

# Voting in Cartels: Theory and Evidence from the Shipping Industry\*

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First Version: February 28th 2004

Revised: March 19th, 2004

## Abstract

We examine the choice of voting rules by legal cartels with enforcement capabilities in the presence of uncertainty about demand and costs. We show that cartels face a trade-off between the commitment advantages of more stringent majority requirements and the loss of flexibility resulting from them. Expected heterogeneity in costs or demand conditions leads away from simple majority toward more stringent rules, while larger membership to the cartel leads away from unanimity toward less restrictive rules. Evidence from the “shipping conferences” of the late 1950s largely supports our model. With few firms, the rule favored by heterogeneous conferences is unanimity. In larger cartels, the favored rule is either 2/3 or 3/4-majority rule.

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# 1 Introduction

Rather than illegal price conspiracies, plagued by opportunities to cheat and haunted by the activity of antitrust authorities (as often depicted in introductory economics textbooks), many real-world cartels are legal organizations, whose price-fixing or volume-restricting agreements are enforced by the coercive power of the state. Some, like the shipping cartels to which we devote attention in this paper, resemble political entities. They have written “constitutions” specifying who belongs in the cartel, as well as how are collective decisions going to be made (usually through some voting procedure).

We study the choice of voting rules by legal cartels with imperfect revenue sharing in the presence of uncertainty about demand and costs. We show that cartels face a trade-off between the commitment advantages of more stringent majority requirements and the loss of flexibility resulting from them. On one hand, supermajority requirements allow the cartel to commit to prices that maximizes the sum of profits, rather than the profits of the majority. On the other hand, supermajority requirements result in a loss of flexibility to modify prices in response to extreme realizations of the demand and cost conditions. The optimal qualified majority rule for a cartel maximizing the expected benefits of member firms results from balancing the benefits and costs of commitment. More expected heterogeneity among cartel members increases the benefits of commitment, while cartel size increases its costs.

Our model is motivated by the U.S. shipping conferences of the 19th and 20th centuries, which were legal cartels with broad enforcement capabilities, encompassing firms exposed to diverse risk sources and that lacked for the most side payments, except in some cases for very limited partial revenue sharing agreements. Evidence from the shipping conferences largely supports our model. With few firms, the rule favored by heterogeneous conferences is unanimity. In larger cartels, the favored rule is either 2/3 or 3/4-majority rule.

Constitutional aspects of legal cartels have been generally disregarded in the economics literature. The classical work of Don Patinkin (1947), for instance, likens legal cartels to multi-plant monopolies (another recurrent textbook image). With complete profit-sharing, the objectives of cartel members are perfectly aligned and collective decisions procedures are largely irrelevant. As pointed by Bain (1948), however, in the absence of side-payments there is no reason for a cartel to behave like a monopolist. Bain’s point has been taken on by Schmalensee (1987), Harrington (1991), and others, who

have applied a variety of cooperative game concepts to predict the behavior of cartels. Though the political character of legal cartels was appreciated early on by Daniel Marx (1953), the actual voting procedures used by cartels to arrive at decisions were ignored in the literature up until the recent work of Cave and Salant (1995).

Cave and Salant (1995) study majority voting about the total production quota of the cartel. Under the assumption that the quota translates into firm-specific quantity restrictions via some exogenous proportions, they show that there is a Condorcet quota and therefore a stable cartel decision under simple majority. This leaves unexplained why many cartels in the shipping industry and in other instances opt instead for supermajority rules.

One possible explanation for supermajority requirements is that, in fact, there is more than one relevant dimension in the collective decision problem faced by cartels. As shown by Caplin and Nalebuff (1988, 1991), rules close to 64%-majority rule lead to stable decisions with very many voters under some assumptions on individual preferences and the distribution of preferences. Shipping cartels in our sample, however, have been concerned mostly with a single-dimension issue, price-fixing, over which single-peaked preferences (and hence the existence of a Condorcet winner) can be easily obtained.

Another possible explanation to supermajority rules is the need for self-enforceable collective decisions. As illustrated by Maggi and Morelli (2003), self-enforceability pushes in the direction of unanimity voting in the context of international organizations. Consistent with our focus on cartels with legally-binding decisions, we ignore the issue of enforceability. Though stability and self-enforceability may indeed play a role in the actual choice of voting rules by legal cartels, we have focused on the need of commitment in the presence of uncertainty about cost and demand conditions as a more appropriate explanation for the case of the shipping cartels.

## **2 Shipping Conferences and Their Constitutions**

Ocean carriers offering regularly scheduled “liner” service have formed cartels, known as shipping conferences, since the 19th century. These cartels have, until recently, largely received the blessing of political authorities. In the United States, the source of our sample, shipping conferences must

file their agreements with the government for approval. If approved, the conference agreement is immune from the antitrust laws. Typically these agreements have been approved without consideration of antitrust principles (Mansfield 1980, Marín and Sicotte 2003b).

Shipping conferences are organized across routes. Examples include the conference covering traffic from United States Pacific ports to Australia, and the conference covering traffic from the Mediterranean to United States Atlantic ports. Many shipping companies operate on multiple routes, and are often members of multiple shipping conferences. Some firms are not members of shipping conferences on one or more of the routes that they serve. There is substantial heterogeneity among shipping conferences in terms of their respective sizes and geographic coverage. Similarly, the characteristics of different shipping companies' fleets, such as the number of ships, their tonnage, and their quality, vary widely.

Shipping conference member firms agree to fix prices jointly. Conferences can best be described as a case of semi-collusion, because they do not regulate many other strategic decisions by member firms, such as investment and deployment of new ships. This often has resulted in substantial "service" competition among conference members (Marx 1953, Jansson and Shneerson 1987). Although the U.S. government effectively has enforced conference freight rates, conferences have also seen fit to include extensive self-policing provisions in their agreements. A conference secretary or an independent party is assigned the responsibility of verifying firms' compliance with the conference agreement. Bonds or cash are often deposited in a separately administered account for the payment of penalties for violations of the agreement. Competition from non conference firms is met through aggressive price cuts or exclusive contracts with customers (Scott Morton 1997, Marín and Sicotte 2003a).

Our interest in shipping cartels is in their decision-making process. Daniel Marx, in his classic (1953) work on shipping conferences, states, "It should be remembered that conferences are in a very real sense political organizations" (p. 148). Their agreements have constitutional attributes in that they carefully lay out procedures for collective decision-making.<sup>1</sup> In particular, shipping conferences make decisions democratically. Each firm is entitled

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<sup>1</sup>Several conference agreements are reproduced in their entirety in the proceedings of an inquiry by the Antitrust Subcommittee of the U.S. House Committee on the Judiciary (1960), our main data source.

to a single vote. Like national constitutions, most conferences employ two types of voting rules: one for day-to-day matters, including freight rates, and another for extraordinary decisions, such as amendments to the conference agreement. The different voting rules employed by 95 conferences serving U.S. foreign trade in the late 1950s are detailed in Table 1. Of the 95 conferences, 35 used the 2/3 rule, 28 required unanimity, 13 used simple majority, 15 required 3/4 of the members to agree, and 4 required all members minus one to agree. For all conferences, amending the agreement requires at least as many votes as deciding on freight rates. All 28 conferences that require unanimity in fixing prices also require unanimity for amendments. All conferences that require 3/4 for price-fixing also require unanimity for amending the agreement. Of the 35 conferences that require 2/3 supermajority for freight rates, 16 require unanimity for amendments, three require 4/5, one requires 3/4 and 15 keep the 2/3 rule. Of the 13 conferences requiring simple majority for price-fixing, nine mandate unanimity for passing amendments, and four keep the simple majority rule. The constitutional set-up thus varies considerably by shipping conference, but most agreements would seem to be designed to be relatively difficult to amend. This suggests that the voting rules themselves are relatively stable over the life of the cartel.<sup>2</sup>

TABLE 1. SHIPPING CONFERENCES' VOTING RULES

*Shipping conferences serving US foreign trade in late 1950's*

Voting Rule	Price-Fixing	Amendments to the Agreement
Simple Majority	13	4
Two-Thirds	35	15
Three-Quarters	15	1
Four-Fifths	0	3
All Save One	4	3
Unanimity	28	69

Observations: 95.

Source: U.S. House Committee on the Judiciary (1960), insert between pp. 690 and 691.

Little is known about exactly how the conferences reached their agreement, and exactly what was the nature of the discussion leading to their

<sup>2</sup>The age of the shipping conferences in our sample varies substantially. Most pre-date World War II, but were disrupted temporarily during the war and a few years thereafter. See U.S. House Committee on the Judiciary (1960).

decision about which voting rule to adopt. Despite the fact that conferences are required to submit their agreements to the government, their internal disputes and negotiations remain highly guarded business secrets.

In the next section, we model the choice of a voting rule assuming that there is *ex ante* uncertainty about the relative positions of firms. There are good reasons that firms would doubt their relative position in the conference *ex ante*. Firms cannot be sure which vessels their partners will decide to deploy, and how their investment in new, higher quality ships over time will proceed. Moreover, because conferences in the United States are “open” by law, entry (and exit for that matter) is possible. The firms negotiating the original agreement cannot know for certain the identity of their future partners.

We assume that firms view their future competitive position within a given conference as a random variable. Firms know the distribution of that variable, which is based on characteristics of member firms and the shipping route at the conference’s inception. As a consequence, firms anticipate the future heterogeneity of the shipping conference. Moreover, firms’ expected discounted profits are similar for every given constitution at the inception of the cartel, so that they agree in the objective of maximizing expected profits. After all, conferences’ constitutions are arrived at by consensus among member firms, and we expect agreement by consensus to be more likely among agents with roughly similar interests. The constitutional problem faced by the cartel, then, corresponds to that envisioned by Harsanyi (1955). Rawls’s (1971) objections to the representation of the choice of a constitution as maximization of expected payoffs under uncertainty, such as difficulties computing probabilities of different events or performing interpersonal comparisons of utility, have less bite when the society is composed of agents single-mindedly maximizing expected monetary profits.

### 3 The Model

We consider an industry with  $n$  firms. All firms are regulated by a cartel that fixes the same price for all. Firm  $i$  profits are given by  $V_i(p, \theta)$ , where  $p \in \mathfrak{R}_+$  is the price set by the cartel and  $\theta = (\theta_1, \dots, \theta_n) \in \{\theta_B, \theta_G\}^n$  is a vector indicating the cost and demand conditions faced by each firm.  $\theta_i = \theta_B$  indicates that firm  $i$  faces “bad conditions” and  $\theta_i = \theta_G$  indicates that it faces “good conditions.” Firms facing similar conditions have the same

profits, and those profits depend only on the fraction of firms facing good conditions. That is, defining  $\gamma$  as the fraction of firms facing good conditions, there is a pair of functions  $V_B$  and  $V_G$  such that for every  $i$  with  $\theta_i = \theta_B$ ,  $V_i(p, \theta) = V_B(p, \gamma)$  and for every  $i$  with  $\theta_i = \theta_G$ ,  $V_i(p, \theta) = V_G(p, \gamma)$ . Finally, we assume that  $V_B(p, \gamma)$  and  $V_G(p, \gamma)$  are concave and single-peaked in  $p$ , achieving their maximum values in  $p_B(\gamma)$  and  $p_G(\gamma)$ , and satisfying  $p_B(\gamma) > p_G(\gamma)$  and  $V_B(p, \gamma), V_G(p, \gamma) \geq 0$  for  $p \in [\min_{x \in [0,1]} p_G(x), \max_{x \in [0,1]} p_B(x)]$  for every  $\gamma \in [0, 1]$ . This implies that profits are positive in an interval containing every firm's favorite prices. We define the domain of the functions  $V_B$ ,  $V_G$ ,  $p_B$ , and  $p_G$  as independent of  $n$  because we are interested in performing comparative statics with respect to the cartel size. Of course, for a fixed  $n$ ,  $\gamma$  can take only finitely many values; that is,  $\gamma \in \Gamma_n = \{0, 1/n, 2/n, \dots, 1\}$ .

Firms set the cartel price according to some voting rule. A voting rule is a pair  $(q, s)$ , where  $q \in Q_n = \{[(n+1)/2]/n, \dots, (n-1)/n, 1\}$  is the supermajority requirement and  $s \in \mathfrak{R}_+$  is the status quo price. If  $\gamma \leq 1 - q$ , the cartel price is set at  $p_B(\gamma)$ . If  $\gamma \geq q$ , the cartel price is set at  $p_G(\gamma)$ . Otherwise, the cartel price is set at  $s$  if  $p_G(\gamma) \leq s \leq p_B(\gamma)$ , at  $p_G(\gamma)$  if  $s < p_G(\gamma)$ , and at  $p_B(\gamma)$  if  $p_B(\gamma) < s$ . In other words, the status quo is chosen as long as it is undominated under the  $q$ -majority rule; if it is dominated, the closest undominated price is chosen. Note that if  $q = [(n+1)/2]/n$  (*simple majority rule*), and  $n$  is odd, the status quo is irrelevant. On the other hand, if  $q = 1$  (*unanimity rule*), the status quo is chosen unless it is Pareto-dominated.

We study the optimal choice of voting rule from an *ex ante* perspective. That is, we assume that  $\theta$  is drawn by nature from some distribution before the cartel price is set but after the voting rule has been chosen by the cartel. The random variables  $\tilde{\theta}_i$  are exchangeable, that is, any realization  $\theta$  is equally likely than any permutation of  $\theta$ . This guarantees that firms share as a common objective the maximization of (the same) expected benefits. For a given  $n$ , we represent prior beliefs about  $\gamma$  by a distribution function  $F_n$  satisfying  $F_n(\gamma) = F_n(\lfloor n\gamma \rfloor / n)$ ,  $F_n(0) \geq 0$ , and  $F(1) = 1$ .

We have:

**Lemma 1** *For every given  $n$ , there is an optimal voting rule.*

**Proof.** Given a supermajority requirement, the expected payoff for the cartel can be easily shown to be a continuous function of the status quo price. Without loss of generality, we can consider exclusively status quo

prices in the interval  $[\min_{\gamma \in \Gamma_n} p_G(\gamma), \max_{\gamma \in \Gamma_n} p_B(\gamma)]$ . Then, by Weierstrass Theorem, there is a status quo price that maximizes the expected payoff for each given supermajority requirement. Since there are only finitely many possible supermajority requirements for each  $n$ , there must be some pair or pairs  $(q, s)$  that maximize the expected payoff for the cartel members. ■

To characterize the effect of cartel size on the optimal voting rule, we make the following assumption:

**(A1)** The sequence of functions  $\{F_n, n \in \mathbb{N}\}$  converges uniformly to a continuous function  $F(\gamma)$  that is strictly increasing for  $\gamma \in (0, 1)$ , with  $F(\gamma) = 0$  for  $\gamma \leq 0$  and  $F(\gamma) = 1 - F(1 - \gamma)$  for every  $\gamma$ .

We can think of  $F$  as the limiting distribution of a cartel with very many firms. Note that the limiting distribution is symmetric around  $1/2$ .

We have

**Theorem 1** *Suppose (A1) is satisfied. Then, there is some finite  $\bar{n}$  such that neither simple majority nor unanimity are adopted if  $n \geq \bar{n}$ .*

**Proof.** Let

$$p(q) = \arg \max_p \left( \int_{1-q}^q (\gamma V_G(p, \gamma) + (1 - \gamma) V_B(p, \gamma)) dF(\gamma) \right)$$

(intuitively, the optimal status quo price in the limiting case when the supermajority requirement is  $q$ ) and consider the function

$$\begin{aligned} g(q) &= \int_{1-q}^q (\gamma V_G(p(q), \gamma) + (1 - \gamma) V_B(p(q), \gamma)) dF(\gamma) \\ &\quad + \int_q^1 (\gamma V_G(p_G(\gamma), \gamma) + (1 - \gamma) V_B(p_G(\gamma), \gamma)) dF(\gamma) \\ &\quad + \int_0^{1-q} (\gamma V_G(p_B(\gamma), \gamma) + (1 - \gamma) V_B(p_B(\gamma), \gamma)) dF(\gamma) \end{aligned}$$

(intuitively, the expected benefit for cartel members in the limiting case when the supermajority requirement is  $q$ ). This expression is continuous so it achieves a maximum or maxima on  $q \in [1/2, 1]$ . We claim that the values

of  $q$  maximizing  $g$  can be bounded away from  $1/2$  and  $1$ . To see this, we compute

$$\begin{aligned} g'(q) &\propto qV_G(p(q), q) + (1 - q)V_B(p(q), q) \\ &\quad + (1 - q)V_G(p(q), 1 - q) + qV_B(p(q), 1 - q) \\ &\quad - (qV_G(p_G(q), q) + (1 - q)V_B(p_G(q), q)) \\ &\quad - ((1 - q)V_G(p_B(1 - q), 1 - q) + qV_B(p_B(1 - q), 1 - q)). \end{aligned}$$

Note that

$$\begin{aligned} g'(1/2) &\propto (V_G(p(1/2), 1/2) + V_B(p(1/2), 1/2)) \\ &\quad - 1/2(V_G(p_G(1/2), 1/2) + V_B(p_G(1/2), 1/2)) \\ &\quad - 1/2(V_G(p_B(1/2), 1/2) + V_B(p_B(1/2), 1/2)), \end{aligned}$$

which is positive because  $V_G(p, 1/2) + V_B(p, 1/2)$  is strictly concave and is maximized at  $p(1/2)$ . Note also that

$$g'(1) \propto V_G(p(1), 1) + V_B(p(1), 0) - V_G(p_G(1), 1) - V_B(p_B(0), 0),$$

which is negative because  $V_G(p, 1)$  is maximized at  $p_G(1)$  and  $V_B(p, 0)$  is maximized at  $p_B(0)$ .

Now, for any given  $n$ , let

$$p_n(q) = \arg \max_p \left( \sum_{\gamma \in \{1-q+1/n, \dots, q-1/n\}} (\gamma V_G(p, \gamma) + (1 - \gamma)V_B(p, \gamma)) \Pr(\gamma) \right).$$

The optimal voting rule given  $n$  is given by the solution to the problem of maximizing  $g_n(q)$  for  $q \in Q_n$ , where  $g_n(q)$  defined by:

$$\begin{aligned} g_n(q) &= \sum_{\gamma \in \{1-q+1/n, \dots, q-1/n\}} (\gamma V_G(p_n(q), \gamma) + (1 - \gamma)V_B(p_n(q), \gamma)) \Pr(\gamma) \\ &\quad + \sum_{\gamma \in \{q, \dots, 1\}} (\gamma V_G(p_G(\gamma), \gamma) + (1 - \gamma)V_B(p_G(\gamma), \gamma)) \Pr(\gamma) \\ &\quad + \sum_{\gamma \in \{0, \dots, 1-q\}} (\gamma V_G(p_B(\gamma), \gamma) + (1 - \gamma)V_B(p_B(\gamma), \gamma)) \Pr(\gamma). \end{aligned}$$

The sequence of functions  $\{g_n, n \in \mathbb{N}\}$  converges uniformly to  $g$ , and the sequence of choice sets  $\{Q_n, n \in \mathbb{N}\}$  includes supermajority requirements

arbitrarily close to  $1/2$  and  $1$  as  $n$  increases. Since the supermajority requirements maximizing  $g$  are bounded away from  $1/2$  and  $1$ , so will be those maximizing  $g_n$  for large enough  $n$ . ■

A uniqueness result (at least for large cartels) can be obtained by assuming that the profits of firms facing good and bad conditions are independent of the conditions faced by other firms.

**(A2)** There is pair of functions  $W_G(p)$  and  $W_B(p)$  such that for every  $\gamma$ ,  $V_G(p, \gamma) = W_G(p)$  and  $V_B(p, \gamma) = W_B(p)$ .

This assumption is just a useful simplification, that allows us to present the optimal supermajority requirement as the result of equalizing the “marginal benefits” and the “marginal costs” of more stringent requirements, as illustrated below.

**Corollary 1** *Suppose (A1) and (A2) are satisfied. Then, there is some  $q^* \in (1/2, 1)$  such that the optimal supermajority requirement converges to  $q^*$  as  $n$  increases.*

**Proof.** We can rewrite the expression for  $g'(q)$  from the prof of the theorem as:

$$\begin{aligned} g'(q) \propto & (1 - q)[V_B(p(q), q) - V_B(p_G(q), q)] \\ & + (1 - q)[V_G(p(q), 1 - q) - V_G(p_B(1 - q), 1 - q)] \\ & - q[V_G(p_G(q), q) - V_G(p(q), q)] \\ & - q[V_B(p_B(1 - q), 1 - q) - V_B(p(q), 1 - q)]. \end{aligned}$$

The first two terms represent the marginal benefit for minorities, while the last two terms represent the marginal cost for majorities due to more stringent supermajority requirements. Note that all terms in brackets are positive. Under (A2), all terms in brackets are constant, so the first two terms in the expression for  $g'$  are continuous and decreasing in  $q$  and the last two terms are continuous and increasing in  $q$ . It follows that there is a unique  $q^*$  such that  $g'(q^*) = 0$ . ■

Considering the choice of voting rule as a result of equalizing the marginal cost and the marginal benefit of more stringent supermajorities resembles the

classic analysis by Buchanan and Tullock (1962). In our case, however, the benefits and costs are grounded in a particular industrial organization model.

We are also interested in performing comparative statics with respect to the heterogeneity of the cartel. We let

$$(A3) \quad V_G(p, \gamma) = V_B(p + \delta, \gamma),$$

where  $\delta > 0$  is an indicator of the heterogeneity of the cartel, as measured by the conflict of interests between firms. We have

**Corollary 2** *If (A1), (A2), and (A3) are satisfied, then  $q^*$  is weakly increasing in  $\delta$ . In particular, for any given  $n \geq 3$ , there is some  $\bar{\delta}_n$  such that optimal supermajority requirement is not simple majority for  $\delta \geq \bar{\delta}_n$ .*

**Proof.** The result follows from the fact that the derivative of

$$V_B(p(q), q) - V_B(p_G(q), q) + V_G(p(q), 1 - q) - V_G(p_B(1 - q), 1 - q)$$

(corresponding to the marginal benefit) with respect to  $\delta$  is positive, and the derivative of

$$V_G(p_G(q), q) - V_G(p(q), q) + V_B(p_B(1 - q), 1 - q) - V_B(p(q), 1 - q)$$

(corresponding to the marginal cost) with respect to  $\delta$  is negative. To see this, using (A2) and (A3), the first expression can be written as

$$W_B(p(q)) - W_B(p_G(q)) + W_B(p(q) + \delta) - W_B(p_B(1 - q) + \delta).$$

The result follows from  $p(q) < p_B(1 - q)$  (in fact, the optimal price for firms facing bad conditions is now independent of  $\gamma$ ) and the fact that  $W_B$  is concave and achieves a maximum at  $p_B(1 - q)$ . Similarly, using (A2) and (A3), the second expression can be written as

$$W_B(p_G(q) + \delta) - W_B(p(q) + \delta) + W_B(p_B(1 - q)) - W_B(p(q)),$$

and we can use  $p_G(q) < p(q)$ . ■

## 4 Data

In this section we describe the data used in the analysis and summarize some of its key features. Our data consists of a sample of 95 shipping conferences. We obtained information about the voting rules that these conferences employed for setting freight rates from hearings before the U.S. House Committee on the Judiciary (Antitrust Subcommittee) in 1959 (U.S. House Committee on the Judiciary 1960).

The model predicts that the number of firms should influence the choice of a voting rule in that the larger the number of firms, the less likely that unanimity and simple majority will be chosen. Data on the firms in each conference were taken from Croner's Directory of Freight Conferences (1961). The distribution of conferences by number of firms and their relationship to voting rules is shown in Table 2.

TABLE 2. FREQUENCY DISTRIBUTION OF VOTING RULES  
BY NUMBER OF CARTEL MEMBERS

# Members	Total	Unanimous	All Save One	Three Quarters	Two Thirds	Simple Majority
3 - 6	30	18	0	3	4	5
7 - 12	29	6	3	6	9	5
13 - 20	27	4	1	3	17	2
21 -	9	0	0	3	5	1
All	95	28	4	15	35	13

Observations: 95.

Source: See text.

For conferences with fewer than six members, unanimity is the rule most often employed, but for larger conferences the 2/3 rule is most common. An issue that arises is that for several conferences, two voting rules may require the same number of firms in order to win given the current number of firms in cartel. For example, in a conference with six members, both simple majority and the 2/3 rule require four votes to win. Nonetheless, we code the dependent variable uniquely as the rule listed in the data source. The logic behind this decision is that the voting rule was chosen at some prior date (unknown), and the current number of members in the conference may or may not be the same as the original number of members who chose the

voting rule. Entry and exit from shipping cartels occurs, and is facilitated by U.S. law that requires conferences to be “open” to new members. We do, however, assume that the number of firms in the conference is correlated with the original number of firms that chose the voting rule.

Some firms also entered into revenue pooling agreements with other firms in the same conference. Each individual firm still maintained their own vote, although the pooling firms’ interests would be aligned. Theory predicts that if cartel members pool revenues, the choice of a rule is irrelevant. Examining the pooling agreements that were active during the period of our study, however, indicates that almost all such agreements consisted involved only a small fraction of cartel members. Omitting the three agreements where pooling involved more than 50% of the firms does not affect the results presented in the following section. Incomplete pooling will align the interests only of the pooling firms, and thus will not diminish the desire of the rest of the members of favoring super-majority rules in the conditions described in the model. (The pooling agreements are listed in U.S. House Committee on the Judiciary 1960, pp. 778-79.) Either measure of cartel size gave nearly identical results.

The model emphasizes the importance of conflicts of interest between firms in the cartel driven by heterogeneity in costs or quality. Quality is associated with the age of a vessel; newer ships typically have lower operating costs and improved cargo handling capabilities, although fixed costs for new ships are often higher than for old ships (see e.g. Benford 1962 and Stopford 1997). We measure the quality of a firm’s fleet by the average age of the ships that it owns. We computed two measures of quality heterogeneity within a conference: the coefficient of variation and Gini coefficient of the member firms’ fleet quality (corrected for small-sample bias as suggested by Deltas 2003). Data on the ships owned by individual firms and the ages of these vessels were obtained from Lloyd’s Register of Shipping.

Table 3 shows the distribution of voting rules by quality heterogeneity. Unanimity is associated with extremely homogeneous cartels, and supermajorities of  $2/3$  and  $3/4$  are more prevalent in the most heterogeneous cartels. Simple majority is more associated with cartels with moderate degree of heterogeneity. We also include in our estimations the distance in thousands of miles of the route covered by a particular shipping conference. This variable is intended to capture barriers to entry, because distance is positively associated with the fixed cost of establishing service on a particular route because of the need for larger vessels. Distance is taken from the U.S. Navy

(1931) and Reed’s Table of Distances (1953). Although not the focus of our model, it is reasonable to expect that barriers to entry might affect the optimal choice of a cartel voting rule. The threat of competition might demand greater flexibility in response, increasing the desirability of rules approaching simple majority. Perhaps, instead, the threat of competition might create the need to “circle the wagons” and adopt joint retaliation. This may induce some firms to exit the cartel, bringing back issues of self-enforceability we have ignored. Finally, larger supermajority requirements may be enshrined in the cartel agreements to avoid newcomers to have an undesirable impact on price policies. We have no a priori expectation as to which effect, if either, is observable in our sample.

TABLE 3. FREQUENCY DISTRIBUTION OF VOTING RULES  
BY QUALITY HETEROGENEITY

Heterogeneity	Total	Unanimous	All Save One	Three Quarters	Two Thirds	Simple Majority
0.0 - 0.5	12	11	0	0	0	1
0.5 - 1.0	23	4	3	4	6	6
1.0 - 1.5	27	6	1	2	13	5
1.5 - 2.0	17	4	0	3	9	1
2.0 -	16	3	0	6	7	0

Heterogeneity measured by average age coefficient of variation.  
Observations: 95.

## 5 Econometric Results

We model the choice of a voting rule in both an ordered probit and a multinomial logit framework. Results are displayed in Tables 4 and 5, respectively. The dependent variable takes the value 0 for unanimity rule, 1 for all save one, 2 for three-quarters, 3 for two-thirds and 4 for simple majority. The number of firms, a measure of quality heterogeneity, and distance are the independent variables.<sup>3</sup> There are two specifications in each table. In the first, the coefficient of variation of the average age of cartel members’ fleets is used

<sup>3</sup>The cut points or constant terms are not displayed. The results for All Save One are not shown in Table 5 or 6. Full results are available upon request.

as the measure of quality heterogeneity. In the second, the Gini coefficient of the average age is employed.

In the ordered probits, the only statistically significant variable is the number of firms. In both specifications, the greater the number of firms, the greater the probability that voting rules employing lower supermajorities or simple majority will be employed. This is only partial support for the theoretical model. The ordered probits do not detect any significant relationship between our measures of quality heterogeneity and the choice of a voting rule. Because the dependent variable begins with the maximum supermajority (unanimity) and ends with simple majority, one would suspect that an ordered probit would be the preferred technique. However, the Schwarz (1978) model selection criterion indicates that the multinomial logit is preferred. This suggests that there is a qualitative difference between the different supermajority rules that is not captured by the ordered probit.

TABLE 4. ORDERED PROBITS

	Specification #1	Specification #2
# Firms	0.044 (1.98)	0.035 (2.27)
Quality Coeff. of Variation	-0.108 (-0.47)	
Quality Gini Coefficient		0.299 (0.19)
Distance (thousand miles)	0.031 (0.71)	0.045 (0.04)
Log-likelihood	-131.025	-131.106
Schwarz Criterion	-146.964	-147.045

z statistics in parenthesis.  
Observations: 95.

We turn now to the multinomial logits. In Table 5, simple majority is the base case. In the first specification, the number of firms is statistically significant (and negative) only in the comparison between unanimity and simple

majority. This is consistent with the data presented in Table 3. Increased quality heterogeneity, as measured by the coefficient of variation, on the other hand, is positively associated with all supermajority rules relative to simple majority. The degree of significance is stronger for the three-quarters and two-thirds rules than for unanimity. Distance is statistically significant only in its positive relationship with the two-thirds rule relative to simple majority. The results of this specification are quite supportive of the theoretical model, illustrating the importance of the number of firms and quality heterogeneity in influencing cartels' choices of voting rules.

TABLE 5. MULTINOMIAL LOGITS

	Specification #1			Specification #2		
	Unanimity	Three Quarters	Two Thirds	Unanimity	Three Quarters	Two Thirds
Firms	-0.268 (-2.51)	-0.036 (-0.40)	-0.014 (-0.16)	-0.164 (-1.91)	0.102 (1.49)	0.118 (1.73)
Quality Coeff. of Variation	1.355 (1.76)	1.931 (2.57)	1.910 (2.80)			
Quality Gini Coefficient				2.702 (0.76)	4.363 (1.24)	6.44 (1.77)
Distance (1000 miles)	0.052 (0.37)	-0.292 (-1.30)	0.293 (1.84)	-0.005 (-0.04)	-0.390 (-1.93)	0.234 (1.40)
Log-likelihood	-108.253			-110.332		
Schwarz Criterion	-137.853			-139.932		
Hausman Test $\chi$ -square (2,12)	3.64			0.81		

z statistics in parenthesis. Base case is simple majority. Observations: 95.

The results in the second specification are also supportive of the model, albeit that specification has a lower log-likelihood than the first. The coefficient on the number of firms is now significant for the three supermajority

rules. Interestingly, it is negative only for unanimity. That is, the larger the number of firms the more likely it is some intermediate supermajority requirement. This is entirely consistent with the theoretical model. The Gini coefficient measure of quality heterogeneity is not significant, although the coefficients have the same sign as in the previous specification. Distance is now significant (and negative) when comparing the three-quarters rule to simple majority.

A major criticism of applying the multinomial logit is the assumption of the independence of irrelevant alternatives. Hausman and McFadden (1984) propose a test of the reasonableness of this assumption by arbitrarily dropping one decision and seeing if the coefficients on the others change dramatically. We conducted this test, and the  $\chi$ -square statistics are reported in Table 5. In both instances, we are unable to reject the null hypothesis that the assumption is valid.

Using the coefficients estimated from the multinomial logits, we have calculated the predicted probabilities for the voting rules and varied one of the independent variables, holding the others constant at their median values. Figures 1 and 2 illustrate the effect of increasing heterogeneity on the predicted voting rule according to the first and the second specification, respectively. In both cases, the effect is a dramatic reduction in the probability of adopting simple majority. The effect is more stark in Figure 1. Going from relatively homogeneous to mildly heterogeneous cartels increases the probability of any voting rule other than majority. Figures 3 and 4, in turn, illustrate the effects of increasing the number of firms in the cartel on the predicted voting rule according to the first and the second specification, respectively. In both cases, it is clear that a larger number leads away from unanimity toward the two supermajority rules (two-thirds and three-quarters). Figure 4, unlike Figure 3, shows also an effect of larger numbers toward reducing the probability of adopting simple majority rule.

Table 6 shows the marginal effects computed according to the specifications in Table 5. An examination of the marginal effects confirms the basic conclusions of the Table 5. There appear to be strong incentives to avoid the unanimity rule when the number of firms is high, and cartels tend to choose the two-thirds and to a lesser extent the three-quarters rule in that case. These results mirror those presented in Table 3. Quality heterogeneity reduces the probability of choosing simple majority and increases the probability of choosing the two-thirds rule. Cartels serving longer routes, perhaps indicating higher barriers to entry, tend to favor the two-thirds rule, and

shorter routes the three-quarters rule. Thus, there is some evidence that lower barriers to entry induce cartel members to “circle the wagons.”

TABLE 6. MARGINAL EFFECTS EVALUATED AT MEANS

	Specification #1			
	Unanimity	Three Quarters	Two Thirds	Simple Majority
Firms	-0.046 (-3.24)	0.006 (0.77)	0.027 (1.92)	0.013 (1.18)
Quality Coeff. of Variation	-0.012 (-0.10)	0.069 (1.00)	0.210 (1.72)	-0.230 (-2.54)
Distance (1000 miles)	-0.013 (-0.70)	-0.052 (-2.67)	0.077 (2.72)	-0.018 (-0.94)

	Specification #2			
	Unanimity	Three Quarters	Two Thirds	Simple Majority
Firms	-0.044 (-4.40)	0.011 (1.75)	0.040 (3.31)	-0.004 (-0.41)
Quality Gini Coefficient	-0.300 (-0.52)	0.052 (0.17)	1.000 (1.47)	-0.717 (-1.54)
Distance (1000 miles)	0.014 (-0.75)	-0.057 (-3.40)	0.073 (2.48)	-0.010 (-0.50)

z statistics in parenthesis.  
Observations: 95.

In sum, the econometric evidence provides substantial, although not overwhelming, support for the theoretical model. Quality heterogeneity is associated with larger supermajorities, up to a point, and increased cartel membership is associated with reduced use of the unanimity rule in favor of lower supermajorities.

## 6 Conclusion

In order to understand the choice of voting rules by legal cartels, we propose a simple theoretical model based on the idea that cartels maximize expected profits. The model predicts that cartels with more firms will favor neither unanimity nor simple majority. The model also predicts that heterogeneous cartels will not favor simple majority. Empirical exercises using a database from the U.S. shipping cartels of the mid-20th century provide substantial evidence to the model. The empirical analysis also suggests that lower barriers to entry induce the adoption of intermediate supermajority rules, an issue we will explore in future work.

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Figure 1: Predicted Probabilities of Adopting Voting Rules as a Function of Firm Heterogeneity (Specification #1)

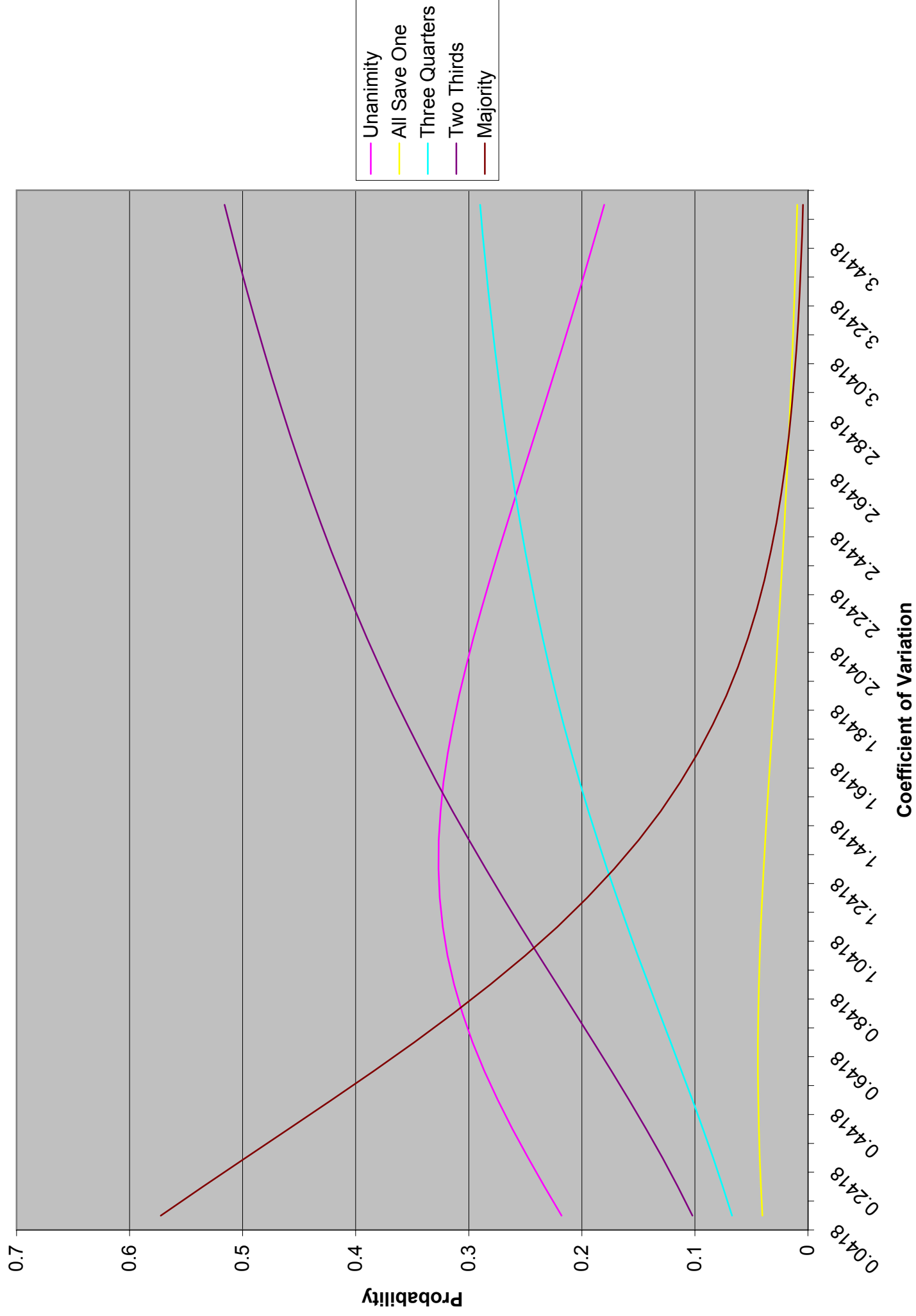


Figure 2: Predicted Probabilities of Adopting Voting Rules as a Function of Firm Heterogeneity (Specification #2)

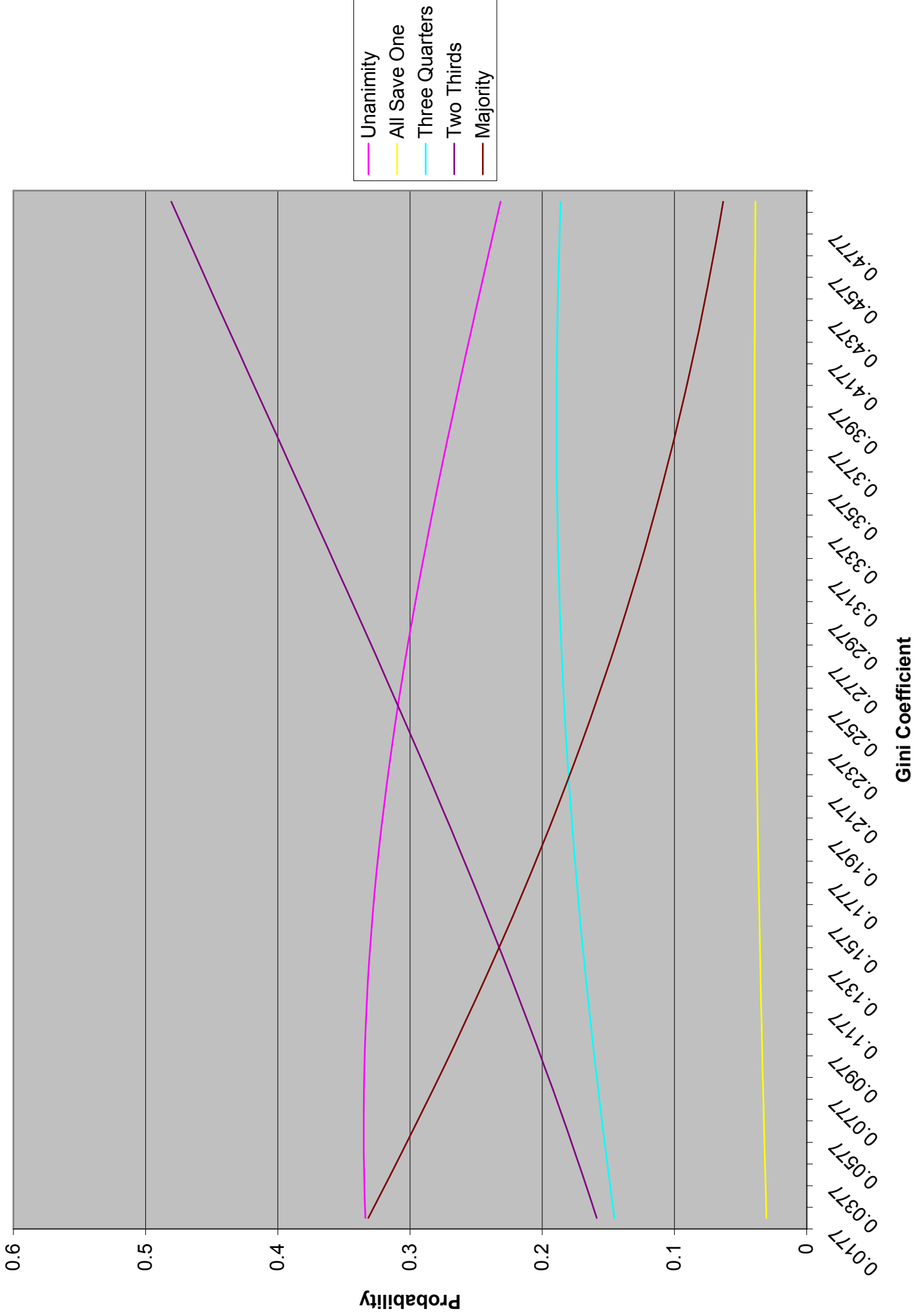
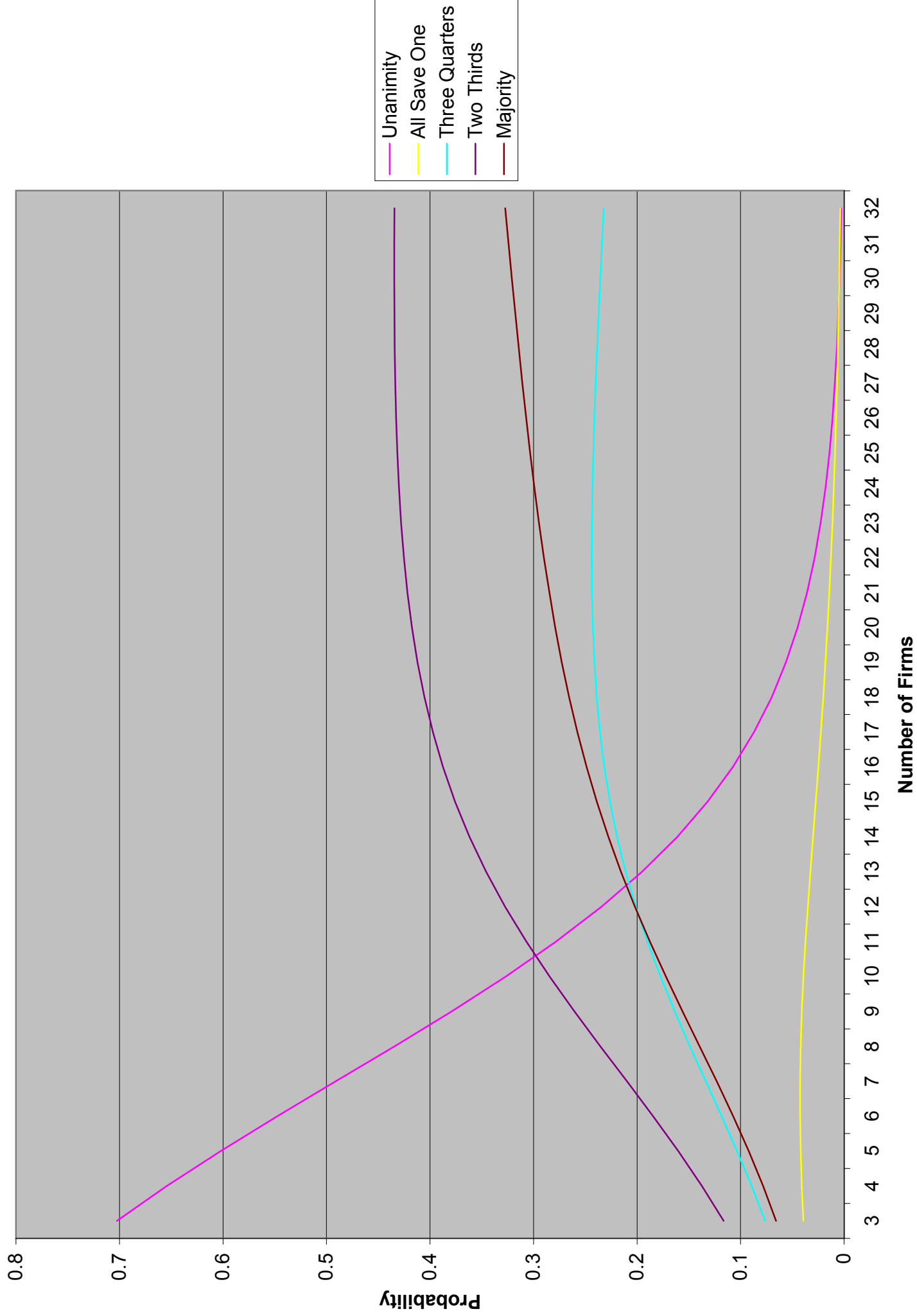


Figure 3: Predicted Probabilities of Adopting Voting Rules as a Function of the Number of Firms (Specification #1)



**Figure 4: Predicted Probabilities of Adopting Voting Rules as a Function of the Number of Firms  
(Specification #2)**

