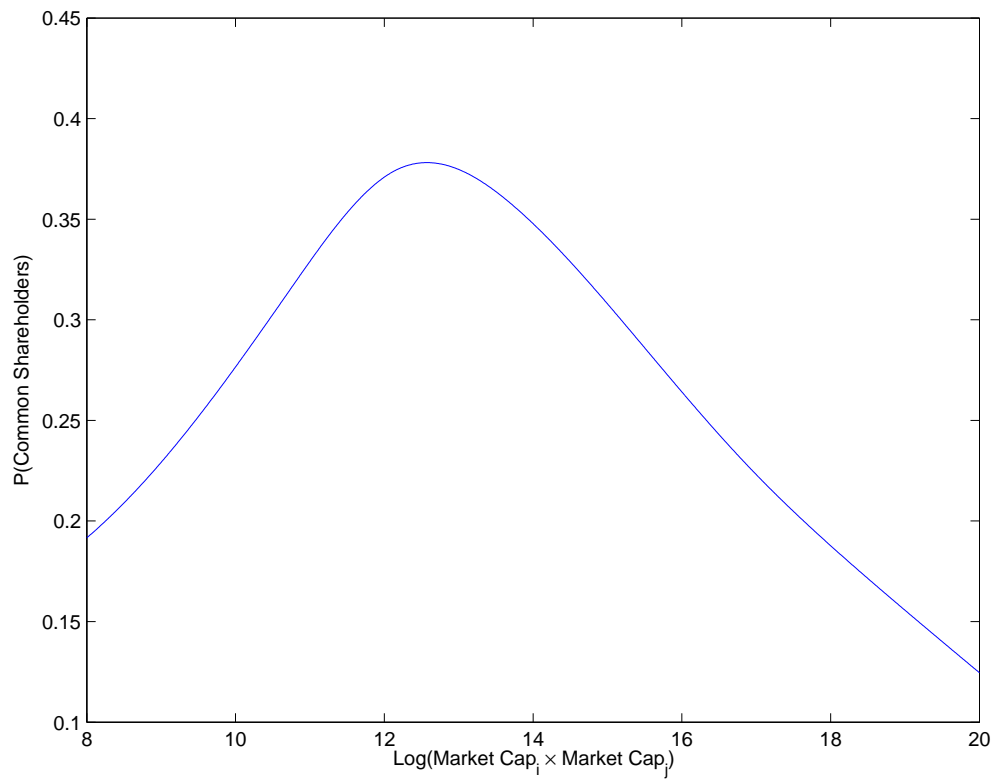


Figure 5.4  
Cubic Spline Polynomial for the Probability of Common Shareholders as a  
Function of the Log of the Product of Firm Sizes

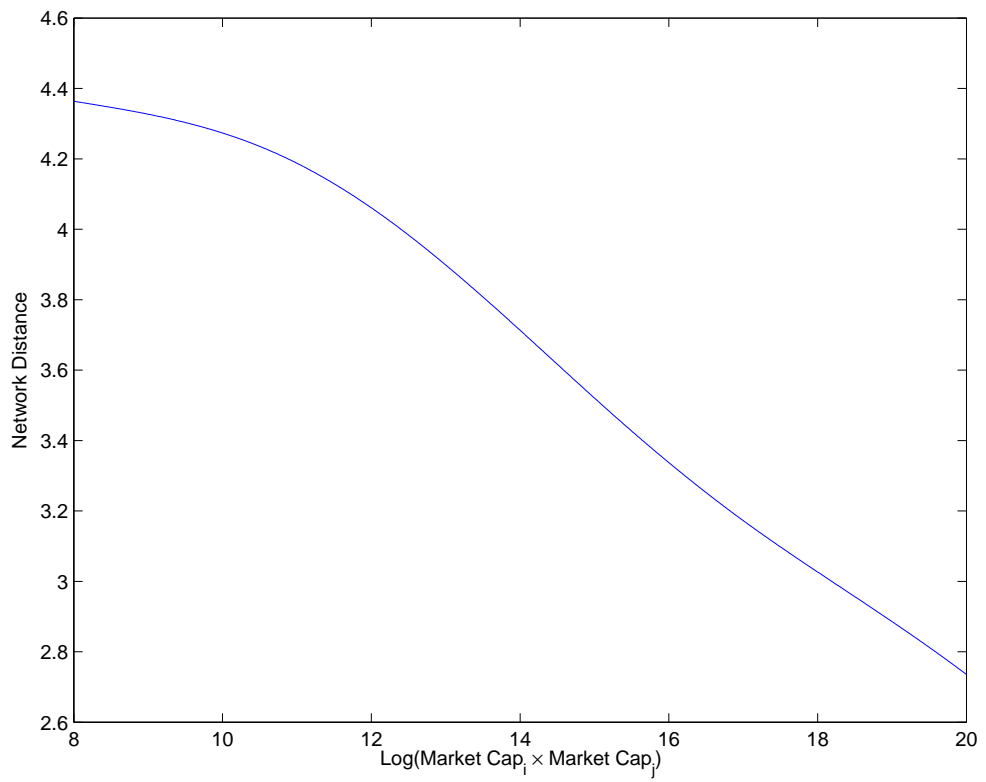


Figure 5.5  
Cubic Spline Polynomial for Network Distance as a Function of the Log of the  
Product of Firm Sizes



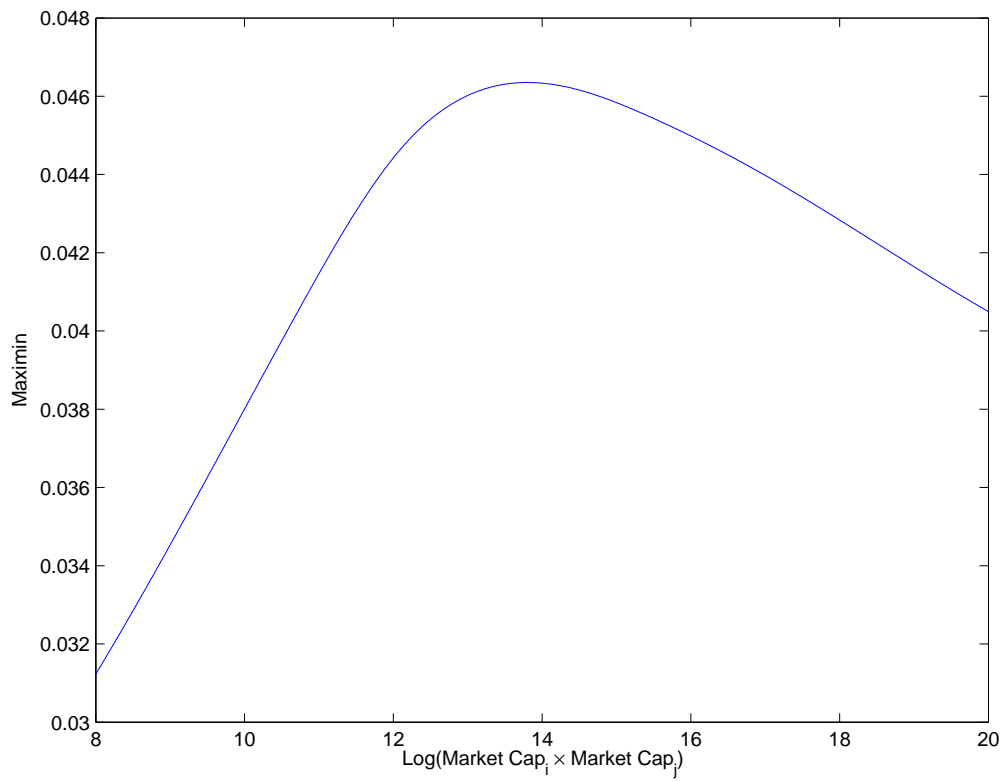


Figure 5.6  
Cubic Spline Polynomial for Maximin as a Function of the Log of the Product of  
Firm Sizes

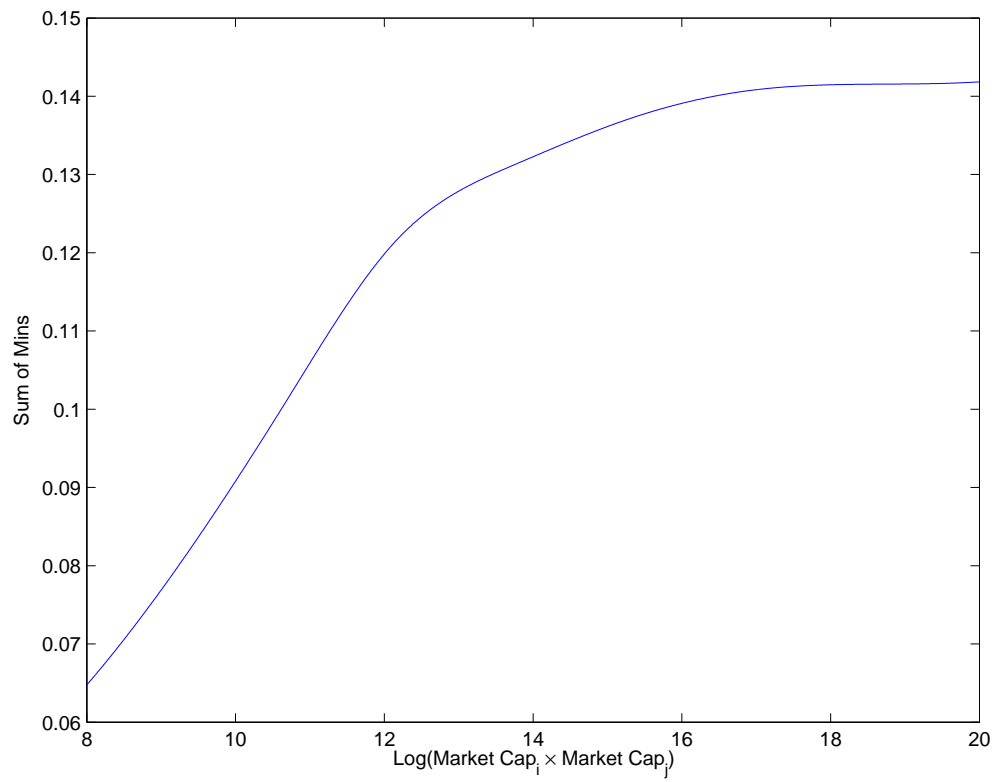


Figure 5.7  
Cubic Spline Polynomial for the Sum of Mins as a Function of the Log of the  
Product of Firm Sizes

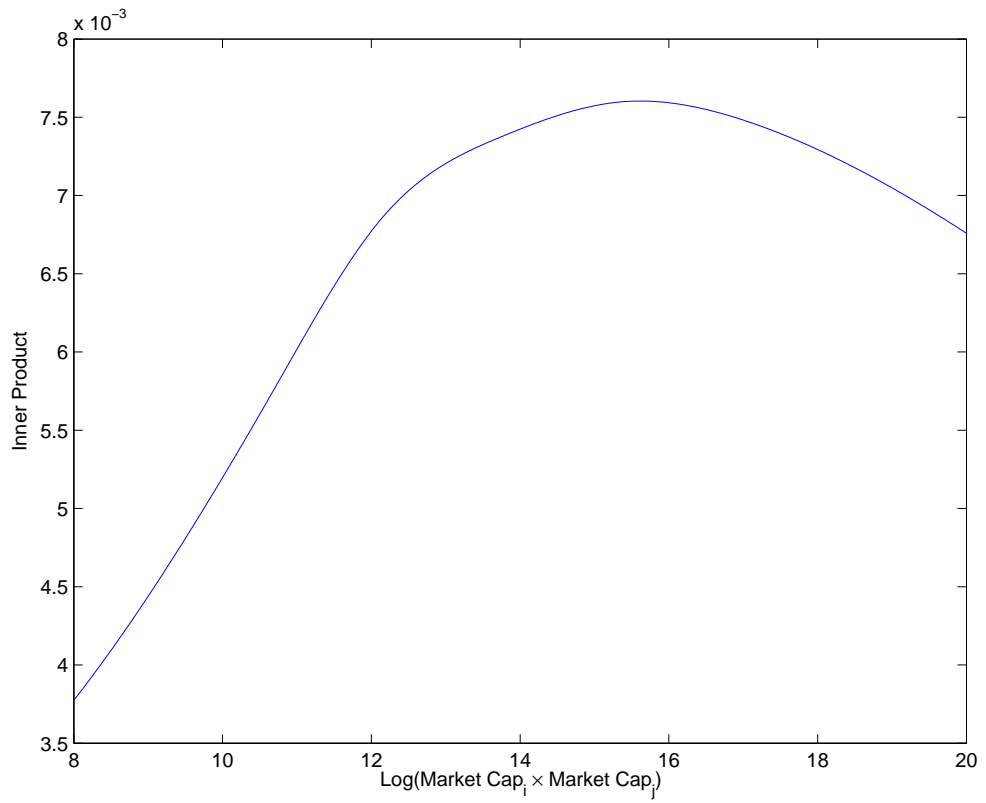


Figure 5.8  
Cubic Spline Polynomial for the Inner Product as a Function of the Log of the Product of Firm Sizes

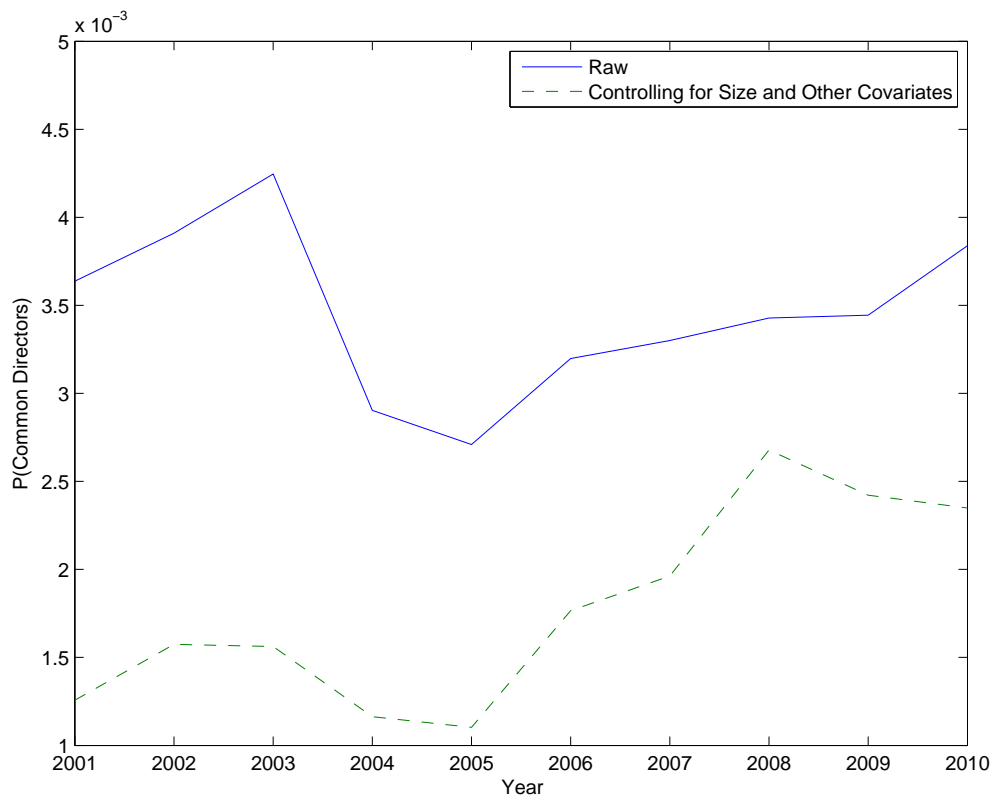


Figure 5.9  
Evolution of the Probability of Director Interlocks

# Chapter 6

## Shareholder Networks and Market Power

### 6.1 Introduction

In this chapter, I study empirically the relationship between common ownership and market power. I start by showing the evolution of markups for a sample of US and Canadian firms over time. Second, I document a positive correlation between a company's markup and the fraction of firms in its industry with which it has common shareholders. To study the relationship in more depth, I show the results of structure-conduct-performance (SCP) regressions at the industry level, with average markups as the dependent variable and measures of common ownership, plus controls, as explanatory variables. The main result is that the industry-level density of shareholder networks is positively associated with average industry markups. I then study the joint dynamics of markups and common ownership measures using a Panel Vector Autoregression. The analysis shows that industry-level density of shareholder networks is a significant predictor of average

markups. Average markups, on the other hand, do not have predictive power for industry-level density.

The structure-conduct-performance literature attempted, for several decades and with limited success, to find a relationship between concentration measures and measures of market power. For a classic survey, see Schmalensee (1989), which highlights the problems of the endogeneity of market structure, and significant issues related to the measurement of markups. The empirical literature on common ownership and market power is scarce. An interesting contribution is the work of Parker and Röller (1997). They study the effect of cross-ownership and multimarket contact in the mobile telephone industry. In the early 1980s in the United States, the Federal Communications Commission created local duopolies in which two firms were allowed to operate in strictly defined product and geographic markets. Since before the market structure was monopolistic, this provides an interesting opportunity to study the effect of changes in market structure on prices. They find that both cross-ownership and multimarket contact led to collusive behavior.

## **6.2 Data**

I use two datasets: Compustat fundamentals quarterly North America for accounting data on American and Canadian firms, and Thomson Reuters institutional holdings for ownership data. I focus on the period 2000Q2-2010Q4. There are 180,355 firm-quarter observations that have data on both accounting and institutional ownership, with a total of 7277 firms. I drop from the sample industries that have only one firm in the data. After this, the sample has 179,201 firm-quarter observations. Then, I drop observations with earnings before taxes higher than revenues, observations with negative markups (the calculation of markups is ex-

plained in detail in the next paragraph), and observations with zero revenues. Thus, I end up with a sample size of 172,247 firm-quarter observations. The average number of firms in the sample per quarter is 4,006, with a minimum of 3,648 firms and a maximum of 4,267. There are 249 industries at the 3-digit SIC level represented in the sample. Because of the presence of extreme outliers, I winsorize the markup at the 1st and 99th percentiles.

The first step in the empirical analysis is to construct the adjacency matrix for a network of firms linked by the common ownership generated by institutional investors. I consider two firms as being connected in the shareholder network if there is at least one shareholder owning at least 5 percent in each firm. Once we have constructed this matrix, we can then calculate the degree of each firm at each point in time, that is, the number of connections with other firms in the network. We can also calculate the density of the network. The formula for the density of a network, given its adjacency matrix  $Y$ , is

$$Density = \frac{\sum_{i=1}^n \sum_{j<i} y_{ij}}{n(n-1)/2},$$

where  $n$  is the number of nodes in the network and  $y_{ij}$  is equal to 1 if firm  $i$  and firm  $j$  are connected, and zero otherwise (by convention, a firm is not considered to be connected to itself, and thus the adjacency matrix has zeros in its diagonal).

In addition to a firm's overall degree, we will find it useful to consider its within-industry degree, that is, the number of connections that it has with other firms in the same industry. Because the number of firms in the sample varies across time, we will normalize both the overall degree and the within-industry degree by dividing them by the number of other firms in the sample, and the number of other firms in the sample that are in the same industry, respectively. These normalized

measures represent the percentage of possible connections, rather than the raw number of connections.

We will also find it useful to consider, in addition to the density of the overall network, the density of the subnetwork for each industry. To do this, we take the firms in only one industry and consider the network formed by those firms and their connections.

Figure 4.1 shows a plot of the network for a random sample of 400 companies in 2010Q4, representing roughly 10% of the companies in the network. There are several clusters generated by a few institutional investors which have ownership stakes of more than 5 percent in a large number of companies. The two largest clusters, in the center of the network plot, are generated by BlackRock and Fidelity. The firms with the highest numbers of connections are those that belong to both of these two large clusters.

To calculate markups, I use data on revenues and earnings before taxes. The difference between these two is a measure of total cost. Markups are then calculated as

$$Markup_{it} = \frac{Revenue_{it}}{Cost_{it}}.$$

As is well known, this measure of markups has several drawbacks. The first is that it uses average cost rather than marginal cost, and is thus a measure of the average markup, rather than the markup at the margin, which is the one that the theory refers to. Second, it fails to capture all of the user cost of capital, since, although it includes interest expenses, does not take into account the opportunity cost of equity capital. Its main advantage is that it is possible to calculate it using standard accounting data, which is readily available for a large number of firms. However, it is important to keep in mind that markups are measured with error.

Table 6.1 shows summary statistics for assets, markups, whether a firm has a large shareholder, the number of connections of the firms in the sample in the



shareholder network, the normalized number of connections (that is, the number of connections divided by the number of other firms in the sample for that quarter), and the normalized number of connections with other firms in the same industry (that is, the number of connections with other firms in the industry divided by the number of other firms in the industry for that quarter).

Figure 6.1 shows the evolution over time of the density of the shareholder network for the economy as a whole, and of the average density of the industry subnetworks. The points for 2010Q1 and 2010Q2 have been interpolated, because the lack of BlackRock data for those quarters distorted the measures substantially. Consistent with the evidence in Chapter 4, industry subnetworks are denser on average than the overall network. This means that the probability that two firms will have a common shareholder is higher if they are in the same industry. A difference-in-means test shows that the difference is statistically significant. Also consistent with the evidence described in that chapter, the density of shareholder networks, both at the industry level and overall, increased substantially between 2000 and 2010. Both the overall density and the average within-industry density have approximately tripled over that period.

Figure 6.2 shows the evolution of the average and median markups over time. Markups are procyclical, consistent with the evidence presented by Nekarda and Ramey (2010). There is also an upward trend, although it is slight compared to the large cyclical movements.

Figure 6.3 shows that there is a positive relationship between markups and firm size, measured as the logarithm of assets. I first average markups and log assets over time for each firm. Then, I divide the firms into deciles by size, and calculate the average markup for each decile. Interestingly, average markups are below one for the bottom 5 deciles, and above for the top 5. Figure 6.4 shows that smaller firms on average also have a higher fraction of periods with negative

income (before taxes), and less periods with observations, presumably because of a higher probability of exit.

Figure 6.5 shows the result of a similar exercise, but dividing the firms by the number of within-industry connections instead of log assets. First, I separate the 2334 (out of 7277) firms that have no connections within their industry in any period, and calculate their average markup. Then, I divide the rest of the firms into quintiles according to the fraction of possible within-industry connections, and calculate the average markup for each group. There is a strong positive correlation between within-industry connections and markups. If we control for log assets, by using the residuals from a regression of markups on log assets (and adding the average markup to the residuals) instead of raw markups, the correlation is smaller, but still significant. Interestingly, there is a positive jump in markups when going from the second to the third quintile of connections. Figure 6.6 shows that more connected firms are on average less likely to have negative profits (before taxes). Figure 6.7 shows that more connected firms have more periods with observations, presumably because their exit probability is lower. In all cases, the relationships described hold when controlling for assets, with the exception that the fraction of periods with negative income is lower for firms with no connections than for connected firms in the lowest two quintiles.

### **6.3 Regression Analysis**

Table 6.2 shows the results of structure-conduct-performance regressions of average industry markups on the density of industry common ownership subnetworks, average overall degree (normalized) of firms in the industry, and controls.

The basic specification is

$$Markup_{it} = \beta_0 + \beta_1 Density_{it} + \beta_2 Average\ Degree_{it} + Controls_{it} + \varepsilon_{it}.$$

Control variables include the average log of assets of the firms in the industry, the Herfindahl index, calculated using the share of revenues of the firms in the dataset, the number of firms in the industry (within the dataset), and the fraction of firms in the industry that have a large institutional shareholder, that is, an institutional investor owning more than 5 percent of the firm.

The first specification is a cross-sectional regression for a balanced panel of 210 industries, using time averages of all variables. The second specification is estimated using a Fama-MacBeth two-step procedure. The third specification uses the data without aggregating over time, and includes quarterly dummies to correct for temporal variation in markups. The fourth specification adds lagged markups, which helps control for omitted variable bias. The fifth specification includes industry fixed effects, which helps control for omitted variables that are constant over the whole period. The last specification includes both lagged markups and fixed effects.<sup>1</sup>

In all specifications, we see a positive relation between markups and within-industry shareholder density. We also see a negative relation between overall connectivity of firms in the industry (that is, including connections with firms in other industries) and markups. The partial correlation between within-industry density and markups is statistically significant in all specifications except the one with fixed effects but no lagged markups. Note that the lack of statistical significance in the case of fixed effects without lagged markups is driven by higher standard errors, rather than a lower coefficient. This suggests that a) some of the effect is

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<sup>1</sup>While in general including both lagged dependent variables and fixed effects leads to inconsistent estimates, given the large number of periods (41 quarters) and the relatively low value of the autoregressive parameter, the bias in this case should be small.

coming from the between-industry variation, and b) some of the omitted variables are time-varying. Fixed effects estimates are known to exacerbate the bias due to measurement error. The measurement error problem could be substantial in this case, since a) we do not observe non-institutional owners, and b) using a 5% threshold will count some firms as connected when they are not, and viceversa.

The positive relationship between average industry markups and within-industry shareholder network density is consistent with a partial horizontal integration interpretation. That is, industries where firms are more likely to share the same owners, according to the theory, should have higher markups all else equal. The negative relationship between average industry markups and average overall connectivity in terms of common ownership is consistent with a partial vertical integration interpretation. When firms become vertically integrated, the double marginalization problem is solved. Thus, standard industrial organization models predict that markups when firms are vertically integrated should be lower than when they are independent (see Tirole, 1994, chap. 4).

Industries with larger firms in terms of assets tend to have higher markups. Ownership concentration, measured as the fraction of firms in the industry with large shareholders (more than 5% ownership) has a statistically significant effect only in two specifications. In the Fama-MacBeth regression, the effect is positive and significant at 5%. In the specification with fixed effects and lagged markups, the effect is negative and significant at 10%. The Herfindahl index has no statistically significant effect, except for a negative effect, significant at 10%, in the specification with fixed effects and lagged markups. The inverse of the number of firms in the industry does not have a statistically significant effect on markups. The lack of a clear relationship between measures of concentration and markups should not be too surprising, given the failure of the structure-conduct-performance literature

to find a strong relationship between these measures of concentration and market power.

## 6.4 Panel Vector Autoregression Analysis

In this section, I study the dynamics of industry-level density and average markups. To do this, I use a Panel Vector Autoregression (Panel VAR). The main econometric issue in the estimation of Panel VARs is the endogeneity problem that arises when including both fixed effects and lagged dependent variables. The endogeneity bias, however, goes to zero as the length of the panel goes to infinity. Since the panel used in this chapter is relatively long (i.e., 42 periods), the bias introduced by having fixed effects and lagged dependent variables should be relatively small.<sup>2</sup>

I estimate the following reduced form specification:

$$y_{i,t} = B_1(L)y_{i,t-1} + B_2x_{i,t} + \varepsilon_{i,t},$$

where  $y_{i,t}$  is a vector of endogenous variables that includes average industry markups, industry density, average industry degree, average log assets for the firms in the industry, the fraction of firms in the industry with a blockholder at 5%, and the Herfindahl index. As exogenous variables,  $x_{i,t}$ , I include quarterly dummies, and also industry fixed effects in some specifications.

To obtain error bands for impulse responses, I use the same Bayesian procedure used in time-series VARs, described in detail in Sims and Zha (1999), with a flat prior. When applying these methods in a panel setting, it is necessary to introduce breaks to separate the observations for different industries.

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<sup>2</sup>For a discussion and a proposed estimator, see Holtz-Eakin et al. (1988). Barcellos (2010) uses a Panel VAR to study the dynamics of immigration and wages in the United States.

To be able to obtain impulse responses, I impose contemporaneous restrictions with the following order of the variables: mean log assets, Herfindahl, average markup, fraction of firms with a large shareholder, average degree, and density. Thus, all variables, and in particular, the markup, can affect density contemporaneously. On the other hand, this ordering assumes that density has a zero contemporaneous effect on all the other variables.

Table 6.3 shows the results of a one-lag panel vector autoregression, with quarterly dummies and without fixed effects. We see that markups do not help to explain the density of shareholder networks. Shareholder network density, on the other hand, has a positive and highly significant effect on markups. Consistent with the results from the regression analysis, average degree has a statistically significant negative effect. This is confirmed by the impulse response analysis, shown in Figures 6.8 and 6.9.

Table 6.4 shows the results of a one-lag panel vector autoregression, with quarterly dummies and fixed effects. The results are qualitatively similar as in the analysis without fixed effects. The effect of common ownership measures on markups is smaller, but still statistically significant. The impulse response posterior densities are shown in Figures 6.10 and 6.11.

## 6.5 Summary

In this chapter, I studied the relationship between networks of common ownership and markups at the industry level. The main result is that the industry-level density of shareholder networks is positively associated with average industry markups. A dynamic analysis using Panel Vector Autoregressions shows that industry-level density of shareholder networks is a significant predictor of average

markups, but average markups do not have predictive power for industry-level density.

	Obs.	Mean	Median	90th Pct.	10th Pct.	Std. Dev.
Assets	172247	6844.6	384.7	8279	24.5	53692.5
Markup	172247	1.04	1.05	1.35	0.59	0.41
Large shareholder	172247	0.71	1.0	1.0	0.0	0.46
Degree (number of connexions)	172247	326.5	88	986	0	424.9
Percentage of possible connections with other firms in the economy	172247	7.7%	2.1%	23.1%	0.0%	0.10
Percentage of possible connections with other firms in the same industry	172247	10.2%	1.2%	32.2%	0.0%	0.15

**Table 6.1**  
**Summary Statistics**

This table shows summary statistics for the variables used in the analysis of shareholder networks and markups. The data is quarterly, and goes from 2000Q2 to 2010Q4. Assets are in millions of dollars. The calculation of markups is described in section 7.1. The percentage of connections with other firms in the economy is the total number of connections for a given firm in a given period divided by the number of firms in that period minus one. The percentage of connections with other firms in the same industry is calculated as the number of connections with firms in the same 3-digit SIC industry for a given firm in a given period divided by the number of firms in that industry in that period minus one. Two firms are considered connected if there is at least one shareholder holding at least 5% in both firms. Large shareholder is an indicator variable, equal to one if a company has a shareholder with at least 5% of the shares and zero otherwise. Outliers are windsorized at the 1st and 99th percentile by quarter.



	Dependent Variable: Average Markup					
	(1)	(2)	(3)	(4)	(5)	(6)
Density	0.246*** (0.0819)	0.0641*** (0.00756)	0.0668** (0.0277)	0.0246** (0.0107)	0.0240 (0.0155)	0.0213** (0.0107)
Average Degree	-1.210*** (0.347)	-0.430*** (0.0559)	-0.403*** (0.124)	-0.125*** (0.0477)	-0.206** (0.0863)	-0.142** (0.0568)
Average Log Assets	0.0312*** (0.00561)	0.0329*** (0.00143)	0.0325*** (0.00458)	0.0112*** (0.00193)	0.0455*** (0.00926)	0.0322*** (0.00674)
1 / (Number of Firms)	-0.0354 (0.0811)	-0.00669 (0.0160)	0.000470 (0.0525)	0.0104 (0.0196)	0.120 (0.111)	0.124 (0.0802)
Herfindahl	0.0489 (0.0493)	0.00725 (0.00800)	0.00365 (0.0353)	-0.00634 (0.0129)	-0.0739 (0.0519)	-0.0671* (0.0398)
Fraction w/Large Shareholders	0.0943 (0.0631)	0.0176** (0.00837)	0.0153 (0.0248)	0.00240 (0.0107)	-0.0221 (0.0180)	-0.0232* (0.0138)
Markup <sub>t-1</sub>				0.679*** (0.0314)		0.403*** (0.0293)
Constant	0.855*** (0.0640)	0.867*** (0.0104)	0.879*** (0.0417)	0.271*** (0.0324)	0.817*** (0.0519)	0.452*** (0.0439)
Quarterly Dummies	N/A	N/A	Yes	Yes	Yes	Yes
Industry Fixed Effects	N/A	N/A			Yes	Yes
Observations	210	9,524	9,524	9,008	9,524	9,008
Number of Industries	210	249	249	246	249	246
R-squared	0.196	0.129	0.141	0.544	0.122	0.275

Table 6.2  
Average Markups and Measures of Common Ownership

This table shows industry-level regression results with average industry markups (before taxes) as the dependent variable and measures of common ownership as explanatory variables. Standard errors are in parentheses. Specification (1) is a cross-sectional regression of averages over time using a balanced panel, with White heteroskedasticity-robust standard errors. Specification (2) is estimated using the two-step procedure of Fama-MacBeth. The standard errors in specifications (3) to (6) are clustered at the industry level. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

	(1) Markup	(2) Density	(3) Degree	(4) Log Assets	(5) Herfindahl	(6) Large Sh.
Markup <sub>t-1</sub>	0.685*** (0.00770)	0.000689 (0.00723)	-0.00255 (0.00165)	-0.0391* (0.0233)	0.00726 (0.00568)	0.0159* (0.00861)
Density <sub>t-1</sub>	0.0267*** (0.00826)	0.798*** (0.00776)	0.00143 (0.00177)	0.0402 (0.0250)	0.00195 (0.00609)	0.00684 (0.00924)
Degree <sub>t-1</sub>	-0.155*** (0.0346)	0.240*** (0.0325)	0.903*** (0.00740)	-0.175* (0.105)	-0.00837 (0.0255)	0.240*** (0.0387)
Log Assets <sub>t-1</sub>	0.00843*** (0.000832)	-6.69e-05 (0.000781)	-0.000107 (0.000178)	0.976*** (0.00252)	-0.000865 (0.000613)	-0.00109 (0.000930)
Herfindahl <sub>t-1</sub>	0.00674 (0.00458)	-0.00957** (0.00430)	-0.00350*** (0.000978)	0.00319 (0.0139)	0.948*** (0.00337)	-0.0223*** (0.00512)
Large Sh. <sub>t-1</sub>	0.00456 (0.00638)	0.0145** (0.00598)	0.00390*** (0.00136)	-0.0664*** (0.0193)	-0.0172*** (0.00470)	0.798*** (0.00713)
Constant	0.277*** (0.0113)	0.00150 (0.0106)	0.00758*** (0.00241)	0.203*** (0.0342)	0.0201** (0.00832)	0.127*** (0.0126)
Quarterly Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9,008	9,008	9,008	9,008	9,008	9,008
R-squared	0.540	0.705	0.835	0.951	0.899	0.704

Table 6.3  
Vector Autoregression Results

This table shows regression results for a vector autoregression with one lag, without industry fixed effects. Standard errors in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

	(1) Markup	(2) Density	(3) Degree	(4) Log Assets	(5) Herfindahl	(6) Large Sh.
Markup <sub>t-1</sub>	0.416*** (0.00979)	-0.0144 (0.00967)	-0.00384* (0.00220)	-0.0252 (0.0302)	0.000910 (0.00705)	0.00444 (0.0112)
Density <sub>t-1</sub>	0.0217** (0.00970)	0.664*** (0.00958)	-0.00226 (0.00218)	0.0159 (0.0299)	-0.00179 (0.00699)	-0.00260 (0.0111)
Degree <sub>t-1</sub>	-0.142*** (0.0405)	0.252*** (0.0400)	0.806*** (0.00911)	0.125 (0.125)	-0.0124 (0.0292)	0.105** (0.0463)
Log Assets <sub>t-1</sub>	0.0105*** (0.00259)	0.00219 (0.00255)	0.00208*** (0.000581)	0.711*** (0.00797)	-0.00506*** (0.00186)	0.0135*** (0.00296)
Herfindahl <sub>t-1</sub>	0.0242** (0.0123)	-0.0511*** (0.0121)	-0.0155*** (0.00276)	-0.0384 (0.0378)	0.568*** (0.00884)	-0.130*** (0.0140)
Large Sh. <sub>t-1</sub>	-0.00440 (0.00814)	-0.0127 (0.00804)	-0.00911*** (0.00183)	0.0450* (0.0251)	-0.0342*** (0.00587)	0.592*** (0.00931)
Constant	0.555*** (0.0203)	0.0657*** (0.0201)	0.0462*** (0.00457)	2.015*** (0.0626)	0.239*** (0.0146)	0.267*** (0.0232)
Quarterly Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9,008	9,008	9,008	9,008	9,008	9,008
R-squared	0.617	0.728	0.848	0.958	0.920	0.742

Table 6.4  
Vector Autoregression Results

This table shows regression results for a vector autoregression with one lag, with industry fixed effects. Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

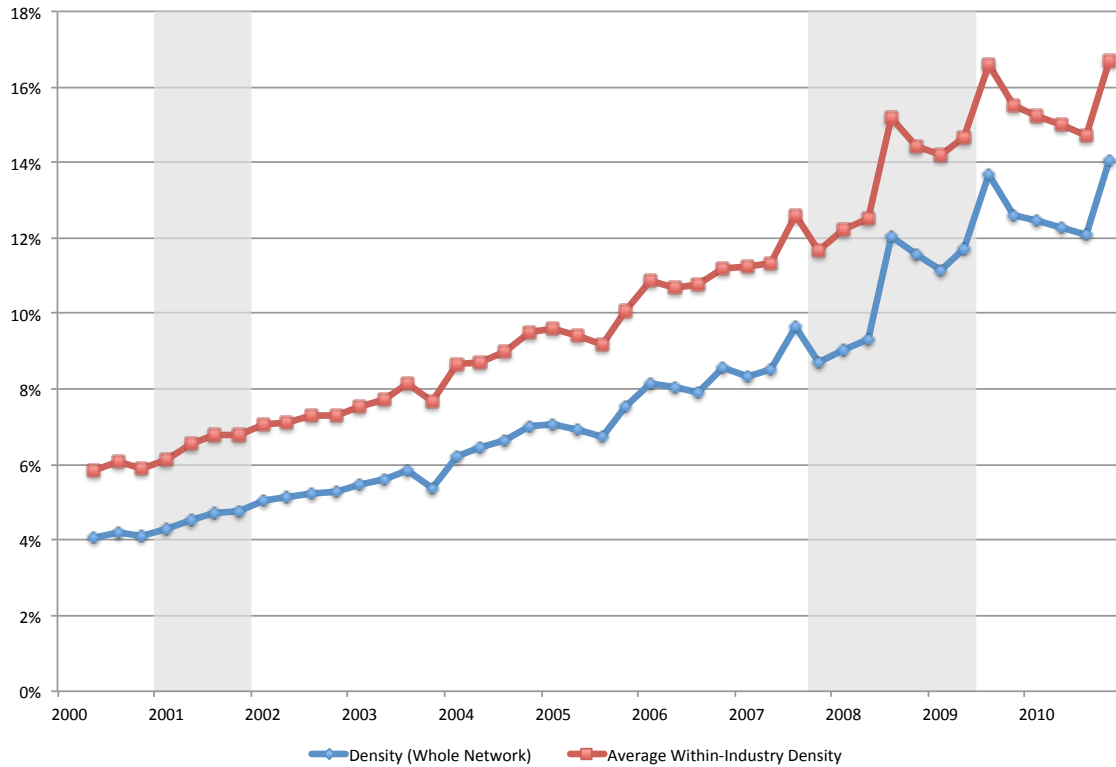


Figure 6.1  
Shareholder Network Density over Time

This figure shows the evolution of the density of the network of firms generated by common institutional shareholders with ownership stakes of at least 5% in a pair of firms, and of the average density of the industry subnetworks. Industries are defined at the 3-digit SIC level. The values for 2010Q1 and 2010Q2 are interpolated (linearly) because ownership data for BlackRock, the top institution in terms of number of blockholdings in 2010, was not available for those quarters.

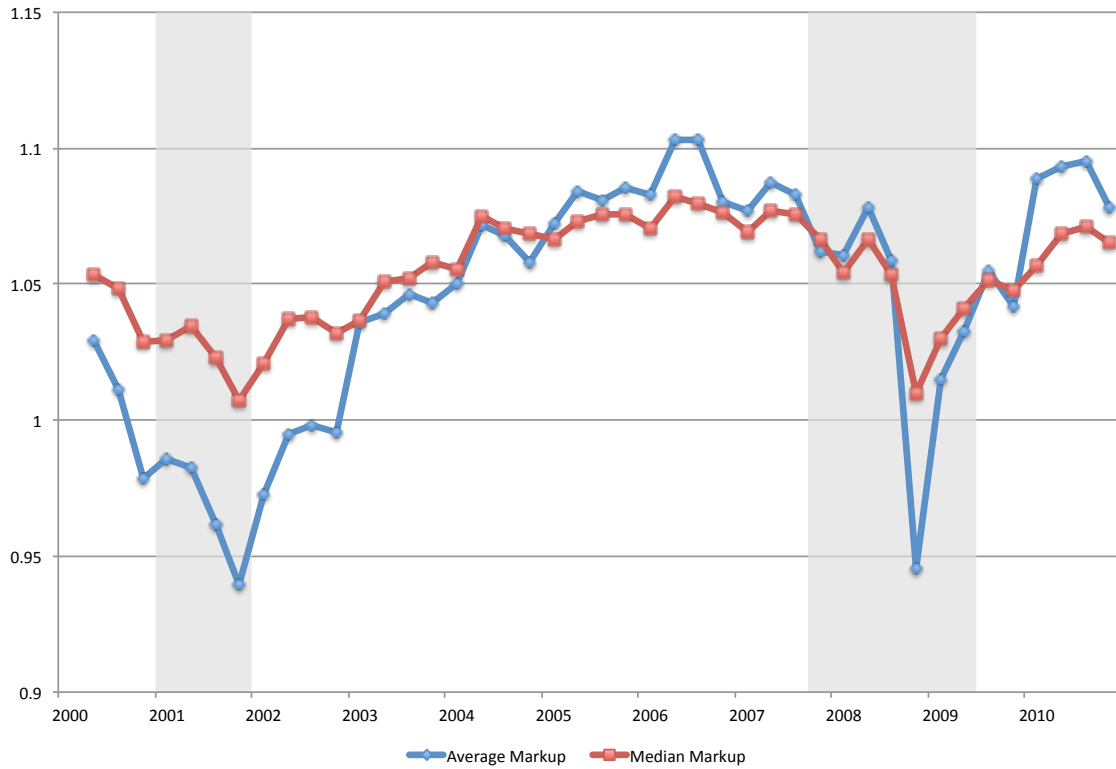


Figure 6.2  
Average and Median Markups over Time

This figure shows the evolution over time of the average and median markup for the firms in the sample. Markups are calculated as total accounting revenues (before taxes) divided by total accounting costs (before taxes).

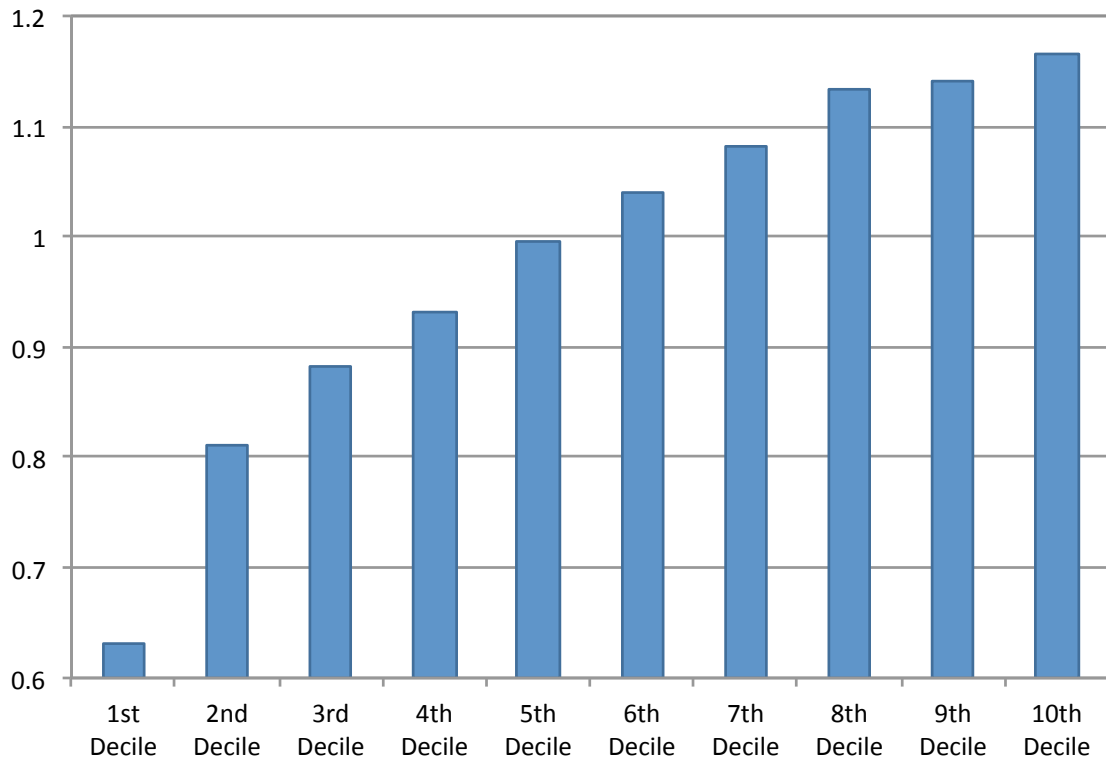
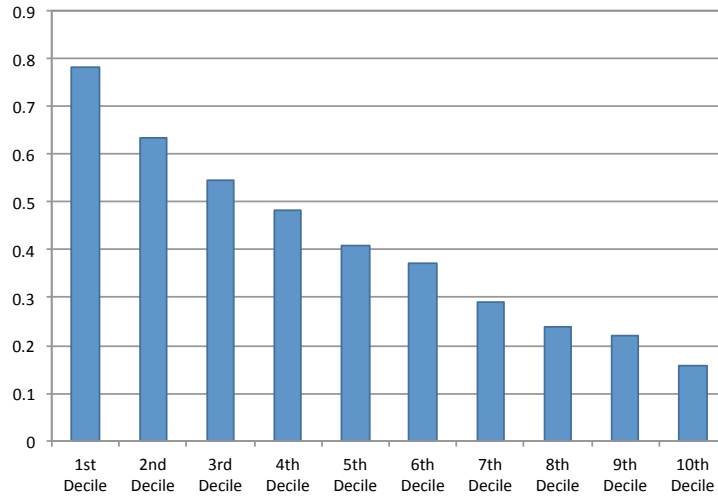
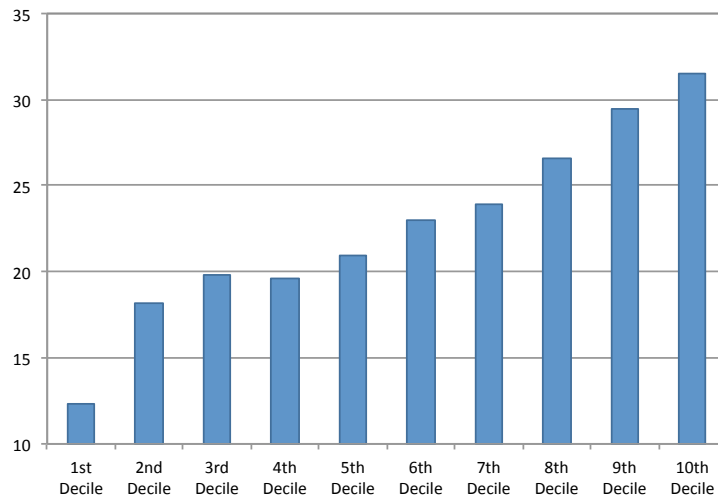


Figure 6.3  
Average Markup, by Decile of Log Assets

This figure shows the average markup in the cross section of firms for each decile of firm size, measured as log assets. The markup of each firm and its log assets are averaged over all the periods for which it has observations.



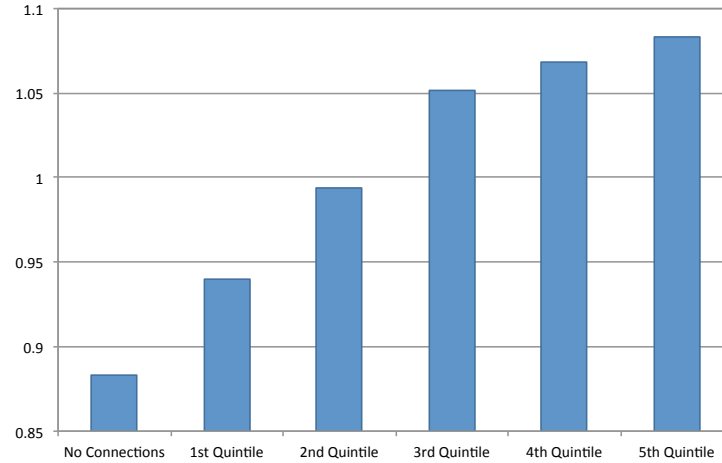
(a) Average Fraction of Periods with Negative Income (Before Taxes)



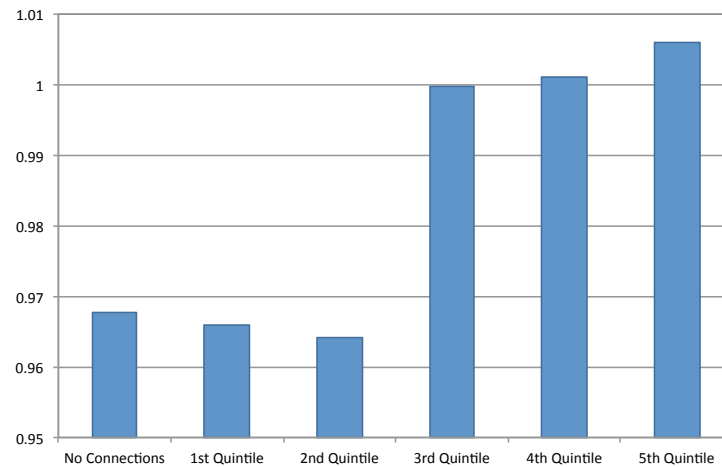
(b) Average Number of Periods with Observations

Figure 6.4  
Average Fraction of Periods with Negative Income (Before Taxes) and Average Number of Periods with Observations, by Decile of Log Assets

This figure shows the average fraction of periods with negative income before taxes and the average fraction of periods for which a firm has observations, in the cross section of firms for each decile of firm size, measured as log assets.



(a) No Controls

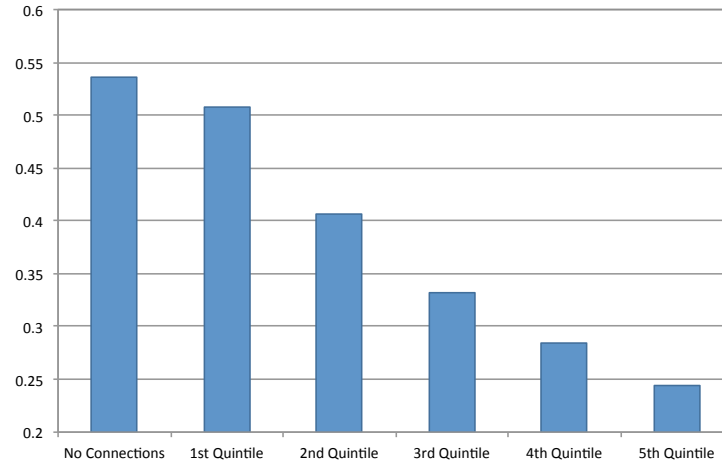


(b) Controlling for Log Assets

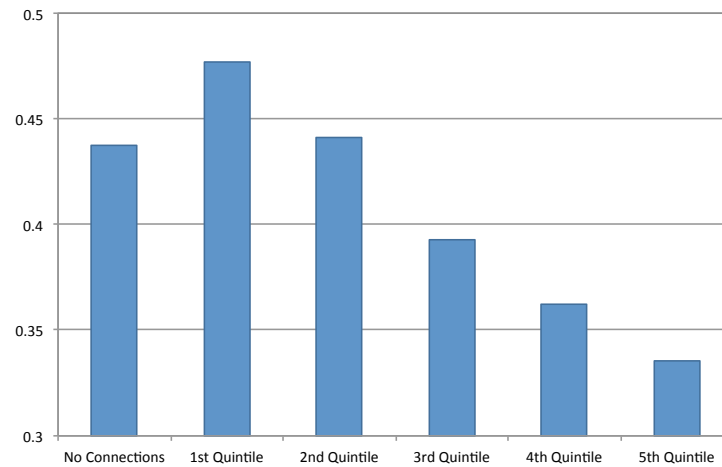
Figure 6.5  
Average Markup, by Quintile of Within-Industry Degree

This figure shows the average markup in the cross section of firms for each quintile of within-industry normalized degree, after separating the observations with zero within-industry connections. Within-industry normalized degree is calculated as the number of connections that a company has with other firms in the same 3-digit SIC industry divided by the number of other firms in the industry (i.e. the number of possible connections). The markup of each firm and its log assets are averaged over all the periods for which it has observations.





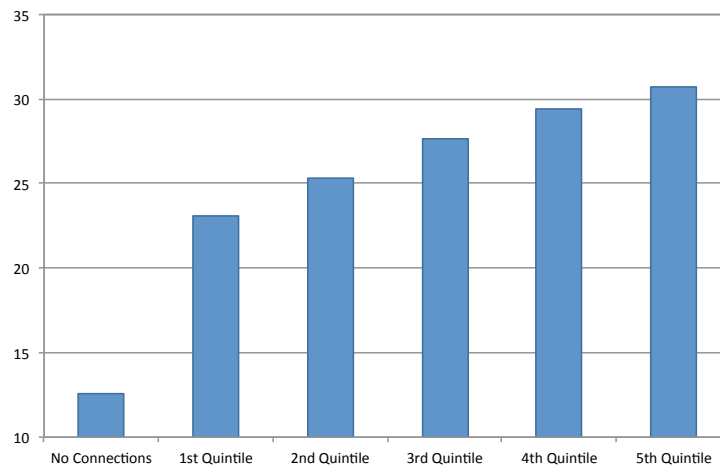
(a) No Controls



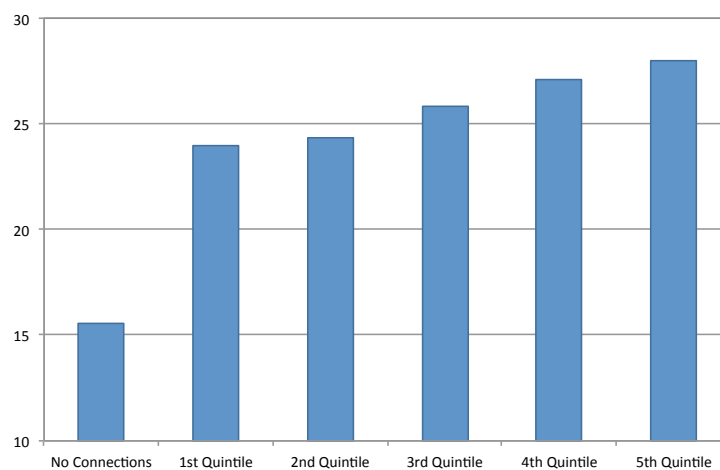
(b) Controlling for Log Assets

**Figure 6.6**  
Average Fraction of Periods with Negative Income, by Quintile of Within-Industry Degree

This figure shows the average fraction of periods with negative income in the cross section of firms for each quintile of within-industry normalized degree, after separating the observations with zero within-industry connections. Within-industry normalized degree is calculated as the number of connections that a company has with other firms in the same 3-digit SIC industry divided by the number of other firms in the industry (i.e. the number of possible connections).



(a) No Controls



(b) Controlling for Log Assets

Figure 6.7  
Average Number of Periods with Observations, by Quintile of Within-Industry Degree

This figure shows the average number of periods with observations in the cross section of firms for each quintile of within-industry normalized degree, after separating the observations with zero within-industry connections. Within-industry normalized degree is calculated as the number of connections that a company has with other firms in the same 3-digit SIC industry divided by the number of other firms in the industry (i.e. the number of possible connections).

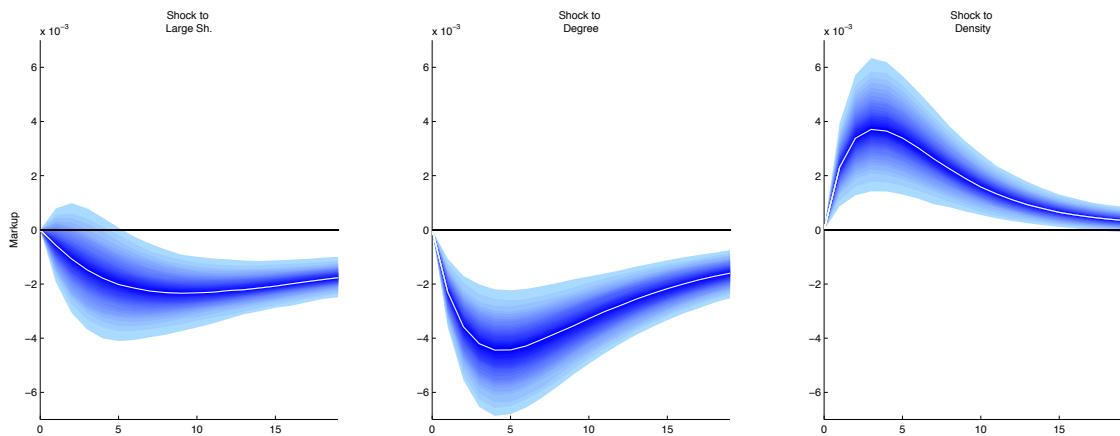


Figure 6.8  
Response of the Average Industry Markup to Shocks to Ownership Structure Variables

This figure shows the posterior density, in a Panel VAR model, of the response of average markups to shocks to the fraction of firms with large shareholders in the industry, the average overall degree of the firms in the industry, and the industry’s shareholder subnetwork density. The endogenous variables in the VAR are average log assets, the Herfindahl index, average markups, the fraction of firms with a large shareholder, the average degree, and the density of the industry network. Quarterly dummies are treated as exogenous variables. In each figure, the x axis indicates number of quarters after shock. The graph shows bands from 5%, up to 95%, in intervals of 5%.

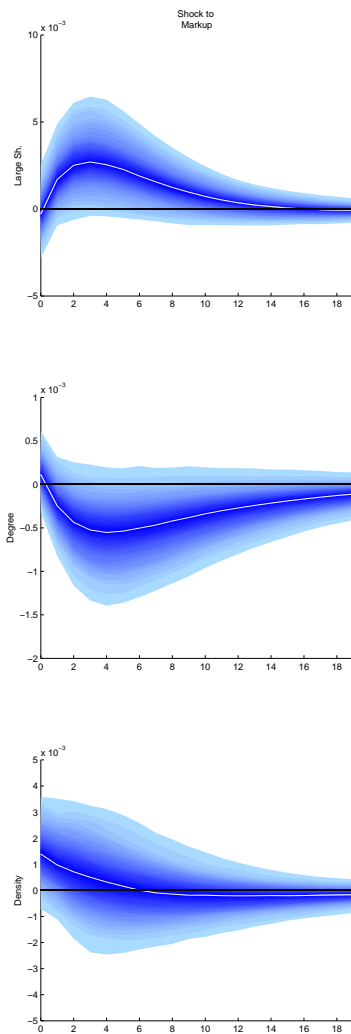


Figure 6.9  
Response of Ownership Structure Variables to Shocks to Average Industry  
Markups

This figure shows the posterior density, in a Panel VAR model, of the response of the fraction of firms with large shareholders in the industry, the average overall degree of the firms in the industry, and the industry's shareholder subnetwork density to shocks to average markups. The endogenous variables in the VAR are average log assets, the Herfindahl index, average markups, the fraction of firms with a large shareholder, the average degree, and the density of the industry network. Quarterly dummies are treated as exogenous variables. In each figure, the x axis indicates number of quarters after shock. The graph shows bands from 5%, up to 95%, in intervals of 5%.

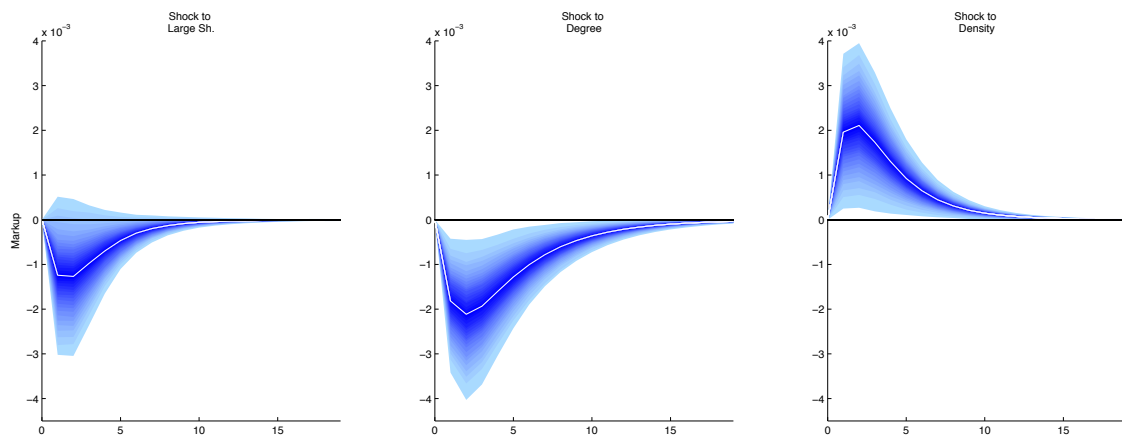


Figure 6.10  
Response of the Average Industry Markup to Shocks to Ownership Structure Variables (including Industry Fixed Effects)

This figure shows the posterior density, in a Panel VAR model, of the response of average markups to shocks to the fraction of firms with large shareholders in the industry, the average overall degree of the firms in the industry, and the industry's shareholder subnetwork density. The endogenous variables in the VAR are average log assets, the Herfindahl index, average markups, the fraction of firms with a large shareholder, the average degree, and the density of the industry network. Quarterly dummies and industry fixed effects are treated as exogenous variables. In each figure, the x axis indicates number of quarters after shock. The graph shows bands from 5%, up to 95%, in intervals of 5%.

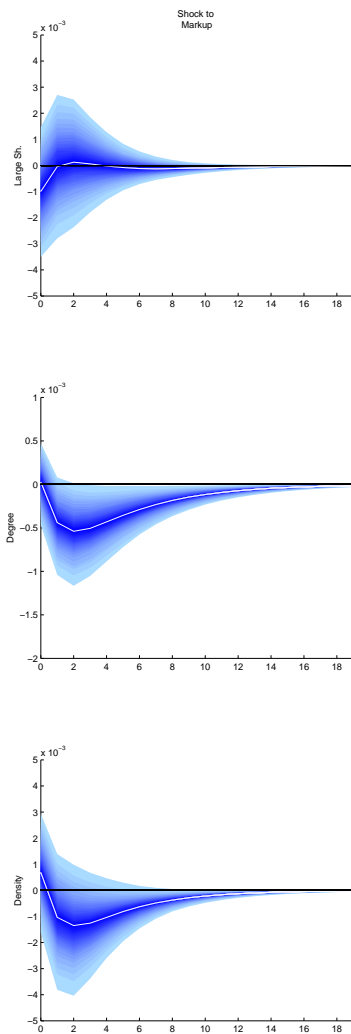


Figure 6.11  
 Response of Ownership Structure Variables to Shocks to Average Industry  
 Markups (including Industry Fixed Effects)

This figure shows the posterior density, in a Panel VAR model, of the response of the fraction of firms with large shareholders in the industry, the average overall degree of the firms in the industry, and the industry's shareholder subnetwork density to shocks to average markups. The endogenous variables in the VAR are average log assets, the Herfindahl index, average markups, the fraction of firms with a large shareholder, the average degree, and the density of the industry network. Quarterly dummies and industry fixed effects are treated as exogenous variables. In each figure, the x axis indicates number of quarters after shock. The graph shows bands from 5%, up to 95%, in intervals of 5%.

## Chapter 7

# Conclusion: Adjusting the Herfindahl Index for Portfolio Diversification?

In this dissertation, I developed a theory of oligopoly with shareholder voting. I also showed evidence that common ownership among publicly traded US firms has increased in the last decade, and that empirical measures of common ownership are predictors of (a) a higher probability of interlocking directorships at the firm-pair level and (b) higher markups at the level of the industry.

I have argued that society faces a trilemma. Portfolio diversification, maximization of shareholder value by managers, and competition are considered desirable objectives. However, it is not possible to completely attain the three. Balancing these objectives presents us with a complex policy problem.

One possible way to proceed would be to adjust the Herfindahl index for portfolio diversification. This could be useful to detect industries with high levels of concentration, taking into account not just market shares but also the links of common ownership between the firms. In the following section, I show how to adjust the Herfindahl index for portfolio diversification based on the model of oligopoly with shareholder voting.

## 7.1 A Herfindahl Index Adjusted for Common Ownership

In this section I derive an analogue to the Herfindahl index of market concentration that takes into account the links of common ownership between the firms in the industry. Consider a Cournot model of oligopoly with shareholder voting, with homogeneous goods and heterogeneous costs, in which all shareholders are equally activist, uniformly across firms. From Chapter 2, we know that the first order condition for firm  $i$  is

$$\int_{g \in G} \theta_i^g \left[ \theta_i^g (\alpha - 2\beta q_i - \beta q_{-i} - m_i) + \sum_{j \neq i} \theta_j^g (-\beta q_j) \right] dg = 0.$$

This can be rewritten as

$$\alpha - 2\beta q_i - \beta q_{-i} - m_i = \sum_{j \neq i} \lambda_{ij} \beta q_j,$$

where

$$\lambda_{ij} \equiv \frac{\int_{g \in G} \theta_i^g \theta_j^g dg}{\int_{g \in G} (\theta_i^g)^2 dg}.$$

This expression, in turn, can be rewritten in terms of the markup, market shares, and the inverse price elasticity of demand, as follows:

$$\frac{P - m_i}{P} = \frac{s_i}{\eta} + \frac{\sum_{j \neq i} s_j \lambda_{ij}}{\eta},$$

where  $s_i = q_i/Q$  is the market share of firm  $i$  and  $1/\eta = -P'(Q)Q/P$  is the inverse price elasticity of demand.



The average Lerner index weighted by market shares is

$$\frac{P - \sum_{i=1}^N s_i m_i}{P} = \frac{\sum_{i=1}^N s_i^2}{\eta} + \frac{\sum_{i=1}^N \sum_{j \neq i} s_i s_j \lambda_{ij}}{\eta}.$$

When firms are separately owned, we are in the classic Cournot case, and the average markup is proportional to the Herfindahl  $H = \sum_{i=1}^N s_i^2$ . However, when firms have common shareholders, this is no longer the case. However, the above expression suggests a formula for an index  $\bar{H}$  that adjusts the Herfindahl in the presence of common ownership links:

$$\bar{H} = H + \sum_{i=1}^N \sum_{j \neq i} s_i s_j \lambda_{ij}.$$

This index can also be expressed more concisely as follows:

$$\bar{H} = \sum_{i=1}^N \sum_{j=1}^N s_i s_j \lambda_{ij},$$

since  $\lambda_{ii} = 1$ . It is straightforward to show that  $\bar{H}$  is between zero and one, and is always higher than the Herfindahl.

We can summarize these results in the following

**Theorem 7.** *Consider a Cournot model of oligopoly with shareholder voting with (a) linear demands, (b) homogeneous goods, (c) heterogeneous constant marginal costs, and (d) the same level of activism for all shareholders and all firms. In this model, the average markup (weighted by the market shares) is proportional to the adjusted Herfindahl index*

$$\bar{H} = H + \sum_{i=1}^N \sum_{j \neq i} s_i s_j \lambda_{ij},$$

where  $H = \sum_{i=1}^N s_i^2$  is the unadjusted Herfindahl index.

Note that all the information in the portfolios necessary to calculate the index is summarized by the  $N \times N$  sufficient statistics  $\lambda_{ij}$ . We can think of these statistics as defining a weighted and directed network connecting the firms in the industry through links of common ownership. The adjusted Herfindahl  $\bar{H}$  is can be thought of a weighted average of the links in the network of common ownership, where the weights are the products of the market shares of each pair of nodes (note that  $\sum_{i=1}^N \sum_{j=1}^N s_i s_j = 1$ ).

### 7.1.1 An Example

Consider an industry with five symmetric firms, each with a market share of .2. The Herfindahl index for the industry is equal to .2. The U.S. Department of Justice and FTC Horizontal Merger Guidelines consider industries with a Herfindahl above .15 and below .25 to be moderately concentrated, and industries with a Herfindahl higher than .25 to be highly concentrated. Thus, this industry would be considered moderately concentrated, but not highly concentrated.

If the firms in the industry have completely separate owners, the adjusted Herfindahl is also equal to .2. However, suppose that the firms have five owners. Each owner owns 80% of one of the firms, and in addition has a 5% stake in each of the other firms in the industry (another way to put it is that each owner has 75% of one firm, plus a diversified portfolio that has 5% of the whole industry). The adjusted Herfindahl is .31. Thus, adjusting for common ownership would put the industry in the highly concentrated category. Note that a merger between two firms in the industry would increase the adjusted Herfindahl by a lower amount than what the same merger would increase the unadjusted Herfindahl, since the firms in the industry are already partially merged.

## 7.2 A Model-Based Measure of Common Ownership at the Firm-Pair Level

In empirical studies of shareholder networks, the links are usually derived in an ad hoc way based on a threshold percentage for ownership stakes. For example, two firms are considered connected if there is a shareholder with ownership stakes of at least 5% in both, and not connected otherwise. While this measure is useful for its simplicity, it would be useful to have a measure of common ownership that did not depend on an arbitrary threshold, and did not have a discontinuity at the threshold. The analysis of the previous section suggests that the normalized inner product  $\lambda_{ij}$  is a good candidate for this measure. The interpretation of  $\lambda_{ij}$  as a measure of the common ownership between a pair of firms applies in contexts much more general than the Cournot model with homogeneous goods.

Consider a model of oligopoly with shareholder voting with risk-neutral shareholders. In equilibrium, firms maximize a weighted average of shareholder utilities. The problem of firm  $i$  is

$$\max_{p_i} \int_{g \in G} \theta_i^g \mathbb{E} \left[ \sum_{j=1}^N \theta_j^g \pi_j(p_j, p_{-j}) \right] dg.$$

This can be rewritten as

$$\max_{p_i} \left( \int_{g \in G} (\theta_i^g)^2 dg \right) \mathbb{E} \pi_i + \sum_{j \neq i} \left( \int_{g \in G} \theta_i^g \theta_j^g dg \right) \mathbb{E} \pi_j,$$

which is equivalent to maximizing

$$\max_{p_i} \mathbb{E} \pi_i + \sum_{j \neq i} \lambda_{ij} \mathbb{E} \pi_j.$$

Thus, the normalized inner product  $\lambda_{ij}$  can be interpreted as the weight of the expected profits of firm  $j$  in the decision problem of firm  $i$ .

This is a directed measure of common ownership, such that  $\lambda_{ij} \neq \lambda_{ji}$ . For some applications it will be useful to define an undirected measure  $\tilde{\lambda}_{ij}$  as the geometric mean of the two directed measures:

$$\tilde{\lambda}_{ij} = \sqrt{\lambda_{ij}\lambda_{ji}} = \frac{\int_{g \in G} \theta_i^g \theta_j^g dg}{\sqrt{\left(\int_{g \in G} (\theta_i^g)^2 dg\right) \left(\int_{g \in G} (\theta_j^g)^2 dg\right)}}.$$

This normalized inner product is an uncentered correlation coefficient for the ownership structures of firm  $i$  and firm  $j$ .

The use of this measure in practice could be problematic if there is no data for all the owners of the firms in the pair. For example, if we take only shareholders with stakes of 1% or more, and ignore shareholders with smaller shares, then the calculated measure would be the same for a pair of firms with one shareholder having 1% in both firms (and all other shareholders having less than 1% in either) as for a pair of firms with one shareholder having 10% in both firms (and all other shareholders having less than 1% in either). Thus, one should be careful when applying this measure.

### 7.3 Possible Directions for Future Research

While theoretically appealing, the practical application of the Herfindahl index adjusted for portfolio diversification poses significant challenges. First, it requires relatively complete data on the ownership of all the firms in the industry. Second, the measure taken literally does not take into account agency problems, and therefore the weight of the links does not put a penalty on lack of concentration of ownership. In practice, however, this could be important: for the same level of

the normalized inner products, if the ownership of the firms is more concentrated, collusion could potentially be easier, because the agency problem would be less intense. One possible way to proceed would be to consider management as having weight in the maximization problem of the firm, and defining what the objective of the management is. For example, one could assume that managers care only about the profits of the firm that they manage.

Another possible avenue for further research would be to relax the assumption of atomistic shareholders. Large institutional shareholders play an important role in the ownership of publicly traded firms in the United States and in other countries. When shareholders are large, this opens the door to the possibility of strategic considerations in portfolio allocation. That is, when choosing their portfolios in the first stage, shareholders would take into account that they can have a significant impact in the outcome of the voting equilibrium in the second stage. Another issue that is related to the presence of large shareholders is the possibility of hostile takeovers, which are not possible in a model with atomistic shareholders, unless they can borrow non-atomistic amounts.

From an empirical point of view, there is also much work to be done. It would be of interest to study the relationship between market power and the Herfindahl adjusted for portfolio diversification. As already noted, this implies significant challenges from the point of view of both data availability and theory.

In this dissertation, I have focused on firms in the United States. However, portfolio diversification includes cross-country diversification, and institutional investors hold stocks in more than one country. Studying the evolution of portfolio diversification and networks of common ownership at an international level would be a natural direction for further research.

# Bibliography

- D. Acemoglu. *An Introduction to Modern Economic Growth*. Princeton University Press, 2009.
- A. Agrawal and G.N. Mandelker. Large shareholders and the monitoring of managers: The case of antitakeover charter amendments. *Journal of Financial and Quantitative Analysis*, 25(02):143–161, 1990. ISSN 0022-1090.
- D.S. Ahn and S. Oliveros. Combinatorial Voting. 2010.
- A. Alesina and H. Rosenthal. *Partisan politics, divided government, and the economy*. Cambridge Univ Pr, 1995. ISBN 0521436206.
- A. Alesina and H. Rosenthal. A theory of divided government. *Econometrica: Journal of the Econometric Society*, 64(6):1311–1341, 1996. ISSN 0012-9682.
- F. Allen, M.K.F. Chui, and A. Maddaloni. Financial systems in europe, the usa, and asia. *Oxford Review of Economic Policy*, 20(4):490–508, 2004.
- K.J. Arrow. A difficulty in the concept of social welfare. *The Journal of Political Economy*, 58(4):328–346, 1950. ISSN 0022-3808.
- K.J. Arrow. *Collected papers of Kenneth J. Arrow: Social choice and justice*. Belknap Pr, 1983. ISBN 0674137604.
- S.H. Barcellos. The dynamics of immigration and wages. *Working Paper*, 2010.
- M. Becht and J.B. DeLong. Why has there been so little block holding in america?, 2005.
- M. Becht and A. Röell. Blockholdings in europe: An international comparison. *European Economic Review*, 43(4):1049–1056, 1999.
- A.A. Berle and G.C. Means. *The modern corporation and private property*. 1940.
- M. Bertrand and S. Mullainathan. Are CEOs Rewarded for Luck? The Ones without Principals Are\*. *Quarterly Journal of Economics*, 116(3):901–932, 2001. ISSN 0033-5533.
- J.E. Bethel, J.P. Liebeskind, and T. Opler. Block share purchases and corporate performance. *The Journal of Finance*, 53(2):605–634, 1998. ISSN 1540-6261.

- B. Blonigen and C. O'Fallon. Foreign firms and local communities. Technical report, National Bureau of Economic Research, 2011.
- J.A. Brander and T.R. Lewis. Oligopoly and financial structure: The limited liability effect. *The American Economic Review*, 76(5):956–970, 1986. ISSN 0002-8282.
- Y. Cai and M. Sevilir. Board connections and m&a transactions. *Journal of Financial Economics*, 2011.
- G. Cestone. Corporate financing and product market competition: An overview. *Giornale degli Economisti e Annali di Economia*, 58(2):269–300, 1999. ISSN 0017-0097.
- V.V. Chari, L.E. Jones, and R. Marimon. The economics of split-ticket voting in representative democracies. *The American Economic Review*, 87(5):957–976, 1997. ISSN 0002-8282.
- P.J. Coughlin. *Probabilistic voting theory*. Cambridge Univ Pr, 1992. ISBN 0521360528.
- S. Cukurova. Interlocking directors and target selection in mergers and acquisitions. 2011.
- H. DeAngelo. Competition and unanimity. *The American Economic Review*, 71(1): 18–27, 1981.
- J.B. DeLong. Did J.P. Morgan's men add value. *Inside the Business Enterprise*, pages 205–36, 1991.
- P.M. DeMarzo. Majority voting and corporate control: the rule of the dominant shareholder. *The Review of Economic Studies*, 60(3):713–734, 1993. ISSN 0034-6527.
- P.A. Diamond. The role of a stock market in a general equilibrium model with technological uncertainty. *The American Economic Review*, 57(4):759–776, 1967. ISSN 0002-8282.
- E. Dierker, H. Dierker, and B. Grodal. Nonexistence of constrained efficient equilibria when markets are incomplete. *Econometrica*, 70(3):1245–1251, 2002. ISSN 1468-0262.
- A. Dixit. A model of duopoly suggesting a theory of entry barriers. *The Bell Journal of Economics*, 10(1):20–32, 1979. ISSN 0361-915X.
- G.W. Domhoff. Who rules america? 1967.
- J.H. Dreze. (Uncertainty and) the firm in general equilibrium theory. *The Economic Journal*, 95:1–20, 1985. ISSN 0013-0133.
- D. Duffie and W. Shafer. Equilibrium and the Role of the Firm in Incomplete Markets, Research Paper no. 915, Graduate School of Business, 1986.

- S. Ekern and R. Wilson. On the theory of the firm in an economy with incomplete markets. *Bell Journal of Economics*, 5(1):171–180, 1974.
- C. Fershtman and K.L. Judd. Equilibrium incentives in oligopoly. *The American Economic Review*, 77(5):927–940, 1987. ISSN 0002-8282.
- R. Foellmi and J. Zweimuller. Inequality, market power, and product diversity. *Economics Letters*, 82(1):139–145, 2004.
- M. Friedman. The social responsibility of business is to increase its profits. *New York Times Magazine*, pages 122–126, 1970.
- S.L. Gillan and L.T. Starks. The Evolution of Shareholder Activism in the United States\*. *Journal of Applied Corporate Finance*, 19(1):55–73, 2007. ISSN 1745-6622.
- P.A. Gompers and A. Metrick. Institutional investors and equity prices\*. *Quarterly Journal of Economics*, 116(1):229–259, 2001.
- R.H. Gordon. Do publicly traded corporations act in the public interest? Technical report, National Bureau of Economic Research, 1990.
- S.J. Grossman and J.E. Stiglitz. On value maximization and alternative objectives of the firm. *Journal of Finance*, pages 389–402, 1977.
- J. Häckner. A Note on Price and Quantity Competition in Differentiated Oligopolies. *Journal of Economic Theory*, 93(2):233–239, 2000. ISSN 0022-0531.
- R.G. Hansen and J.R. Lott. Externalities and corporate objectives in a world with diversified shareholder/consumers. *Journal of Financial and Quantitative Analysis*, 31(1), 1996.
- J. Harford, D. Jenter, and K. Li. Institutional cross-holdings and their effect on acquisition decisions. *Journal of Financial Economics*, 99(1):27–39, 2011.
- O. Hart and J. Moore. The governance of exchanges: Members’ cooperatives versus outside ownership. *Oxford Review of Economic Policy*, 12(4):53–69, 1996.
- J.C. Hartzell and L.T. Starks. Institutional investors and executive compensation. *The Journal of Finance*, 58(6):2351–2374, 2003. ISSN 1540-6261.
- D. Holtz-Eakin, W. Newey, and H.S. Rosen. Estimating vector autoregressions with panel data. *Econometrica: Journal of the Econometric Society*, pages 1371–1395, 1988.
- T. Itō. *The Japanese Economy*, volume 10. The MIT Press, 1992.
- M.C. Jensen and J.B. Long. Corporate investment under uncertainty and pareto optimality in the capital markets. *The Bell Journal of Economics and Management Science*, pages 151–174, 1972.



- J.K. Kang and A. Shivdasani. Firm performance, corporate governance, and top executive turnover in Japan. *Journal of Financial Economics*, 38(1):29–58, 1995. ISSN 0304-405X.
- S.N. Kaplan and B.A. Minton. Appointments of outsiders to Japanese boards: Determinants and implications for managers. *Journal of Financial Economics*, 36(2): 225–258, 1994. ISSN 0304-405X.
- S.N. Kaplan and B.A. Minton. How has ceo turnover changed? *International Review of Finance*, 2008.
- D. Kelsey and F. Milne. The existence of equilibrium in incomplete markets and the objective function of the firm. *Journal of Mathematical Economics*, 25(2):229–245, 1996. ISSN 0304-4068.
- D. Kelsey and F. Milne. Imperfect competition and corporate governance. *Journal of Public Economic Theory*, 10(6):1115–1141, 2008. ISSN 1467-9779.
- D.W. Kim. Interlocking ownership in the korean chaebol. *Corporate Governance: An International Review*, 11(2):132–142, 2003.
- A.F. Ledvina and R. Sircar. Bertrand and Cournot competition under asymmetric costs: number of active firms in equilibrium. 2010.
- L. Makowski. Competition and unanimity revisited. *The American Economic Review*, 73(3):329–339, 1983.
- Harry Markowitz. Portfolio selection. *The Journal of Finance*, 7(1):pp. 77–91, 1952. ISSN 00221082. URL <http://www.jstor.org/stable/2975974>.
- G. Matvos and M. Ostrovsky. Cross-ownership, returns, and voting in mergers. *Journal of Financial Economics*, 89(3):391–403, 2008.
- F. Milne. Corporate Investment and Finance Theory in Competitive Equilibrium\*. *Economic Record*, 50(4):511–533, 1974. ISSN 1475-4932.
- F. Milne. The firm’s objective function as a collective choice problem. *Public Choice*, 37(3):473–486, 1981. ISSN 0048-5829.
- M.S. Mizruchi. What do interlocks do? an analysis, critique, and assessment of research on interlocking directorates. *Annual review of sociology*, pages 271–298, 1996.
- G.D. Myles. *Public economics*. Cambridge Univ Pr, 1995.
- J.P. Neary. The road less travelled: Oligopoly and competition policy in general equilibrium. 2002.
- J.P. Neary. International trade in general oligopolistic equilibrium. *University College Dublin, mimeo*, 2009.

- C.J. Nekarda and V.A. Ramey. The cyclical behavior of the price-cost markup. *University of California, San Diego (July), 2010.*
- P.M. Parker and L.H. Röller. Collusive conduct in duopolies: multimarket contact and cross-ownership in the mobile telephone industry. *The RAND Journal of Economics*, pages 304–322, 1997.
- M. Poitevin. Collusion and the Banking Structure of a Duopoly. *Canadian Journal of Economics*, 22(2):263–277, 1989. ISSN 0008-4085.
- R. Radner. A note on unanimity of stockholders' preferences among alternative production plans: a reformulation of the ekern-wilson model. *The Bell Journal of Economics and Management Science*, pages 181–184, 1974.
- T. Renstrom and E. Yalcin. Endogenous firm objectives. *Journal of public economic theory.*, 5(1):67–94, 2003. ISSN 1097-3923.
- R. J. Reynolds and B. R. Snapp. The competitive effects of partial equity interests and joint ventures. *International Journal of Industrial Organization*, 4:141–153, 1986.
- M.J. Roe. *Strong managers, weak owners: The political roots of American corporate finance.* Princeton Univ Pr, 1996.
- R. Schmalensee. Inter-industry studies of structure and performance. ch. 16 in r. schmalensee and r. willig (eds.): *Handbook of industrial organization*, vol. 2, 1989.
- C.A. Sims and T. Zha. Error bands for impulse responses. *Econometrica*, 67(5): 1113–1155, 1999.
- N. Singh and X. Vives. Price and quantity competition in a differentiated duopoly. *The RAND Journal of Economics*, 15(4):546–554, 1984. ISSN 0741-6261.
- T.E. Stuart and S. Yim. Board interlocks and the propensity to be targeted in private equity transactions. *Journal of Financial Economics*, 97(1):174–189, 2010.
- J. Tirole. *The theory of industrial organization.* MIT press, 1994.