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The Pricing of Shares with Different Voting Power and the Theory of Oceanic Games

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Kristian Rydqvist

Contents

1. Introduction and Summary

On the Stockholm Stock Exchange, several firms have listed shares which carry different voting rights but which are identical in all other respects. The shares with high voting power usually command a price premium, which is very small in some firms but which can far exceed 100 % in others. The purpose of this dissertation is to explain the price difference for shares with different voting power. The aim is to provide a rationale both for the existence of the voting premium and for the cross-sectional variation. The methodology and limitations of the study will be presented in this introductory chapter, which closes with a summary of the dissertation.

1.1 Methodology and Limitations

The different prices for shares with different voting rights are a measure of the value of the vote. Votes are used at the corporate meeting to elect the board of directors, who have control over the decision-making process of the firm.

The existence of a price premium for high-vote shares thus implies that control has economic value. The value of control will be discussed in Chapter 2. The analysis starts from unanimity theory, which is concerned with the conditions when control has no value. The critical assumption of unanimity is identified, to indicate the main source of the value of control.

Control is a collective-choice problem which is solved with the help of the simple majority rule and the votes attached to the shares. This situation seems to imply an unequal distribution of power among shareholders. A major shareholder with a large block of shares has more influence on the decisions of the firm than a minor shareholder with a small stake. A majority shareholder, for example, will make all decisions himself. Thus, the right of control and the related economic value fall in their entirety to the majority shareholder with nothing over for the remaining shareholders. The value of a vote inside or outside a block of shares will thus generally be different.

This problem, the distribution of power among shareholders, is the subject of Chapter 3, which presents a model of the power distribution designated as the theory of oceanic games. The model regards the voting premium as a function of the shareholder structure, and it is found to be empirically highly relevant.

In addition to the problems concerning the value of control and its distribution among shareholders which apply to all corporations, there is also the problem of how voting power differentiation influences the value of the vote. The price premium should depend on the voting differential and the proportion of high-vote shares.

To sum up, three problems will be addressed below:

- What is the source of the value of control?
- How is the value of control distributed among the shareholders?
- What is the impact of the voting differential and the proportion of high-vote shares?

The answers to these three problems provide a rationale for the existence of the voting premium and the cross-sectional variation.

1.2 Previous Research

Practically no previous research exists concerning the value of control. In financial literature, the conditions of unanimity are clear: unanimity implies that control has no value. The critical condition studied is the assumption of spanning (see Chapter 2). When spanning does not hold, control is valuable because it provides an opportunity for choosing production level. This conclusion is derived direct from unanimity theory and can be found explicitly in Daems (1978).

The choice of production level (with known return on investment for each choice) is a minor decision for the shareholders and so cannot be a great source of the value of control. In Section 2.5 I therefore suggest another source of the value of control, namely disagreement about the shape of the production function. This means that the shareholders have different ideas about what production function is most efficient. In this case control is valuable with or without spanning (since an efficiency gain or loss affects the value of the firm in both complete and inomplete markets). The role of asymmetric information in takeovers has been previously analyzed by Stiglitz (1972), Grossman and Hart (1981), and Baron (1983) but these authors do not explicitly deal with the value of control. Manne (1964, 1965) recognized the considerable gains to be made from exchanging inefficient management, but he did not explicitly raise the question as to why there had to be a takeover in order to run the firm efficiently. The answer to this question suggested in Section 2.5 is that the shareholders disagree about which production function is most efficient (since they have different ideas about it).

In the literature there is another hypothesis regarding the value of control. It is noted that the minor shareholders delegate decision-making to inside shareholders, because it does not pay for the minor shareholders to collect costly information and to attend the corporate meeting when they have almost no chance of affecting the outcome. As a result of this delegation, and because of the cost of writing and enforcing perfect contracts, inside shareholders can acquire personal benefits at the expense of the shareholders as a whole (Jensen and Meckling, 1976). I have called this the agency hypothesis of the value of control, as examined by Meeker and Joy (1980) for example.

According to the agency hypothesis, there is unanimous agreement among shareholders that some decisions decrease the value of the firm. The controlling premium is then the value of the benefit to the controlling shareholder at the expense of the firm. Or, from the point of view of the minor shareholders, the controlling premium is a risk premium to cover the probability of value-decreasing decisions as a result of contracting costs.

According to the information hypothesis of the value of control, the shareholders disagree about whether some decision increases or decreases the value of the firm. The controlling premium is paid by the controlling shareholder to ensure that the most efficient production function will be chosen. From the point of view of the minor shareholders, the controlling premium is a risk premium to cover the probability that what they believe to be the most efficient production function will not be chosen.

The agency hypothesis of the value of control will not be discussed in the dissertation. It will be generally assumed that all shareholders cast their votes for all decisions of the firm.

The second problem in the dissertation is the distribution of power among shareholders. This kind of problem can be analyzed as a cooperative game. There are basically two models: the Shapley value (Shapley, 1953) and the Banzhaf value (Banzhaf, 1965).

Milnor and Shapley (1961) applied the Shapley value to the corporate meeting to determine the distribution of power among shareholders. They computed the Shapley value for a few major shareholders individually and for an infinite number of minor shareholders collectively. The model was named "the theory of oceanic games", which refers to the ocean of minor shareholders and which also appears in the title of my dissertation.

In the present dissertation, the theory of oceanic games is empirically investigated. It is one of the first and most powerful tests of the Shapley value. The data supports the hypothesis that the theory of oceanic games provides an empirically relevant description of the power distribution.

The third problem addressed below is: how should we model the way in which voting differentials and the proportion of high-vote shares affect the voting premium. Levy (1982) constructed a voting inequality index which related the proportion of high-vote shares to equity. The larger the high-vote shares' percentage of the votes in relation to the proportion of equity, the larger the predicted price premium for the high-vote shares. Levy (1982) tested the voting inequality index and found it empirically relevant.

Levy's voting inequality measure will not be described here, because his index represents an approximation of an exact measure of voting inequality, such as will be derived in the present dissertation. The voting inequality measure presented in Chapter 4 shows the precise relation between the price of one vote in a firm with only one class of common shares and the price of one vote in a firm with two classes of common shares. The accuracy of the measure permits the use of the price of a vote in a firm without voting power differentiation as the latent dependent variable. This is valuable in the statistical analysis.

There has been very little previous research directly devoted to the pricing of the vote and its cross-sectional variation.

Manne (1964) wrote the seminal paper on the pricing of the vote. He defined the vote and the investment segment of the share price, where the vote segment is what is paid for the vote attached to the share. He hypothesized that the vote segment varied with the performance of the firm. In a poorly run firm, the vote segment is large, since a raider can profit from acquiring votes and replace the incumbent management. (As we shall see in Chapter 2, the vote segment is large when there is shareholder disagreement, something which can occur in either profitable or unprofitable firms.)

Lease et al (1983) measured the voting premium for firms in the USA. These authors did not try to explain the cross-sectional variation. Levy (1982) estimated the voting premium on the Israel Stock Exchange. He could explain some of the cross-sectional variation with the help of his voting inequality index. Meeker and Joy (1980) estimated the premiums for majority blocks of closely-held bank shares. They measured the transaction price against the book value of the firm and found considerable premiums (50-70 %). DeAngelo et al (1985) presented four cases with differential takeover bids for firms with two classes of voting shares. The high-vote shares were offered a premium of between 83.3 % and 200.0 % over the shares with low voting power. The authors did not aim to explain the cross-sectional variation.

1.3 Summary

The present dissertation is concerned with the pricing of the vote. Three problems will be analyzed: what is the value of control, how is it distributed among shareholders, and how is it distributed between high-vote and low-vote shares?

Chapter 2 is concerned with the value of control. Control has no value, if there is unanimity among shareholders. However, disagreement can generally be expected. Control may have a value connected with choosing the production function. This value stems from disagreement about how to run the firm efficiently. A shareholder with majority control can ensure that the firm is efficiently operated from his point of view. The remaining minority shareholders have to accept the risk that the firm may be run inefficiently according to their ideas. The value deriving from selecting the most efficient production function can be considerable.

Chapter 3 presents a model of the power distribution among shareholders, and this is designated the theory of oceanic games. The model predicts the value of a vote inside or outside a block of shares. There are three testable hypotheses: the power ratio of the minor shareholders may predict the price premium for high-vote shares in the daily trading between the minor shareholders; the power ratio of blocks may predict the controlling premium in block trades; and the model may predict the likelihood of power struggles.

In Chapter 4 a measure of the percentage weight of a vote is derived, and is designated voting inequality. This is a function of the voting differential and the proportion of high-vote shares. The voting inequality measure is used to let the price of the vote in a firm without voting power differentiation act as the latent dependent variable. This retains two degrees of freedom in the statistical analysis.

Chapter 5 describes the sample which includes firms listed between 1 January 1975 and 31 December 1985. The price difference for shares with different voting power is estimated for a sample of 20 firms during 1975-1983 and 40 firms during 1984-1985. Descriptive data show that voting power differentiation and crosswise shareholding have become increasingly popular as control devices. The degree of concentration in the shareholder structures has increased dramatically during the sample period. The voting premium has increased from close to zero in the 1970's to roughly 5 % in the last three years. These are all indications of increased competition for corporate control during the 1980's.

In Chapter 6 it is shown that the voting premium can be predicted by the Shapley value. The model is not significant until 1983, which coincides in time with a dramatic increase in competition for corporate control in Sweden. The hypothesis that the Shapley value can predict controlling premiums in block trades and that some shareholder structures are more unstable is also supported.

2. The Value of Control

Control is the right to make production decisions in a firm. It is a right of the shareholders who have votes attached to their shares. If all shareholders agree on all production decisions, control has no value and the voting right is worthless. It is the purpose of this chapter to identify when there is unanimity, and to point out the major source of disagreement when unanimity does not obtain.

The analysis is simplified to cover two production decisions: the choice of production function and the choice of production level. The firm is all-equity financed, and the output is paid as dividends. Thus, financing and dividend policy cannot be a source of shareholder disagreement.

The first step is to examine the conditions of unanimity when there is agreement on production function but possible disagreement on production level. This is in line with traditional unanimity theory. In the second step of the analysis, the shareholders may disagree on both production function and production level.

The purpose of the present chapter is to structure the problem. Sections 2.2 through 2.4 provide a survey of unanimity theory. Section 2.5 is about the choice of production function, which has not been analyzed before.

2.1 Uncertainty

Uncertainty is preponderant in decision making. In economic analysis uncertainty is handled by introducing states of nature, or states of the world. A state of nature is a non-random description of the world at a future date. The set of states, or state space, contains information about all future events that could affect the welfare of some individual in the economy. Thus, the states of nature provide all the information about the future relevant to a decision at a present date, except what state of nature will actually occur. The individual associates with each state of nature a subjective probability of the state actually occurring at the future date.

In the analysis in this chapter it is assumed that there is only one good, and this is envisaged as wealth. The welfare of the individual is affected only by the amount of wealth which he can acquire. Wealth is achieved through the acquisition of securities. An Arrow-Debreu or primitive security is a contingent claim which promises to deliver one krona at a future date contingent on the state of the world. If the specified state occurs, the Arrow-Debreu security pays one krona; otherwise it is worthless. A normal or complex security is a contingent claim which pays off different amounts in more than one state of the world.

Since the welfare of the individual is affected only by the amount of wealth acquired from securities, the state space is defined by all combinations of future payoffs of the available securities. A market is said to be complete, if there are at least as many linearly independent securities as there are states of nature. An Arrow-Debreu economy is such that there is exactly one Arrow-Debreu security for each state of nature. The Arrow-Debreu economy is a complete market. A set of normal securities may also span a complete market.

It can be noted that the subtraction or addition of a linearly independent security may change a market from complete to incomplete, or vice versa. When the shareholders vote on the production function, they vote yes or no to replacing an old security by a new one, which may change the state space.

A state price or implicit price is implied from a set of complex securities. One of many possible state prices is the marginal rate of substitution between consumption at a future date in a specified state of the world, and consumption today. In an Arrow-Debreu economy the individuals can trade until their state prices equal the price of an Arrow-Debreu security, which pays one krona in the corresponding state of the world. In a certain world, the state price will equal the safe interest rate. The price of a normal security is a weighted sum of implicit prices, where the weights are the state-contingent payoffs of the security.

The implicit prices are individual-specific. In a complete market, the individuals can trade until the implicit prices are equal for all individuals and states. Individuals will then evaluate each state equally, and all individuals will price a new linearly dependent security identically.

2.2 The Model

In this section, a model is presented, which is a variant of the model introduced by Diamond (1967) and later used by Drèze (1974), Hart (1977), and Baron (1979).

General Assumptions

- The decision rule of the firm is to pursue production decisions which are supported by a majority of the votes.
- There is no separation of ownership and control, and there is no agency problem.
- The economy lasts for two periods only.
- There is only one good, which is used for consumption and as input into production. The good is envisaged as wealth.
- There is a finite set of $i = 1 \ldots I$ individuals, $j = 1 \ldots J$ firms, and $s = 1 \ldots S$ states of the world.

Consumers

- The individuals maximize a von Neumann-Morgenstern expected utility of wealth function. The utility function, U_{is}, is individual-specific and state-dependent.
- The utility functions are strictly increasing, strictly concave, and continuously differentiable.
- The individuals have different subjective beliefs about the states of the world, $\pi_i = (\pi_{i1} \ldots \pi_{iS})$. This heterogeneity is due to asymmetric information. $\pi_{is} > 0$ for all i and s.
- The individuals are differently endowed as regards the amount $\bar{c}_{io}$ of the commodity, and as regards shares $\bar{z}_i = (\bar{z}_{i1} \ldots \bar{z}_{iJ})$ in the J firms. The shares are fractions of each firm so that $\sum_i \bar{z}_{ij} = 1$ for all $j = 1 \ldots J$ firms.
- The individual makes three decisions:
  1/ consumption in period one, c_{io}
  2/ investment in a portfolio of $z_i = (z_{i1} \ldots z_{iJ})$ shares.
  The firm pays the amount a_{js} which is used for consumption in period two, state s, w_{is}, i.e. $w_{is} = \sum_j z_{ij} a_{js}$.
  3/ investment in production opportunities a_{jo} for all $j = 1 \ldots J$ firms.

- The first two decisions represent a portfolio-consumption decision whose outcome is a consumption plan $(c_{io}, w_{i1} \ldots w_{iS})$ which is achieved by holding the portfolio $z_i = (z_{i1} \ldots z_{iJ})$.

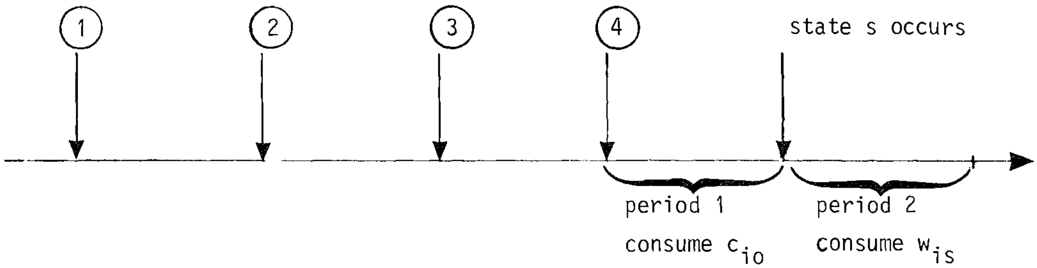
Firms

- The production possibility set is regular (closed, bounded, and contains the origin), strictly increasing, and strictly convex.
- A firm is represented by a production function f_{js} which summarizes the relation between the input a_{jo} in period one and the output in period two $a_{j1} \ldots a_{jS}$, i.e. $a_{js} = f_{js}(a_{jo})$. The production function is firm-specific and state-dependent.
- It is assumed that a change in input level in one firm does not cause a change in another firm, i.e. $da_{ko}/da_{jo} = 0$ for all $k \neq j$.
- The value of the firm is V_j. The initial shareholders invest an amount proportionate to their share in the firm. The total investment is a_{jo}. Thus, the net value of the firm is $(V_j - a_{jo})$.
- The initial shareholders choose the production level a_{jo} according to the simple majority rule. All production decisions are captured by the production plan $(a_{jo}, a_{j1} \ldots a_{jS})$.

Markets

- The individuals trade in the shares of the J firms.
- The markets are perfect and competitive. This perfection means that there are no transaction costs and no taxes, there are perfectly divisible shares, and short sales are permitted.

The whole sequence of events and decisions in the model is shown in Figure 2.1.



1. firms announce their production plans
2. somebody proposes a revision of the input level
3. initial shareholders vote yes or no to proposal
4. the individuals make a portfolio-consumption decision and trade in the shares

Figure 2.1: <u>The Time Sequential Model</u>

In the model there is agreement on the production functions, but the initial shareholders can vote about investment level in each firm. When a firm proposes a change in input level, the shareholders evaluate the proposal and vote yes or no. If all shareholders unanimously vote yes or no to any proposal, control has no value. On the other hand, control is valuable if at least one shareholder votes in the opposite direction on at least one proposal, since there is then a conflict.

Suppose that all revisions are made such that the production plans are fixed. Then the portfolio-consumption decision of individual i is

$$\max_{(c_{io},\, z_i)} \quad \sum_s \pi_{is} U_{is} (c_{io}, w_{is}) \tag{2.1}$$

$$\text{s.t.} \qquad c_{io} + \sum_j z_{ij} V_j \leq \bar{c}_{io} + \sum_j \bar{z}_{ij} (V_j - a_{jo}) \tag{2.2}$$

$$\text{and} \qquad w_{is} = \sum_j z_{ij} a_{js} \qquad , \quad s = 1 \ldots S \tag{2.3}$$

Define the Lagrangian λ_i associated with condition (2.2). The first-order conditions for an optimum are

$$\sum_s \pi_{is} \frac{\partial U_{is}}{\partial c_{io}} = \lambda_i \tag{2.4}$$

$$\sum_s \pi_{is} \frac{\partial U_{is}}{\partial w_{is}} a_{js} = \lambda_i V_j \qquad , \quad j = 1 \ldots J \tag{2.5}$$

Individual i's evaluation of firm j is (from (2.4) and (2.5))

$$V_j = \frac{\sum_s \pi_{is} \frac{\partial U_{is}}{\partial w_{is}} \cdot a_{js}}{\sum_s \pi_{is} \frac{\partial U_{is}}{\partial c_{io}}}$$

or (2.6)

$$V_j = \sum_s R_{is} a_{js}$$

where $R_{is} = \pi_{is} \dfrac{\partial U_{is}}{\partial w_{is}} / \lambda_i$ = the individual i's implicit price of state s

An equilibrium is a set of consumption plans which solve the maximization problem for all individuals subject to market clearing conditions (i.e. $\sum_i c_{io} = \sum_i \bar{c}_{io} - \sum_j a_{jo}$ and $\sum_i z_{ij} = 1$, $j = 1 \ldots J$) and non-negativity constraints on consumption in period one and two (i.e. $(c_{io}, w_{i1} \ldots w_{iS}) \geq 0$). It is a production-exchange equilibrium, if all individuals hold their optimal portfolios and no firm musters support for changing its production plan.

2.3 Unanimity in a Certain World

The certainty case is a special case of the model with only one state of the world, i.e. there is only one security with a risk-free output. The decision problem of individual i in the certain world is shown in Figure 2.2.

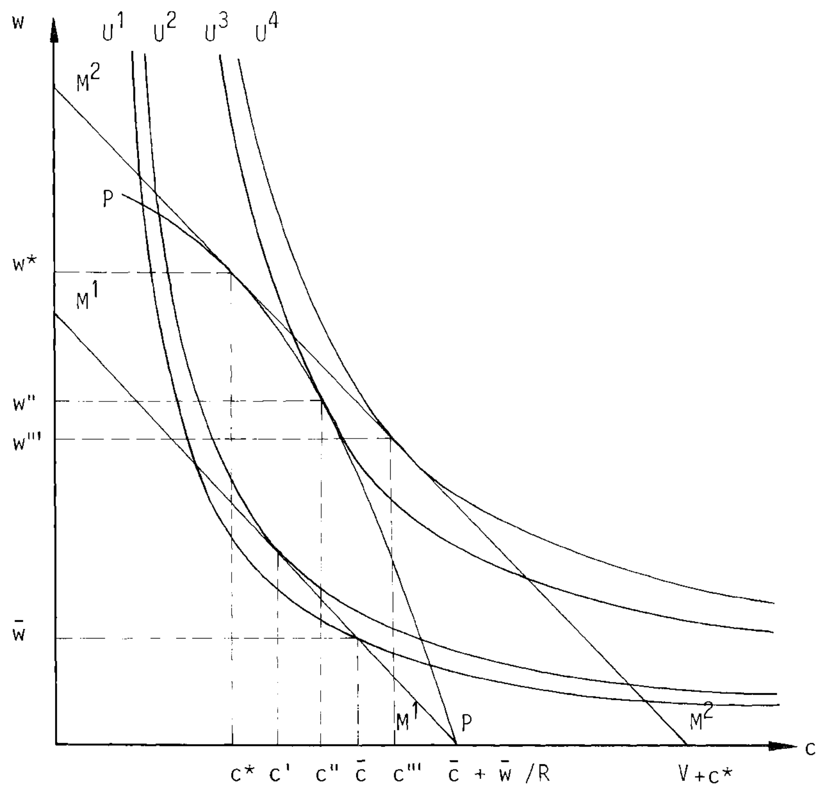


Figure 2.2 : A Capital Market with One State of Nature
Source: Hakansson (1966)

The horisontal axis represents consumption in period one, and the vertical axis consumption in period two. The utility function of individual i is represented by the indifference curves U^1 through U^4. The individual faces both production and market opportunities. The production opportunities of individual i are limited by the production possibility frontier PP. The market opportunities are represented by a set of lines among which M^1M^1 and M^2M^2 are drawn in the figure. Such a line is a capital market line and it has the slope -R, where R = 1 + discount rate.

Without engaging in any transactions or production activity, the individual reaches the utility level U^1 with his endowed wealth of $(\bar{c}\ ,\ \bar{w})$ where $\bar{c}$ is wealth in period one and $\bar{w}$ is an amount of bonds which pay one krona in period two.The net present value of his endowment is $\bar{c} + \bar{w}/R$. If he redistributes his wealth between the two periods, he can reach the utility level U^2. This is achieved by acquiring bonds to the amount of $\bar{c} - c'$.

The individual can further increase his utility by investing in the production opportunities. Investing the amount $\bar{c} + \bar{w}/R-c''$ of which $\bar{w}/R$ is borrowed, he can fulfil consumption plan (c'', w'') which brings him to utility level U^3. But there are still improvements to be made. By investing the amount $a^* = \bar{c} + \bar{w}/R-c^*$ in the production opportunities and then borrowing the amount $c''' - c^*$ for period one consumption, utility level U^4 is achieved with the optimal consumption plan (c''', w'''). The production and consumption plans require total borrowing of $\bar{w}/R + (c''' - c^*)$ in the bond market. The optimal investment a^* maximizes the net present value of the individual's share in the firm, which is $V + c^* - (\bar{c} + \bar{w}/R) = V - a^*$.

The figure tells us that the welfare of the individual is improved by his engaging in both the production and the market opportunities. The figure also immediately implies that any change in the investment level, which pushes the capital market line out from the origin, increases the net present value of the firm and is unanimously supported by all shareholders independently of preferences. It is clear that all shareholders attain their maximal utility when the firm maximizes its net present value. Thus, the firm's objective is value maximization, which is unanimously supported by all shareholders. If the shareholders can delegate to management to maximize the value of the firm, the shareholders do not have to engage in the production decisions. The consumption decisions can then be made independently of the production decisions. This is the Fischer separation theorem.

In the model control means the right to choose production level within the production opportunity set. It is obvious that control has no value if all shareholders prefer exactly the same point, e.g. the point which maximizes the net present value of the firm. There is one prerequisite for unanimity on production level (beside the assumptions of the model). This is the existence of a bond market which allows for choosing the individually preferred consumption level in each period. Consider Figure 2.3 which describes the same world but without a bond market.

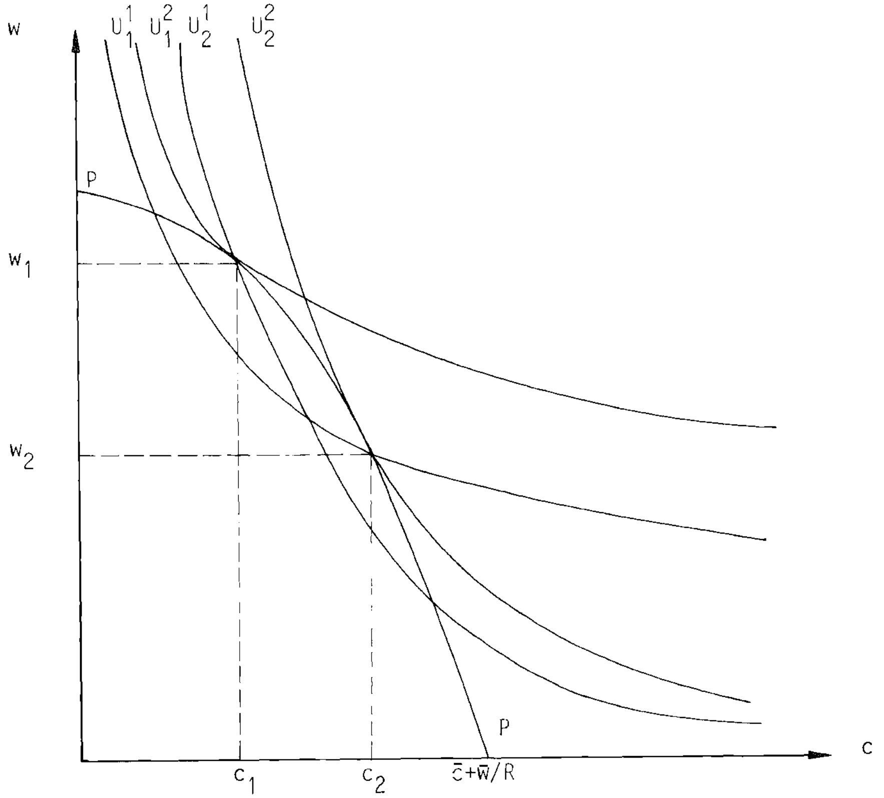


Figure 2.3 : A Certain World without a Bond Market

In Figure 2.3 there are two individuals with the same endowments, $\bar{c} + \bar{w}/R$, who also face the same production opportunities but who have different preferences. Individual 1 is represented by the indifference curves U_1^1 and U_1^2, and individual 2's utility function is represented by the curves U_2^1 and U_2^2. Since there is no bond market, the best individual 1 can do is to invest $\bar{c} + \bar{w}/R-c_1$ in the production. Correspondingly, individual 2 attains his maximal utility by investing $\bar{c} + \bar{w}/R - c_2$. There is disagreement, because the two individuals have to invest in proportion to their share in the firm, and the firm has to choose a single production level. The conflict therefore has to be solved by vote. Control for individual 1 has a value of $U_1^2-U_1^1$, and for individual 2 a value of $U_2^2-U_2^1$ (measured as either compensating or equivalent variations). Thus, if there is no bond market, control has a value from choosing production level even in a certain world.

2.4 Unanimity under Uncertainty

We shall now examine whether the Fischer separation theorem and the unanimity result can be extended to an uncertain world. For a full analysis of this type, see Baron (1979).

Let $(c_{io}^*, w_{i1}^*...w_{iS}^*)$ be the optimal consumption plan achieved with the optimal portfolio $(z_{i1}^*...z_{iJ}^*)$ relative to a set of production plans. Define $W_i^* = W_i^* (c_{io}^*, w_{i1}^*...w_{iS}^*, a_{jo})$ the maximum expected utility of individual i relative to the set of productions plans. The evaluation of a marginal increase in input level in firm j can be found by differentiating W_i^* with respect to a_{jo}. Insert the budget constraints (2.2) and (2.3) into W_i^* and note that indirect derivatives are zero according to the envelope theorem.

$$b_i \equiv \frac{dW_i^*/da_{jo}}{\lambda_i} = z_{ij}^* \sum_s R_{is}\frac{\partial a_{js}}{\partial a_{jo}} + \sum_k(\bar{z}_{ik}-z_{ik}^*)\frac{\partial V_k^i}{\partial a_{jo}} - \bar{z}_{ij} \qquad (2.7)$$

The left-hand side of equation (2.7) is shareholder i's evaluation of a marginal increase in input level in firm j when all other production plans are fixed. The right-hand side decomposes into two parts, a consumption and a wealth effect. The consumption effect corresponds to the individual's role as a consumer, while the wealth effect reflects the individual's role as a producer. The consumption effect is the first part of equation (2.7), which depends on the final shareholdings. The wealth effect is composed of the change in net value of endowments $\left(\sum_k \bar{z}_{ik}\frac{\partial V_k^i}{\partial a_{jo}} - \bar{z}_{ij}\right)$, and the change in the cost of purchasing the optimal portfolio $\left(\sum_k z_{ik}^* \frac{\partial V_k^i}{\partial a_{jo}}\right)$.

In order to evaluate equation (2.7), the individual has to forecast the value of the firm after the change in input level. The perceived change in the value of the firm is found by differentiating (2.6) with respect to a_{jo}, since that equation is satisfied when shareholder i holds his optimal portfolio.

$$\frac{\partial V_k^i}{\partial a_{jo}} = \sum_s R_{is}\frac{\partial a_{ks}}{\partial a_{jo}} + \sum_s \frac{\partial R_{is}}{\partial a_{jo}} a_{ks} \text{ , } k = 1\ldots J \qquad (2.8)$$

The forecast of the change in the net value of the firm is dependent on both a change in the state payoffs $(\partial a_{js}/\partial a_{jo})$ and a change in the implicit prices $(\partial R_{is}/\partial a_{jo})$.

The structure is to evaluate equation (2.7) when the markets are complete. Then the incomplete markets case is examined.

In complete markets, the implicit prices are equal between all states and individuals, i.e. $R_{is} = R_s$ for all i and s. Since no firm can produce what was not available before in complete markets, the implicit prices do not change as a result of the change in the input level of firm j, i.e. $\sum_s \left(\partial R_s / \partial a_{jo}\right) a_{js} = 0$. To put it another way: the consumption effect is cancelled out by the cost of purchasing the optimal portfolio, since there is no consumer surplus to be achieved from the change in investment level in firm j. If the investment in firm j does not affect the value of other firms, i.e. $\partial V_k^i / \partial a_{jo} = 0$ for all $k \neq j$, equation (2.7) reduces to

$$b_i = \bar{z}_{ij} \left(\frac{\partial V_j}{\partial a_{jo}} - 1 \right) = \bar{z}_{ij} \left(\sum_s R_s \frac{\partial a_{js}}{\partial a_{jo}} - 1 \right) \qquad (2.9)$$

Now it can be seen that unanimity obtains, because the implicit prices are equal and all shareholders evaluate the proposal identically. The unanimity concerns value maximization, because the welfare of the individual is maximized when $b_i = 0$, and value maximization implies that

$$\frac{\partial (V_j - a_{jo})}{\partial a_{jo}} = \frac{\partial V_j}{\partial a_{jo}} - 1 = 0 \qquad (2.10)$$

Thus, the utility of the individual is maximized when the firm maximizes its net present value. This is a direct generalization of the Fischer separation theorem to apply to an uncertain world. Complete markets ensure unanimity on value maximization, and the separation of consumption and production decisions becomes possible. Moreover, just as in the certainty case (which is a complete market with a bond market),control has no value.

What if the markets are incomplete? It is clear that, if the implicit prices are equal for all individuals, equation (2.7) takes a positive or negative sign for everybody and unanimity thus prevails. If the individuals are identical, implicit prices are obviously equal for all individuals. Rubinstein (1974) shows what other restrictions on endowments, expectations, and preferences will generate unanimity. The conditions imply unanimity but not necessarily about value maximization, since a change in input level may cause a change in implicit prices (though equally for all individuals). It is then possible that the consumption effect may negatively dominate the wealth effect. In that case, there is unanimous rejection of a value-increasing investment (Baron, 1979). However, all such cases involving in some sense identical individuals, are not very interesting in the present context.

It is possible to obtain unanimity in incomplete markets with heterogeneous individuals. Two assumptions are required, competitivity and spanning.

Competitivity means that each individual perceives his implicit prices as given, i.e. the revision of the production plan does not change his implicit prices. Competitivity is not the same as perfect competition, which means that the value of the firm is unaffected by the trading in shares. The competitivity assumption makes sense, if there are plenty of substitutes (DeAngelo, 1982), or if there are a great many consumers competing for the new state output (Hart, 1979). Individuals cannot then get any consumer surplus from the changed state payoffs of firm j, and the consumption effect is thus cancelled out by the changed cost of purchasing the optimal portfolio.

Formally, competitivity implies that $\sum_s (\partial R_{is}/\partial a_{jo})a_{js} = 0$ so that equation (2.7) is reduced to (again assuming that $\partial V_k^i/\partial a_{jo} = 0$ for all $k \neq j$)

$$b_i = \bar{z}_{ij}\left(\frac{\partial V_j^i}{\partial a_{jo}} - 1\right) = \bar{z}_{ij}\left(\sum_s R_{is}\frac{\partial a_{js}}{\partial a_{jo}} - 1\right) \qquad (2.11)$$

This equation (2.11) is dependent on the individual-specific implicit prices, which are likely to differ in incomplete markets. Spanning, however, ensures that there is a portfolio of $(q_{j1}\ldots q_{jk})$

securities, which replicates the changed state outputs of firm j. Then

$$\frac{\partial V_j^i}{\partial a_{jo}} = \sum_s R_{is} \frac{\partial a_{js}}{\partial a_{jo}}$$

$$= \sum_s R_{is} \sum_k q_{jk} a_{ks}$$

$$= \sum_k q_{jk} \sum_s R_{is} a_{ks}$$

$$= \sum_k q_{jk} V_k \qquad (2.12)$$

and

$$b_i = \bar{z}_{ij} \left(\sum_k q_{jk} V_k - 1 \right) \qquad (2.13)$$

This final equation (2.13) says that all individuals evaluate the investment in firm j as equal to the value of the replicating portfolio, which is already priced in the market. Thus, there is unanimity about value maximization also in incomplete markets, given that spanning and competitivity obtain. There is unanimity because all shareholders know the value of the replicating portfolio, which can be compared with the cost of investment, so that the shareholders agree on the net present value of the investment.

Spanning is a weaker condition than complete markets, but it holds automatically in this case. The spanning condition requires that the markets are complete or incomplete in the same way, independently of the changed production plan of one firm.

This concludes our survey of the traditional theory. The results are summarized in Table 2.1. It is clear that only under special conditions does unanimity obtain and control lack any value.

Equation (2.7) is generally evaluated heterogeneously, which implies that control has a value derived from choosing production level.

Table 2.1 : The Unanimity Conditions with Heterogenous Individuals

1. The Certainty Case

   a. With bond market

      Separation, value maximization, unanimity.
      Control has no value.

   b. Without bond market

      Control has some value from choosing production level.

2. The Uncertainty Case

   a. Complete markets

      Separation, value maximization, unanimity.
      Control has no value.

   b. Spanning and competitivity

      Separation, value maximization, unanimity.
      Control has no value.

   c. Absent complete markets and spanning

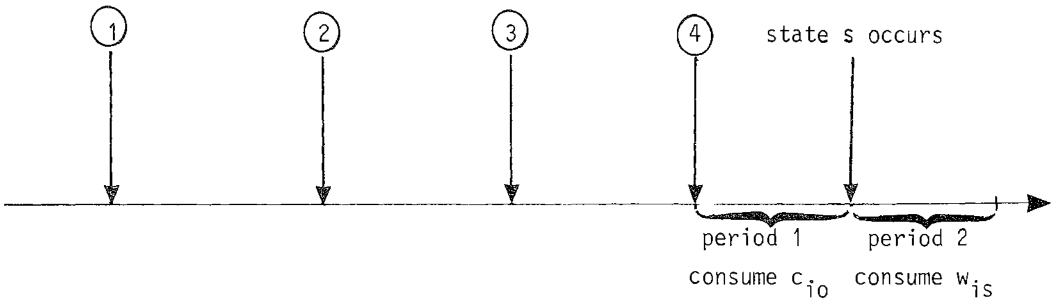
      Control has some value from choosing production level.

2.5 Disagreement about the Shape of the Production Function

Thus far there has been only one production decision, choice of production level. For each possible input level it has been assumed that the shareholders know the exact rate of return a_{js}/a_{jo} for all states of the world. As indicated in Table 2.1, when the rate of return is known for each input level, the choice of production level is hardly a source of great value for control. However, if the shareholders disagree on the rate of return, perhaps due to the choice of production level, then there will be disagreement about the shape of the production function, and the choice of production level may be an important decision. For example, the profitability of a firm may be highly dependent on the scale of the firm or the speed of expansion, which then become the subject of major decisions for the shareholders.

The aim of this section is to introduce disagreement with regard to the shape of the production function. The shareholders meet twice. At the first corporate meeting the proposed production plans to be discussed include both production function and production level. First the shareholders vote about production function, and then choose production level. This is the logical order, since a producer should be mainly concerned with what to produce and how to produce it, before deciding on the exact production level. At the first vote, there is a list of proposed production functions. The voting is always between a current and an alternative production function. If the alternative production function is selected, it then becomes the current function in a comparison with the next proposed production function on the list. Once a production function has been rejected, it cannot reappear. A simple majority vote leads to the selection of one production function. Once the production function has been chosen, the shareholders choose the production level. The outcome is a production plan.

After the corporate meeting, the production plan is implemented. When all production decisions have been made, the shareholders know the true shape of the production function. They may want to meet a second time to revise the production level. This voting is the equivalent of the analysis in the preceding sections, and all the results will apply once the production functions are known. Finally the shareholders make a portfolio-consumption decision, and they trade their shares. The whole sequence of events is illustrated in Figure 2.4.



1. the initial shareholders meet and choose production plan (production function and production level)
2. the production plan is implemented and all shareholders learn the true shape of the production function
3. the shareholders may meet a second time and vote yes or no to revised production levels
4. individuals make their portfolio-consumption decisions and trade their shares.

Figure 2.4: The Time Sequential Model with Two Meetings

The voting scheme in Figure 2.4 and the idea of disagreement on the shape of the production function are best illustrated graphically for the certainty case. Consider Figure 2.5.

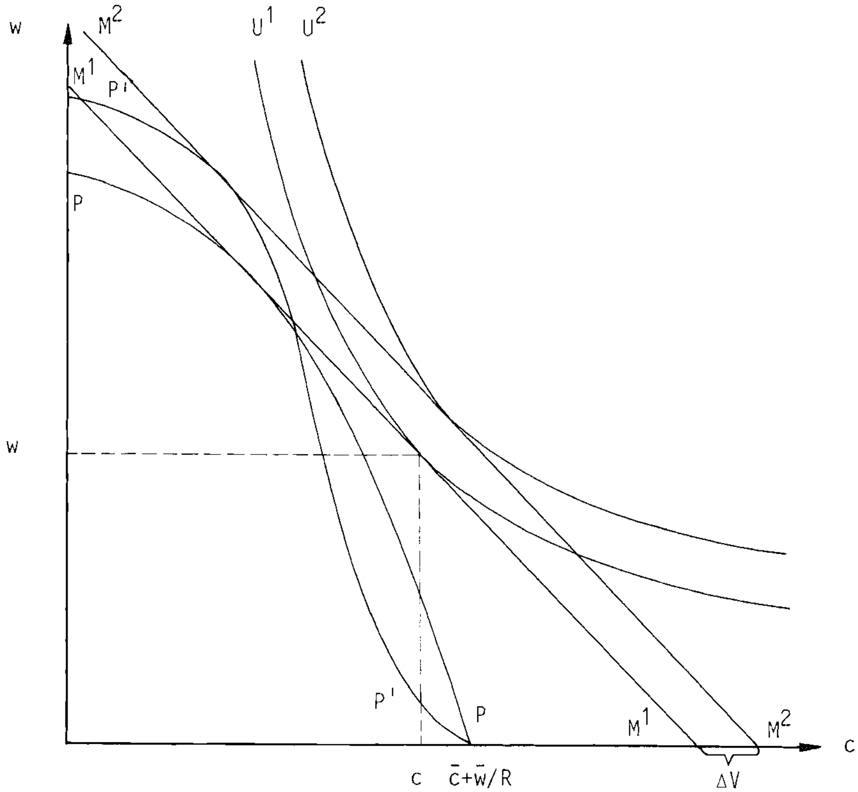


Figure 2.5 : Disagreement about the Shape of the Production Function

Figure 2.5 is a variant of Figure 2.2. The individual is endowed with $\bar{c} + \bar{w}/R$ and his optimal consumption plan is (c , w) given the current production function PP, which promises a certain payoff in period two. However, the individual thinks that he knows how to produce more efficiently. His idea is expressed in the alternative production function P'P', which he proposes at the corporate meeting. If he can realize his production function, he increases the value of his share in the firm by an amount ΔV, which is the value of producing more efficiently.

Suppose that some shareholders believe in the production function P'P', while because of asymmetric information others do not. If the shareholders representing a simple majority of the votes believe in the alternative production function P'P', this will replace the current production function. Those who voted for the production function P'P' will unanimously support the production level which maximizes the net present value of the production function P'P', because there is a competitive bond market. The production function P'P' is implemented, and all the shareholders will learn whether P'P' or something else is the true production function. The shareholders may want to revise the production level when the shape of the true production function becomes known.

The example is an illustration of genuine disagreement about how to produce efficiently. The disagreement is due to asymmetric information, which generates different ideas about which production opportunities are the most profitable. Major decisions which could be subject to shareholder disagreement might concern the speed of expansion, which firms to acquire in an acquisition program, whether salaries can be cut, what product lines to include in a strategy of diversification, etc. There is no conflict, if no cost is attached to setting up a new firm which is identical in all respects except for the critical decision, e.g. the scale of the firm. All shareholders can then buy shares in the firm with their preferred production function. However, it may be prohibitively costly to set up a new firm for a small though economically significant change in the production plan. In this case, control has a value deriving from choosing the production function, because two production functions cannot coexist in one firm. It is a value ex ante, before implementing the production function.

The introduction of uncertainty does not change the analysis. If the markets are complete in relation to the chosen set of production functions, control has a value from selecting the production function but not from choosing the production level, as described in the previous section. The same result applies when there is spanning and competitivity with respect to the set of production functions. When the markets are incomplete and there is no spanning, control has a value from choosing both the production function and the production level.

Disagreement regarding the shape of the production function is often revealed when there is a change in control. A striking example is the Fermenta case (see Affärsvärlden, 1985:45).

Refaat el Sayed acquired Fermenta from the large firm, Astra, which produces medicines. Fermenta produced the basic input for penicillin and for other biotechnical products with the help of an old and well-known production technology. The problem for Fermenta and most of its competitors was the highly volatile demand for their product, which caused a lot of uncertainty about output levels and the price of the product. Refaat el Sayed acquired the unprofitable plant from Astra for next to nothing. Three years later the Stockholm Stock Exchange valued Fermenta at roughly 6000 million kronor, which classified Fermenta as one of the ten largest firms on the Stock Exchange (at its highest the price for Fermenta was 11 000 million kronor, which was even more than for Astra).

What did he do? Refaat el Sayed started acquiring other unprofitable plants around the world until he controlled a major part of world production. He then integrated forward, which made it possible to produce smoothly at high capacity in the various plants, in spite of the highly volatile demand for the base product. The integration of many small entities into one large entity meant that all units were producing efficiently in the large integrated firm.

Fermenta is a spectacular case of shareholder disagreement. If the major shareholders of Astra had believed in Refaat el Sayed's production plan, they would not have sold their plant but would have implemented the alternative production plan themselves. Either they did not know the production plan, or they did not believe in it. Control was therefore traded and Refaat realized his production plan.

There are numerous other examples of changes in the production plan when control is traded. However, there need not necessarily be any voluntary trading of control for implementing a new production function. A firm can be raided, as in the Sandvik case described in Affärsvärlden 1984:7.

The old controlling shareholder in Sandvik expanded the firm through a series of acquisitions during the 1970's. A few years later, the steel industry experienced a recession, but the shareholders stuck to the too-large production capacity, possibly in the hope of an increase in demand for their products. The share price fell considerably during those years,until a raider started acquiring votes. In this way the raider, Skanska, assumed control of the board within a few weeks. Skanska then cut down production capacity and fired a great many people. Two years later the Sandvik share had become one of the best shares on the Stock Exchange.

The Sandvik case is an illustration of heterogeneous ideas about the demand for the products. The old controlling shareholder believed in high production capacity, or did not believe that he could successfully reduce production capacity. The raider apparently believed that he could reduce production capacity and transform unprofitable production into profitable.

The two cases are examples of actual changes in the production plansof firms, due to shareholder disagreement about the shape of the production function. In a dynamic multi-period context some shareholder may consider holding large blocks of shares in order to prevent undesired changes in the production plan. The controlling block of shares then has a strategic value for future conflicts about production decisions, which are unknown but likely. A striking example is the entrepreneurial firm. The entrepreneur is an individual who typically holds a diverging opinion about what production function will be most profitable. The entrepreneur strives to keep control of his firm so as not to endanger his preferred production plan, because he may be the only person who believes in it. If the production plan is replaced by another, the entrepreneur cannot realize the profit from his superior information.

I believe that conflicts about the production function can be the major source of the value of control. There is empirical evidence that control is economically significant: power struggles, the acquisition of large blocks of shares at a considerable premium, the holding of large blocks of shares instead of diversifying, etc. These observations may well be explained by heterogeneous expectations about the profitability of various production opportunities. For example, consider two shareholders who want to profit from their ideas about the high, or the low, demand for steel products. The one who holds the largest block of shares has the highest probability of initiating his own production plan and preventing the alternative plan. If the two shareholders are equally strong, perhaps each holding 30 % of the votes, they may be prepared to spend a lot of money to acquire a few additional votes. This I think is the typical case of a power struggle. The value of holding controlling blocks of shares derives from the prevention of future power struggles. And this value may be sufficiently high to offset the cost of bearing diversifiable risk. The entrepreneurial firm is perhaps the best illustration of the point, but control can be of great value also in mature businesses.

2.6 Conclusions

The analysis has been limited to a model with several assumptions. It has been shown that control lacks value only under certain specially favorable conditions. It can thus generally be expected that shareholders will disagree on production decisions, so that the voting right thus has a value.

Conflicts about production decisions may arise whenever an assumption of the model does not hold. For example, there may be conflict about financing and dividend policy. However, I believe that the major source of the value of control is asymmetric information about the shape of the production function or, equivalently, that ideas vary as to which production opportunities are likely to be most profitable.

3. The Distribution of Power among Shareholders

The preceding chapter has shown that control is valuable, because the shareholders usually disagree on the choice of production plan. The value of control has to be shared in some way, because control is a collective choice problem. It is the purpose of this chapter to present a model which distributes the value of control among the shareholders. It will be shown that the value of control is generally distributed disproportionately among the shareholders, so that the value of a vote differs inside or outside a block of shares.

The model is the Shapley value which is applied particularly to the theory of oceanic games. This is a model of the corporate meeting with a few major shareholders holding large blocks of shares, and an ocean of an infinite number of minor shareholders with infinitesimally small shareholdings. The Shapley value of each of the major shareholders or of the collective of minor shareholders reflects the ability of the respective shareholders to affect the outcome of a vote, i.e. the Shapley value reflects the power of the individual shareholder. Loosely interpreted, the power of a shareholder determines his share in the right to control and in the value of control.

The power ratio is the Shapley value per share. The main argument of this chapter is that the oceanic power ratio can predict the price premium for shares with high voting power. It is also hypothesized that the power ratios of the major shareholders predict the control premiums of blocks of shares, and that the power ratio of the minor shareholders can predict the stability of a shareholder structure. The empirical application of the model in Section 3.6 is a contribution to the theory of games.

3.1 The Shapley Value

The shareholders vote about production plans at the corporate meeting. Usually a simple majority of the votes selects the production plan. If one shareholder has more than 50 % of the votes, he can select his preferred plan. But if there is no majority shareholder, a coalition has to be formed to be able to select the production plan.

Cooperative game theory is about coalition formation. The theory is concerned with what coalitions form, and with the value which a coalition can achieve. The analysis in this chapter is limited to the value issue.

The following set of assumptions applies throughout the chapter.

- Control is valuable, i.e. there is conflict about the choice of production plan.
- It costs nothing to cast a vote and to form a coalition, there is no separation of ownership and control, and there is no agency problem.
- The shareholders, interchangeably referred to as players, maximize a von Neumann-Morgenstern expected utility function.
- Sidepayments are permitted. Some shareholders may compensate others for voting against their preferences.
- Sidepayments require that utility is linearly transferable. Sidepayment is effectuated by way of some good, e.g. wealth. This implies that the utility function is risk-neutral.
- The analysis is static, i.e. preferences, expectations, and endowments (votes) are exogenous.

Cooperative games are usually analyzed in terms of a characteristic function. Let N be a finite set of players and let S be a subset of N. The characteristic function of a game v is a function which associates a real number with the utility which a coalition can guarantee its members. v(S) is the minimal utility which the coalition S can achieve. The utility v(S) is obtained when the complementary coalition N-S is formed to oppose the coalition S. The game is then reduced to a two-person game played by the coalitions S and N-S. The complementary coalition may not be formed, in which case the characteristic function may underestimate the utility of the coalition S. v(N) is the total utility of the grand coalition to all players in a game.

The characteristic function does not specify how the utility is distributed among the members of a coalition, which means that utility must be linearly transferable among the members. The characteristic function is usually normalized and assessed with the superadditivity property.

$$v\ (\emptyset) = 0 \qquad \text{(normalization)}$$

$$v\ (S \cup T) \geq v(S) + v(T) \text{ for all } S,T\text{: } S \cap T = \emptyset \qquad \text{(superadditivity)}$$

Superadditivity is a weak assumption which implies that cooperation is no worse than acting individually, and may be beneficial. Superadditivity implies that v(N) is a sum of something.

The choice between a current and an alternative production plan can be regarded as a cooperative game. The shareholders can form coalitions of yes and no voters. Since the present dissertation is about the pricing of votes, the question arises: what is the value of a vote, a priori, for a player in a voting game? This ought to reflect the price of the vote.

Shapley (1953) analyzed the player's problem in evaluating a game before actually playing it, e.g. a shareholder's evaluation of a vote before using it at the corporate meeting. He approached the problem with a set of axioms which the player's evaluation ought to meet, and showed that a set of three axioms was sufficient to uniquely determine the player's expected value from participating in a game.

Let $\varphi_i(v)$ be the expected value to player i of participating in the game with the characteristic function v. Let w be some other characteristic function, and let π denote a permutation of the players, i.e. an ordering of the players in the game. The three axioms of the Shapley value are then

1. $\sum_{i \in N} \varphi_i(v) = v(N)$ (efficiency)

2. $\varphi_{\pi(i)}(\pi v) = \varphi_i(v)$ (symmetry)

3. $\varphi_i(v+w) = \varphi_i(v) + \varphi_i(w)$ (aggregation)

The efficiency axiom says that the sum of the values for all players equals the total utility of the game. It means that the players' subjective evaluations of the game are consistent. If some players are too optimistic about their opportunities in the game, the distribution of the expected values is not feasible and it is not possible for all players to get what they expect. Again, if some players are too pessimistic, the distribution is not efficient and the players may get more utility from the game than they expect.

The symmetry axiom states that the value of a player is dependent on the characteristic function only. It means that the value of the game is dependent on the player's strategic position in the game and independent of the names of the other players. There are no relations between the players outside the game which can affect the player's utility.

The aggregation or linearity axiom states that there are no interaction effects between two games, so that a player is indifferent between playing the two games separately or playing them as one game. For example, the value derived from participating at two corporate meetings is merely the sum of the value of each voting game.

The axioms and the general formulation of the Shapley value is discussed in Section 3.6, when the predictions of the model have been examined. If the players evaluate a game in accordance with the three axioms, there is only one way which they can compute the expected utility from participating in a game. It is the Shapley value.

$$\varphi_i(v) = \sum_{S \subseteq N-\{i\}} \frac{s!(n-s-1)!}{n!} \left[v(S \cup i) - v(S)\right] \tag{3.1}$$

Minuscule s and n are the number of players in coalition S and in the grand coalition N respectively. The summation covers all coalitions excluding player i. The coefficient of each term is the probability that coalition S is formed. The second half of each term is the contribution of player i to the value of coalition S. Player i gets all his contribution.

A heuristic interpretation of the formula (3.1) is to consider a meetingplace at which each player arrives in turn. Each player gets his marginal contribution to the coalition of players who have already arrived. All orderings of the players are equiprobable. Thus, formula (3.1) is the expected marginal contribution of player i.

The Shapley value is thus a measure of the expected value to be derived from casting a vote at the corporate meeting, for example. Roth (1977) has shown that the Shapley value is a cardinal and risk-neutral utility function, which can rank games. The vector $\varphi = \left[\varphi_1(v), \ldots, \varphi_n(v)\right]$ is the distribution of the values in the game. It can be used to predict the distribution of the value of control among the shareholders, because control is the right to make future production decisions. If vector φ is the distribution of the value of control, the total value of the control of a firm is defined as the sum of the individual values, i.e. the value of control equals $\sum_{i \in N} \varphi_i(v)$.

A problem in equation (3.1) concerns the difficulty of specifying the characteristic function empirically. This problem is solved by transforming the game into a simple game. Such a game has two kinds of coalition only: winning and losing. The value of a winning coalition is assumed to be a constant, which is normalized to be equal to 1. The value of a losing coalition is equal to zero.

A special class of simple games is the class of weighted majority games. The game is represented by the symbol $[c ; w_1 \ldots w_n]$, where c is the majority quota and w_i is the percentage weight of player i. The characteristic function of the weighted majority game is

$$v(S) = \begin{cases} 1 & , \text{if } \sum_{i \in S} w_i \geq c \\ 0 & , \text{if } \sum_{i \in S} w_i < c \end{cases} \tag{3.2}$$

It is necessary that the total number of votes be odd or, for example, that the chairman's vote is decisive when two coalitions are the same size. The set of players which gains the majority of the votes wins the vote and acquires a value proportional to 1, regardless of the issue at stake, which suggests that the players are only concerned with winning, i.e. they value power for its own sake. The weighted majority game asserts that all shareholders set exactly the same value on the strategic position of 1 % of the votes.

The use of the characteristic function of (3.2) greatly simplifies the Shapley value.

$$\varphi_i\ (v) = \Sigma\ \frac{s!\ (n-s-1)!}{n!} \tag{3.3}$$

The summation covers all coalitions where player i can make a contribution by joining, since all other terms are zero. Though the formula is a special case of the Shapley value, it can be regarded as a different, probabilistic model. Suppose that the players are aligned in order to favor a proposal. The yes-voters arrive first and the no-voters last. Suppose that the preceding players in some permutation form a coalition of yes-voters. Player i is approached by the coalition and is invited to join the coalition of yes-voters. There are three possible situations. First, the coalition does not achieve 50 % of the votes, even if player i joins it. In this case player i makes no contribution. Second, the coalition achieves 50 % of the votes with player i, but not without him, i.e. player i guarantees the success of the coalition and gets his marginal contribution of 1. Third, the coalition of yes-voters already has 50 % of the votes when player i is approached, and he cannot make any contribution by joining.

Player i is <u>pivotal</u>, whenever he guarantees the success of the coalition of the preceding players. Each time he is pivotal, he makes a contribution. The equation (3.3) is summed over all coalitions in which player i is pivotal. If all permutations are equiprobable, the value of player i equals his probability of being pivotal, which is his probability of affecting the outcome of the voting under the postulated randomization scheme. Hence, the probability of being pivotal is a measure of the power of player i, wherefore equation (3.3) is usually referred to as the Shapley-Shubik power index (Shapley and Shubik, 1954).

The interpretation of equation (3.3) as a measure of power is clearly supported by the qualitative implications in the following sections. Thus the Shapley value is usually called power, even though equation (3.3) is the expected value from participating in a game.

3.2 The Theory of Oceanic Games

The purpose of this section is to apply the Shapley value to oceanic games. In such a game there are two kinds of players. There are a few atomic players, and there is an infinite number, or continuum, of non-atomic players. The atomic players correspond to major shareholders holding large blocks of shares, and the non-atomic players are minor shareholders with small holdings in the firm. The term ocean is used to denote the collective of minor shareholders.

The study of non-atomic players in game theory corresponds to asserting perfect competition such that no individual player is large enough to affect the outcome, i.e. there is no strategic uncertainty in a game with non-atomic players only. The theory of oceanic games is one of the first trials of integrating game theory with the competitive model, but it is not a purely competitive model. It is a mixed game, a mixture of atomic and non-atomic players. It will be seen that the predictions of the pricing of the vote differ, depending on who is trading in the shares. For example, the marginal value of a vote can differ very much as between a major shareholder and an oceanic shareholder, who cannot affect the market price of the vote. This point will be elaborated in the next section.

The theory of oceanic games was first presented in papers by Shapiro and Shapley (1961), and by Milnor and Shapley (1961). Most of the papers are concerned with the rather advanced mathematics of permuting an infinite number of players. The main theorem is restated here. The reader is referred to the paper by Shapiro and Shapley (1961) for a proof of the theorem.

Theorem 1 (Shapiro, Shapley)

For each major player the value of the game converges to the limit

$$\varphi_i = \sum_{S \subseteq M-\{i\}} \int_{t_2}^{t_1} p^s (1-p)^{m-s-1} \, dp \tag{3.4}$$

where the limits of integration are given by

$$t_1 = \left\langle \frac{c - w(S)}{\theta} \right\rangle$$

$$t_2 = \left\langle \frac{c - w(S \cup i)}{\theta} \right\rangle$$

and where

$$\langle x \rangle = \text{median of } (0, x, 1) = \begin{cases} 0, & \text{if } x \leq 0 \\ x, & \text{if } 0 \leq x \leq 1 \\ 1, & \text{if } x \geq 1 \end{cases}$$

M = set of major players

$\{i\}$ = set of player i

$\theta = 1 - \sum_{i \in M} w_i$ = the oceanic weight

m = no. of major players in the game

s = no. of major players in coalition S

$w(S) = \sum_{i \in S} w_i$ = sum of weights of major players in S

p = a continuous variable on $[0, 1]$

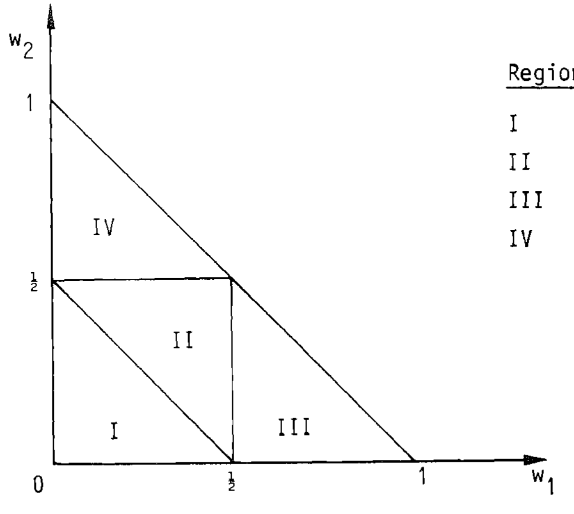
The value of the game for the ocean as a collective is defined by equation (3.5).

$$\Phi = 1 - \sum_{i \in M} \varphi_i \tag{3.5}$$

Formula (3.4) is a sum of integrals, one for each possible coalition of major players without player i. For practical use, the very long sum of terms with five or six major players can be programmed once. The value, when there are five major players, is obtained by letting the weight of player 6 be zero. In this case the five-player game is obtained, and similarly for fewer major players. The transition between the games with varying number of major players is perfectly continuous. The economic implication is that the advantage of being a major player disappears as the size of the controlling block tends toward zero (cf. Theorem 2).

3.3 Predictions for the Pricing of the Vote

In an appendix Milnor and Shapley (1961) illustrate the model for the corporate meeting, given two major shareholders and the remaining votes scattered throughout the ocean. They define four regions of shareholder structures. A shareholder structure is the relative distribution of votes among the shareholders, and it is represented by the symbol $[\frac{1}{2}; w_1, \ldots, w_m; \theta]$, where $\frac{1}{2}$ is the simple majority quota and θ is the oceanic weight.



Regions

I : $\theta \geq \frac{1}{2}$
II : $w_1 \leq \frac{1}{2}$, $w_2 \leq \frac{1}{2}$, $\theta \leq \frac{1}{2}$
III : $w_1 \geq \frac{1}{2}$
IV : $w_2 \geq \frac{1}{2}$

Figure 3.1: The Range of Parameters for the Games $[\frac{1}{2}; w_1, w_2; \theta]$
Source: Milnor, Shapley, figure 6, p.300

Region I is called the interior oceanic game, where the ocean by itself holds the majority of the votes. Shareholder structures in region I refer roughly to the case of diffuse ownership with complete diffusion in the origin. Region II is the balance of power region, where none of the major players holds the majority, and where the ocean holds less than 50 %. In regions III and IV player 1 and player 2 respectively hold the majority. The terms interior oceanic game, balance of power structure and majority control extend naturally to different numbers of major players in the game.

The value of player 1 in the respective regions is, for the case of two major players

$$\varphi_1 = \begin{cases} \dfrac{w_1}{\theta} - \dfrac{w_1 w_2}{\theta^2} & \text{in region I} \\[2ex] \dfrac{(1 - 2w_2)^2}{4\,\theta^2} & \text{in region II} \\[2ex] 1 & \text{in region III} \\[1ex] 0 & \text{in region IV} \end{cases} \qquad (3.6)$$

The value of player 2 is obtained by symmetry. The total power of the ocean is given by equation (3.7).

$$\Phi = 1 - \varphi_1 - \varphi_2 \qquad (3.7)$$

With all the assumptions of the Shapley value, the distribution of power is solely a function of the simple majority quota and the shareholder structure. The vector $\varphi = (\varphi_1, \varphi_2, \Phi)$ is the power distribution or the distribution of the value of control. The power index is monotonically increasing in the weights, and the index is roughly proportional to the weights. Milnor and Shapley (1961) state in a theorem that the value of any major player, averaged over all possible quotas c over the whole interval, is precisely equal to his weight. When c approaches the unanimity game, all players become equally powerful. This means that the major players become very weak, while the ocean becomes all-powerful. This has to be counterbalanced, according to the theorem, with power in excess of the weight for small quotas. The quota $c = \frac{1}{2}$ is usually favorable to the major players, but not always. It will be demonstrated that in the balance of power region, the minor shareholders are more powerful in spite of very little weight, just because the minor shareholders hold the balance of power between the major shareholders.

In order to study the relative importance of the players, Milnor and Shapley (1961) transferred the power index to the power ratios of the players.

$$R_1 = \varphi_1/w_1 \quad , \quad R_2 = \varphi_2/w_2 \quad , \quad R_{0c} = \Phi\,/\theta$$

I use these ratios to analyze the pricing of the vote. The ratios R_1 and R_2 predict the price of a vote in the whole block of shares of shareholders 1 and 2 respectively. The oceanic power ratio is the price of a single vote outside any substantial block of shares. It is important to make the following assumption.

<u>Assumption:</u> The share trading on the stock market represents the trading within the ocean. It is equivalent to assuming that the large blocks of shares of the major shareholders are closely held.

When this assumption holds, the oceanic power ratio is a ready predictor of the price premium for shares with high voting power. Then, the oceanic power ratio can be used to predict the voting premium cross-sectionally as observed on the Stock Exchange.

Three examples of shareholder structures are examined to see how the price of the vote depends on the relative shareholdings. The cases correspond to the regions: majority control, the interior oceanic game, and the balance of power.

The first example is a shareholder structure with one shareholder holding the majority of the votes.

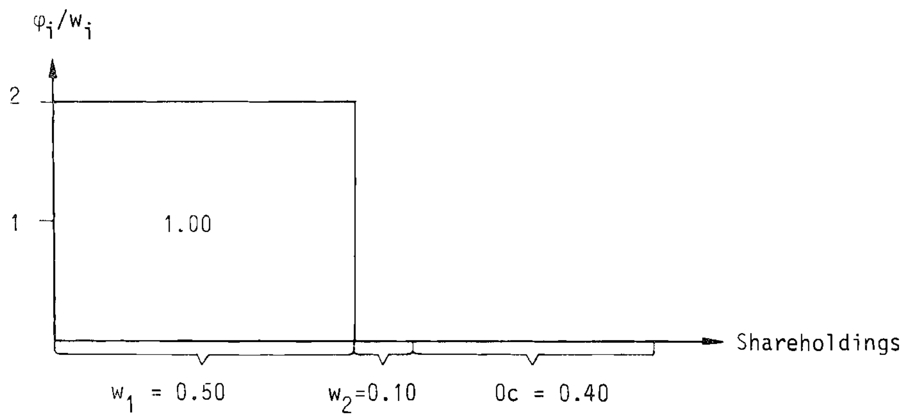


Figure 3.2 : Majority Control in the Game [½ ; 50, 10; 40]

The horizontal axis exhibits the shareholder structure. The vertical axis is the power ratio of each shareholder. The figures 1.00 within the block is the power index of the majority shareholder.

It can be seen from Figure 3.2 that the majority shareholder has full power, and that his block of shares has a control premium proportional to $\varphi_1/w_1 = 2.00$. The power ratio of the second major shareholder is zero, as is the oceanic power ratio. Thus, the trading of small lots of shares outside the majority block is carried out with a zero voting premium according to the model. It is in this kind of shareholder structure that we can expect to find a very low price difference for shares with differential voting rights. Further, the voting premium is equally low regardless of the value of the control of a particular firm, because the votes outside the block have no decisional power. In real life there may be a small premium, due to minority rights or to the prospect of a possible future change in the shareholder structure.

The second example is the case of one large shareholder holding 30 % of the votes. This is often referred to as working control.

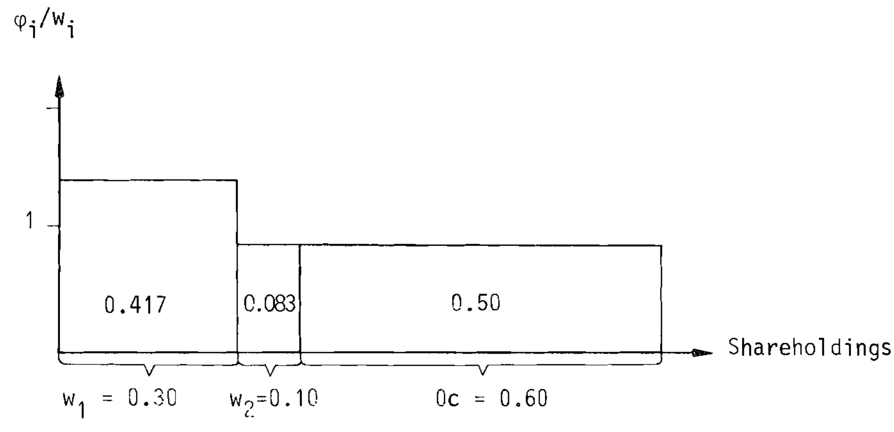


Figure 3.3 : The Interior Region in the Game [½ ; 30, 10 ; 60]

There are two interesting points in the example. The first point is the relatively low power ratio of the seemingly strong shareholder with 30 % of the votes. The reason is that the dominant shareholder can hardly deviate from what most shareholders perceive as value-maximizing decisions. In other words, the major shareholder cannot have very divergent beliefs without being outvoted by a majority of the shareholders. The major shareholder is really bound to decisions which most shareholders perceive as value-maximizing, which severely limits working control in comparison with majority control. The second point is that the power ratio of the second major shareholder is hardly distinguishable from the power ratio of the ocean. Milnor and Shapley provide a theorem for this.

Theorem 2 (Milnor, Shapley)

If a major player's weight in the general oceanic game tends to zero, his power ratio φ_i/w_i approaches the power ratio Φ/θ of the oceanic players.

The theorem says that small blocks of shares do not have very much more power than the corresponding number of votes scattered throughout the ocean. This is demonstrated in Table 3.1 with some numerical examples.

Table 3.1 : Numerical Examples of Power of Small Blocks of Shares

Shareholder Structure	φ_1 / w_1	Φ / θ	Difference
$[\frac{1}{2} ; 5 ; 95]$	1.0526	0.9972	0.0554
$[\frac{1}{2} ; 5 , 25 ; 70]$	0.9184	0.8892	0.0292
$[\frac{1}{2} ; 5 , 40 , 40 ; 15]$	3.2100	1.9753	1.2347

It can be seen that a block of 5 % of the votes does not have very much power in the interior oceanic game. The economic implication is that relative size is not sufficient to generate power; rather, absolute size of the controlling block is necessary to force through investment proposals which the other shareholders may dislike. However, a 5 % block is not small and unimportant in the balance of power region. The explanation of the difference of holding 5 % in the interior oceanic game or in the balance of power region can be seen in the third example of shareholder structures.

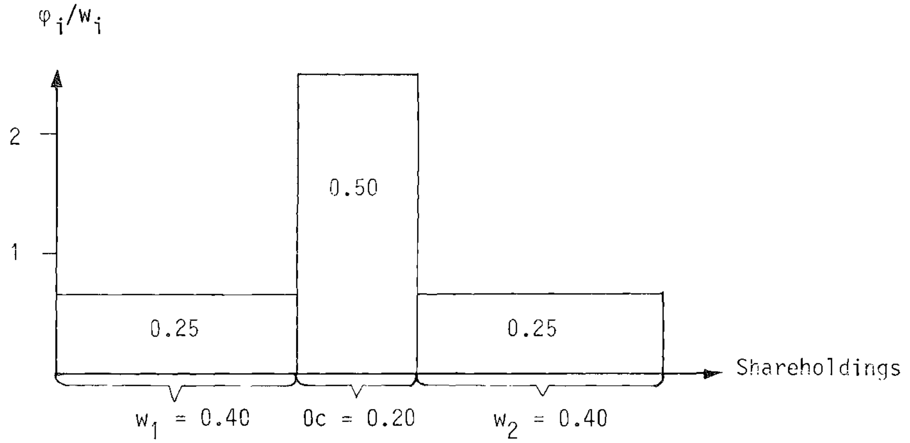


Figure 3.4 : Balance of Power in the Game [½ ; 40 , 40 ; 20]

In this shareholder structure, the ocean holds the balance of power between two large blocks of shares. This makes the small ocean very powerful. The reason is that either of the major players has to rely on the oceanic votes each time the two major players disagree. In such a case it is not advantageous to be large, and a single vote has a lot more decisional power than a vote in the controlling blocks of shares. Thus, the block should be traded at a lower price than a single share in the ocean for this special case. Otherwise, blocks of shares should be traded at a premium.

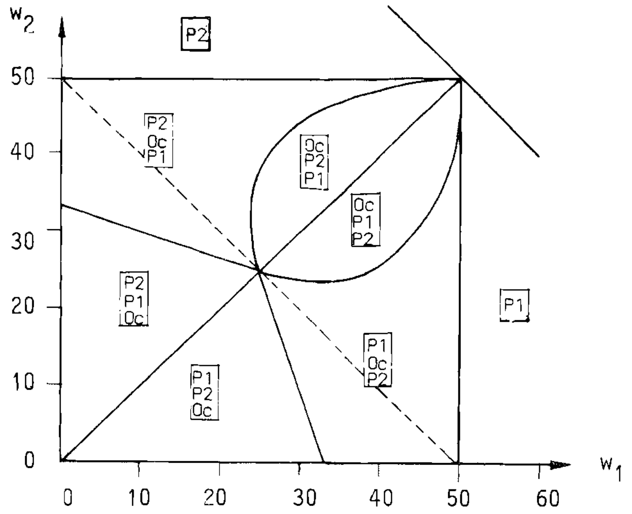


Figure 3.5 : Ranking of Players by Power Ratio in the Games [$\frac{1}{2}$;w_1,w_2; θ]

Source: Milnor, Shapley figure 9, p.302

Figure 3.5 summarizes the ranking of power ratios for all possible shareholder structures with two major players. The figure shows that the oceanic power ratio is the highest ratio only when the two major players are equally strong, i.e. the oceanic power ratio becomes very high, as in Figure 3.4, in the center of the balance of power region but not elsewhere. Elsewhere in the balance of power region either player 1 or player 2 has the highest power ratio, but the oceanic power ratio is always higher than the ratio of the smaller of the two major shareholders. The reason is that the smaller of the major players can hardly win without the larger major player, but the larger major player is dependent on support from the ocean.

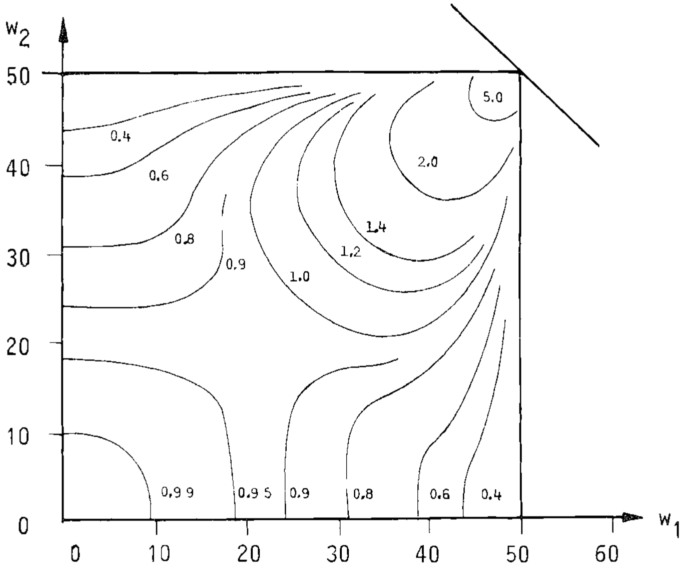


Figure 3.6 : The Oceanic Power Ratio in the Games [$\frac{1}{2}$;w_1,w_2; θ]

Source: Milnor, Shapley figure 8, p.301

The contours in Figure 3.6 show the power ratio of the ocean. It is a mountain with a saddle point in the interior oceanic game and with two peaks. One peak reaches the ratio 1 for completely diffused ownership. The second peak moves toward infinity, when there is only one vote left in the ocean which holds the balance of power between two equally large blocks.

An important feature is that the oceanic power ratio is almost entirely insensitive to the nature of the shareholder structure, provided neither of the two major players owns more than 25 % of the votes. This reduces the impact of measurement errors in the empirical analysis. However, the oceanic power ratio is very sensitive to a change in the shareholder structure in the center of the balance of power region. This is a rare case for firms listed on a stock exchange, though extreme voting power differentiation can generate such a structure even for these firms. Finally, the power ratio decreases very rapidly as one of the major players becomes all-powerful, something which starts at around 35 per cent, provided that the second player is small.

The contours in Figure 3.6 become very steep as the weight of one major player tends toward zero. This is due to the phenomenon referred to in theorem 2, namely that the power ratio of small blocks of shares is almost indistinguishable from the oceanic power ratio. This implies that the model does not require the oceanic players to be symmetrically small, so long as they are small in relation to the total.

An interesting game with three major players is $[\frac{1}{2}$; 25, 25, 25 ; 25$]$. In this game the oceanic power ratio is zero, because every winning coalition has to consist of two of the major shareholders. Thus in this case the oceanic power ratio is zero, in spite of there being a shareholder structure in the balance of power region.

A final example is the game $[\frac{1}{2}$; 49, 20, 20, 5 ; 6$]$. The oceanic power ratio is as high as 3.22, because there is a high probability of the other major players forming a coalition and outvoting the largest shareholder with the votes from the ocean.

The game model is static, and the predicted price premiums are valid only if the shareholder structure is unchanged despite the trading. A problem arises if the major shareholders acquire votes from the ocean, or if block transactions take place between the major shareholders. In such cases the model is not valid. The premium of a block of shares is indicated, rather, by the incremental power $\Delta\varphi_i / \Delta w_i$. And, correspondingly, for the acquisition of a single vote from the market the price premium is indicated by the marginal power $\partial\varphi_i / \partial w_i$. The marginal power is not a predicted price, since the power ratio of the seller is lower, thus permitting a wide range of possible control premiums.

Both the incremental power and the marginal power tend to be larger than the power ratios. For example, in the shareholder structure $[\frac{1}{2}\ ;\ 40,\ 30\ ;\ 30]$, the marginal power of player 1 exceeds the oceanic power ratio.

$$\frac{\partial \varphi_1}{\partial w_1} = 2.96 > 1.48 = \frac{\Phi}{\theta}$$

This gives a rationale for the very high prices observed in on-going power struggles, and explains why the price of a share drops considerably when the power struggle is over. This will be examined further in the empirical part of the dissertation.

3.4 Interfirm Shareholdings

In practice the existence of interfirm shareholdings such as pyramiding or crosswise shareholding represents a problem. In this section I suggest a way of computing the Shapley value for various cases of interfirm shareholdings.

In the simplest case shareholder i holds shares in firm A and B, and firm A holds shares in firm B. The calculation of the power index in firm A is straightforward. For firm B the situation is more complicated, since shareholder i has some influence over firm A's voting in firm B. Consider the example:

	Firm A	Firm B
Shareholder 1	25	25
Firm A	-	25
Ocean	75	50

The weight of player 1 is 0.25 in both firms. Firm A holds 25 per cent of firm B, and the other votes are scattered throughout the ocean. The power distribution in firm A is $\left(\frac{1}{3}, \frac{2}{3}\right)$. In firm B, two coalition structures are possible:

Coalition structure 1: $[\frac{1}{2}\ ;\ 50\ ;\ 50]$

Coalition structure 2: $[\frac{1}{2}\ ;\ 25{,}25\ ;\ 50]$

The first coalition structure arises, if shareholder 1 can vote firm A's votes in firm B. Coalition structure 2 arises, if shareholder 1 cannot count on voting firm A's votes in B.

An analysis of games with a priori coalitions can be found in Aumann and Drêze (1974). The Shapley value can be computed for each coalition in a coalition structure, i.e. each a priori coalition is regarded as one player in the game. This is mathematically correct because there is a unique pivot in each ordering. It implies that the power of a coalition, e.g. the coalition of shareholder 1 and firm A, is exactly the probability that the coalition contains the pivot (Dubey and Shapley, 1979). This is a property of the Shapley value which does not hold, if the efficiency axiom is relaxed.

If there is more than one coalition structure, the power of each player in a coalition structure has to be weighted with the probability of the coalition structure. The problem is to identify these probabilities.

I suggest as a solution to this problem that the Shapley value itself be used. It has been shown that the Shapley value can be interpreted as a measure of power, and as such it is closely translated into and interpreted as a probability (even though the Shapley value is not a probability).

Suppose that the voting game in firm A concerns how to vote the 25 % in firm B. This can be regarded in the same way as any other investment proposal, because the outcome of the voting in firm B affects the value of the 25 % stake and hence the value of firm A. The power of shareholder 1 in firm A is 1/3. I therefore suggest that the probability of coalition structure 1 is 1/3, and that coalition structure 2 occurs with the complementary probability. Thus the power index of shareholder 1 in firm B can be computed as the weighted average of his power in the two coalition structures.

$$\varphi_1(B) = \frac{1}{3} \cdot \varphi_1 \ [\tfrac{1}{2} \ ; \ 50 \ ; \ 50] + \frac{2}{3} \cdot \varphi_1 \ [\tfrac{1}{2} \ ; \ 25, \ 25 \ ; \ 50]$$

$$= \frac{1}{3} \cdot 1 + \frac{2}{3} \cdot \frac{1}{4} = \frac{1}{2}$$

Analogously, the oceanic power in firm B is

$$\Phi \ (B) = \frac{1}{3} \cdot 0 + \frac{2}{3} \cdot \frac{1}{2} = \frac{1}{3}$$

Now, it can be seen that the power indices of player 1 and the ocean do not add up to unity. There is a residue of 1/6, which belongs to the ocean in firm A.

$$\Phi_A \ (B) = \frac{1}{3} \cdot 0 + \frac{2}{3} \cdot \varphi_A \ [\tfrac{1}{2} \ ; \ 25, \ 25 \ ; \ 50]$$

$$= \frac{2}{3} \cdot \frac{1}{4} = \frac{1}{6}$$

Thus, the power distribution in firm B is $\left(\frac{1}{2}, \frac{1}{6}, \frac{1}{3}\right)$, and the power ratios of the players are

$$R_1 \ (B) = \frac{1/2}{0.25} = 2$$

$$R_{Oc(A)}(B) = \frac{1/6}{0.25} = 2/3$$

$$R_{Oc}(B) = \frac{1/3}{0.50} = 2/3$$

The calculations can easily be extended to more complicated cases of interfirm shareholdings. For example, if there is a second major player in firm A, this player will have some power in firm B through his indirect ownership in firm B, just as the ocean of firm A has some power in firm B.

A particularly interesting case of interfirm shareholding is crosswise ownership. The meaning of crosswise shareholding is best illustrated by a serie of examples.

	Firm A	Firm B
Firm A	x	50
Firm B	25	x
Shareholder 1	25	25

Firm A holds 50 % in firm B, which holds 25 % in firm A (it is prohibited for subsidiaries to hold shares in the parent company).

It is clear that those who control firm A will control firm B and can thus vote firm B's shares in A. Firm A is controlled by the shareholders who get a majority of the votes, net of the 25 % of firm B. In other words the following coalition structure applies to firm A.

$$\left[\tfrac{1}{2} ; \frac{25}{100 - 25} ; \frac{50}{100 - 25}\right]$$

It can be seen that shareholder 1 has 1/3 of the remaining votes in what can be called the netted game. Thus, the power of shareholder 1 in firm A as well as in firm B is $\varphi_1 \left[\tfrac{1}{2} ; \frac{1}{3} ; \frac{2}{3}\right] = 1/2$. This is his power in firm B, since firm A holds the majority in firm B.

What if firm A does not hold the majority in firm B? Consider the following example:

	Firm A	Firm B
Firm A	x	25
Firm B	25	x
Shareholder 1	25	-

In this case firm B's shares in A can be voted by the ocean of firm B with a probability of 2/3, which is the oceanic power in firm B. There is also the probability that firm A can vote firm B's shares in A. That probability is 1/3, and it is the probability of the netted game. Thus, the power of shareholder 1 in firm A is given by

$$\varphi_1 \ (A) = \frac{1}{3} \cdot \varphi_1 \left[\tfrac{1}{2} \ ; \frac{25}{100 - 25} \ ; \frac{50}{100 - 25} \right] +$$

$$+ \frac{2}{3} \cdot \varphi_1 \left[\tfrac{1}{2} \ ; 25, \ 25 \ ; \ 50 \right] = \frac{1}{3} \cdot \frac{1}{2} + \frac{2}{3} \cdot \frac{1}{4} = \frac{1}{3}$$

In a final example shareholder 1 holds shares in firm B as well. Three coalition structures are possible in firm A.

	Firm A	Firm B
Firm A	x	25
Firm B	25	x
Shareholder 1	25	25

The three coalition structures in firm A appear with the probabilities φ_1 (B) for the grouped game, φ_A (B) for the netted game, and Φ (B) for the separate game, when the ocean of firm B decides how to vote in firm A.

$$\begin{aligned}
\varphi_1 (A) &= \frac{1}{4} \cdot \varphi_1 \; [\tfrac{1}{2} ; 50 ; 50] \; + && \text{(grouped game)}\\
&+ \frac{1}{4} \cdot \varphi_1 \left[\tfrac{1}{2} ; \frac{25}{100 - 25} ; \frac{50}{100 - 25}\right] + && \text{(netted game)}\\
&+ \frac{1}{2} \cdot \varphi_1 \; [\tfrac{1}{2} ; 25, 25 ; 50] && \text{(separate game)}\\
&= \frac{1}{4} \cdot 1 + \frac{1}{4} \cdot \frac{1}{2} + \frac{1}{2} \cdot \frac{1}{4} = \frac{1}{2}
\end{aligned}$$

This third example is the general case with two firms involved in crosswise shareholding. There is a grouped, a netted, and a separate game. In the first example the netted game occurs with probability 1, and the grouped and separate games with probability zero.

The three examples show that crosswise shareholding is a control device which reduces the equity base, while maintaining voting power. Shareholder 1 increases his power above his weight as a result of the grouped and netted games.

3.5 Some Dynamic Implications

All this theory is static. However, comparative-static analysis can give some information on the stability of a shareholder structure. Milnor and Shapley (1961) present some hypotheses about changing shareholder structures.

It is natural to start with a hypothesis about how shares migrate between shareholders. It can be expected that the high marginal power of a share will be an incentive to a transaction. If shares do not move between the major shareholders, equation (3.8) governs the migration of shares.

$$u_i = \frac{\partial \varphi_i}{\partial w_i} - \frac{\Phi}{\theta} \tag{3.8}$$

The difference u_i indicates, in some way, the likelihood that shares migrate from the ocean to shareholder i. The vector field $u = (u_1, u_2)$ is shown in Figure 3.7.

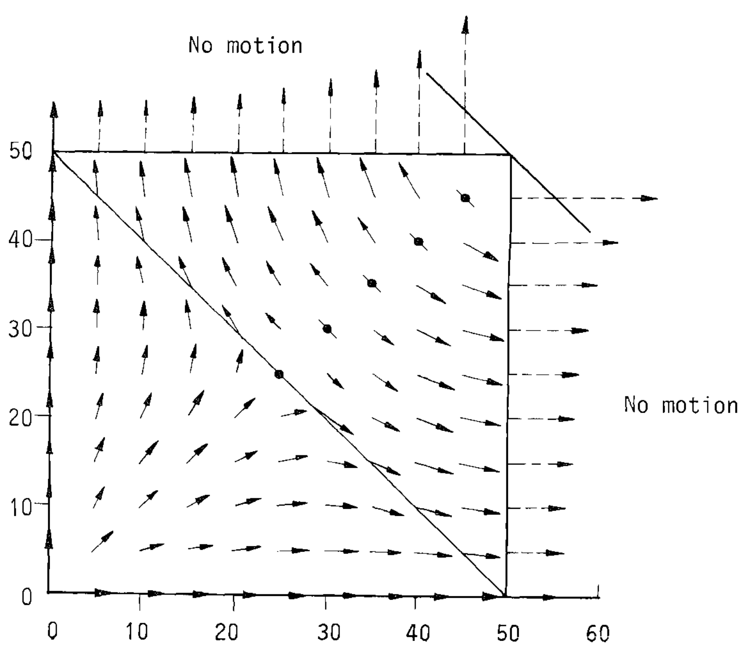


Figure 3. 7: The Migration of Shares

Source: Milnor, Shapley, figure 11, p.306

The length of the arrows shows the relative size of the measure u_i. It can be seen that the larger major player always grows faster, and the smaller major player often declines. The ocean never increases its power, but in the balance of power region the ocean is constant when the two major players are exactly equal. The magnitude of the measure u_i is small in the interior oceanic game and large in the balance of power region,particularly when the weight of a major player is close to the majority quota. This implies that the balance of power region is generally more unstable than the interior oceanic game.

Figure 3.7 predicts majority control in all firms, which is not the case for two reasons. First,the shareholder's budget constraint can make an investment in additional control in one firm quite expensive, in that the shareholder has to trade off investments in other securities. In other words, large blocks of shares are associated with the high cost of bearing diversifiable risk. Second, even if the shareholder is prepared to carry diversifiable risk, he may not be able to do so because of credit rationing. This is a practical constraint on pyramiding and crosswise shareholding.

There are several techniques for benefitting from holding a large percentage of the votes while also reducing the equity base. Examples are issuing shares with differential voting rights, pyramiding, crosswise shareholding, etc.

Another dynamic hypothesis concerns the birth of a third major player. There is no first-order incentive for this, since according to theorem 2 the power ratio of the ocean and the marginal power per share are approximately equal for small blocks of shares. In other words, there is equilibrium with respect to the birth of a third player. But whether this equilibrium is stable or unstable depends on the second-order terms. In particular, the difference Δ is in the order of magnitude ε^2.

$$\Delta = \frac{\varphi_3}{\varepsilon}\left[\tfrac{1}{2}\ ;\ w_1, w_2,\ \varepsilon;\ \theta - \varepsilon\right] - \frac{\Phi}{\theta}\left[\tfrac{1}{2}\ ;\ w_1, w_2,\ 0;\ \theta\right] \qquad (3.9)$$

(In theorem 2, the second term is $\frac{\Phi}{\theta}\left[\tfrac{1}{2}\ ;\ w_1, w_2,\ \varepsilon;\ \theta - \varepsilon\right]$.) Milnor and Shapley draw the following figure (Figure 3.8) with the magnitudes of the measure Δ. Plus signs are used to indicate when it is advantageous for a new player to appear, and minus signs for the reverse.

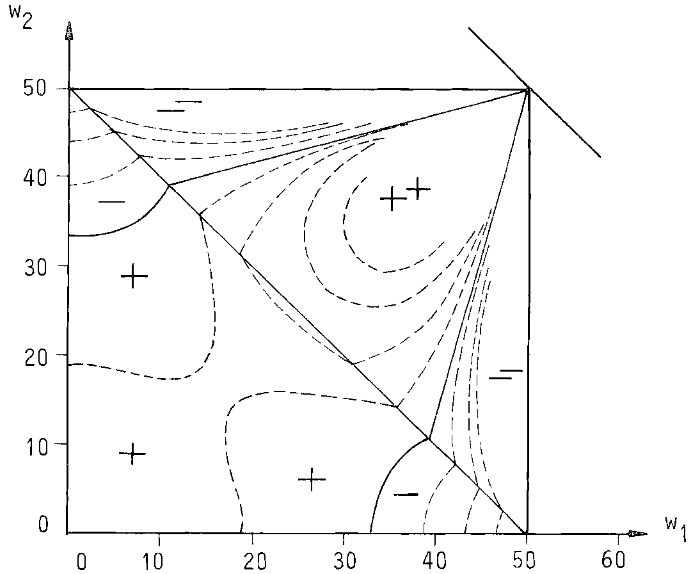


Figure 3.8 : The Birth of a New Player

Source: Milnor, Shapley, figure 12, p. 306

It can be seen that a new player is most likely to appear in the center of the balance of power region. This is not advantageous when one major player is close to majority control. The interior oceanic game is unstable, but quite a number of votes are needed to generate power, in contrast to the situation in the balance of power region.

I suggest that the oceanic power ratio is in itself a measure of the instability of a shareholder structure. If the power of the ocean is great, while the ocean itself is very small, a major shareholder can considerably increase his power through the acquisition of a few votes from the ocean. In the balance of power region only a small percentage of the votes can shift a player from a position of little power to a position of all-powerful majority control. Since this is an opportunity also open to the second major player, a balance of power structure can be expected to be very unstable.

The reverse holds in the case of majority control, where the oceanic power ratio is zero. In such a shareholder structure power struggles are not launched, since the majority shareholder always wins. The case of diffused ownership lies in between these two. It is unstable because a major shareholder can achieve an advantageous position by aggregating votes. But it is less unstable than the balance of power region, since quite a number of votes are needed to reach a strong position.

It is possible to test empirically whether some shareholder structures are more unstable than others. This is done by recording such things as power struggles, major acquisitions from the ocean, block transactions, etc. and looking to see which firms such events typically occur in.

3.6 The Validity of the Shapley Value as a Model of the Corporate Meeting

The Shapley value has been proposed as a model for the distribution of the value of control among shareholders. The model has several strong implications which can be empirically examined. In this section the validity of the assumptions will be discussed: first, the general formulation of the model, and then the three axioms.

The most striking assumption is perhaps that all shareholders cast their votes at the corporate meeting. In real life the minor shareholders only occasionally cast their votes, because each individual has little chance of affecting the outcome of a vote and because participation in the control of the firm consumes time and calls for costly information. The tiny fraction acquired in the value of control cannot compensate for the cost of taking an active part in the production decisions of the firm. Decision making is therefore delegated from the ocean of minor shareholder to a few major shareholders. It should be noted that this delegation of decision making does not simply mean free riding on the decisions of the major shareholders, because the major shareholders are likely to make decisions some of which are good and some bad from the point of view of a minor shareholder. If this shareholder knew that all the decisions would be good ones, he could be a free rider. But we have already seen in Chapter 2 that shareholders are likely to disagree here, so that some decisions are sure to be bad from the minor shareholder's angle.

In any case the obvious fact that the minor shareholders do not make production decisions raises the question as to whether the model is empirically valid for the corporation with an ocean of minor shareholders. Manne (1964) put forward the following hypothesis. The minor shareholders delegate decision making to the few major shareholders, who select the production plan. If the major shareholders implement a production plan which a majority of the shareholders consider to be less profitable than some other production plan, the share price falls to reflect the inefficient management of the firm. This creates an incentive for somebody to acquire votes from the ocean, with a view to gaining a position strong enough to change the inefficient production plan. This threat can make a strong impact on decision making, so that production plans are not implemented which could not win support in a hypothetical vote.

If this is correct, the theory of oceanic games describes the power distribution which results from hypothetical votes. Votes are not actually held. The ocean effectuates its power through the threat of share trading. This motivates the minor shareholders to pay a premium for the vote attached to a share, even though they never intend to use the vote at a corporate meeting. The vote is used when it is sold to a raider at a high price. Indirectly the minor shareholders are voting for the raider's production plan when they sell their shares.

The hypothesis requires the existence of competition for corporate control. Otherwise, the minor shareholders cannot vote by trading their shares. In a competitive market for corporate control, information about the value to a potential raider of the oceanic vote should be incorporated into the share price.

It could be argued that the minor shareholders would not sell their shares to a raider, if they believed in his production plan. But there is one major reason why this is not so. The marginal value of a vote to a raider increases the marginal share price considerably above the value to the raider of the alternative production plan. The minor shareholders want to sell their votes when they are priced highest, because they know that the share price will drop after the power struggle. Empirical support for this will be presented in Chapter 6.

The empirical test of the model will thus be a simultaneous test of the hypothesis that the price of the vote is speculation in the likelihood of a power struggle. The controlling block is paid at a premium, because the block increases the likelihood of winning a power struggle. The oceanic vote has a value because it has great decisional power in a power struggle, when it may be traded at a high price. If this is true, the price of the vote does not refer to the choice between specific production plans; rather, it represents the price to be paid for a strategic position in preparation for a future but uncertain power struggle.

The Shapley value relies on several other assumptions. One is the use of a characteristic function. The characteristic function allows for sidepayments, which means that the utility function must be risk-neutral. The characteristic function is also restricted to the class of simple games.

Sidepayments in the shape of selling votes separately from shares is prohibited by law, but shareholders are free to trade in proxies. A proxy may be limited to a specific issue, or it may apply generally with respect to the particular issue but be limited to a maximum of one year. Since proxies can be written with or without compensation, sidepayments may take place. This is not a critical assumption.

The risk-neutrality of the utility function does not hold, but this is not a critical assumption in the present analysis, because varying degrees of risk aversion are hardly a major source of disagreement about the choice of production plan.

The assumption that the characteristic function assumes a constant value for winning coalitions is an interesting one. It implies that the shareholders value power for its own sake, while the conclusion reached in Chapter 2 was that power has a value which derives from choosing the production plan of the firm. The value of a winning coalition ought to depend both on the issue and on the members of the coalition. However, the constant value of the characteristic function may be a good approximation, if the price of the vote reflects the strategic position of the vote without reference to particular issues. The shareholders do not know that votes will be held in the future, but they know that there will be votes about production plans.

Empirical data support that this may be a good description. Shareholders hold controlling blocks for decades without ever changing their positions. The control of firms passes from one generation to the next within a family. Many changes in the shareholder structure, such as corners or green-mailing, are hardly related to the choice between specific production plans but they do refer to the strategic value of a position. This justification of the constant value of the characteristic function is in line with the hypothesis that the price of the vote is a speculation in a future power struggle.

The specific assumptions of the Shapley value deserve discussion, since the strength of the Shapley value compared with similar models is due to the validity of the three axioms.

The efficiency axiom requires that the players' subjective evaluations are consistent. The importance of the axiom can be seen from an examination of another model which is identical except that the efficiency axiom does not hold. Such an analysis is made in Dubey and Shapley (1979).

The alternative model is the Banzhaf value (Banzhaf, 1965). A swing is a pair (S,S-{i}) such that the coalition S wins if player i joins, and the coalition S loses, if player i leaves. When player i is a swinger he is essential to the success of both coalition S and N-S. If all coalitions are a priori equiprobable, the Banzhaf value is the number of coalitions in which player i is a swinger divided by the total number of possible coalitions

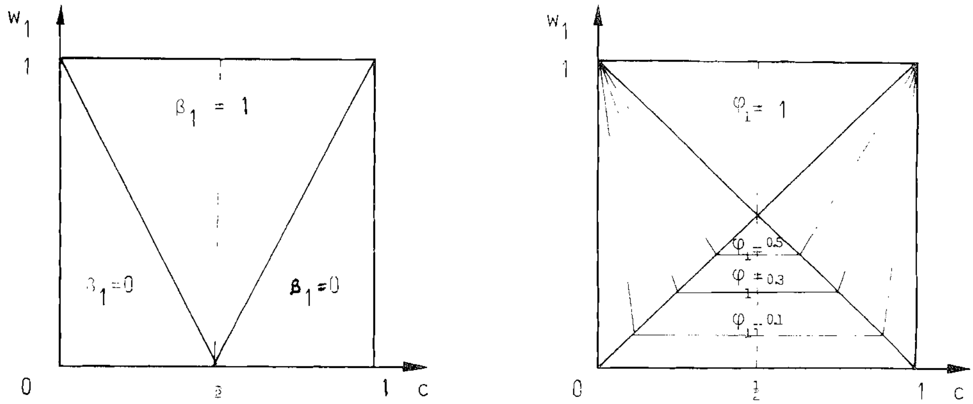
$$\beta_i\ (v) = \frac{\eta_i(v)}{2^{n-1}} \tag{3.10}$$

where $\beta_i(v)$ is the Banzhaf value

$\eta_i(v)$ is the number of swings of player i

This model is very similar to the Shapley value, but it fails to meet the efficiency axiom. The computational difference is that all coalitions or combinations of players are equally likely in the Banzhaf case, while in the Shapley case the likelihood of a coalition forming depends on its size. Although the difference is so small, however, the predictions are very different. This can be seen in Figures 3.9 and 3.10.

Figure 3.9 displays the one major player case in the two models. The horizontal axis exhibits all possible control quotas c, and the weight of the major player is varied on the vertical axis. The dotted mid line is the simple majority quota. For the quota $c = \frac{1}{2}$, the Banzhaf value gives all power to the major player, so long as he is not infinitesimally small. The Shapley value on the other hand does not give very much power to small blocks of shares according to theorem 2.



a) The Banzhaf Value

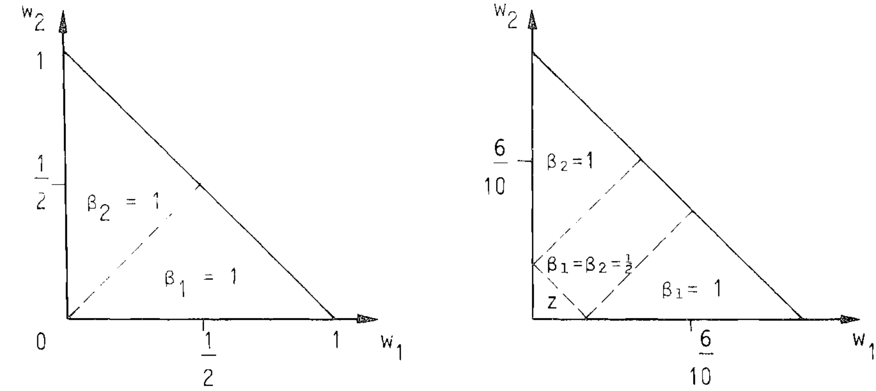
b) The Shapley Value

Figure 3.9 : The Banzhaf and Shapley Values for the Games $[c\ ; w_1;\ \theta]$

Source: Dubey, Shapley (1979), figure 1, p. 113

Change the control quota to c = 0.51 and suppose that the major player has a weight less than 1 %. For the Shapley value there is no difference at all between the quotas 0.50 and 0.51, since the value is independent of the quota for the interior oceanic game. However, according to the Banzhaf value the major player goes from being all-powerful to having no power at all when the quota changes from 0.50 to 0.51. This remarkable difference is due to the efficiency axiom. For the quota $c = \frac{1}{2}$, the Banzhaf major player believes he has full power, i.e. he thinks that he will always get support from exactly half the ocean. The Banzhaf minor players are all very pessimistic about their opportunities in the voting game. However, changing the quota slightly makes the major player very pessimistic and the minor players very optimistic about their abilities. The Shapley value states that the power distribution is independent of changes in the quota for interior oceanic games, which means that the players' expectations on the voting game do not change at all in that case. The latter seems to be more realistic.

Also in the two player case, the Banzhaf value has some curious economic implications, as can be seen in Figure 3.10.



a) The Games $[\frac{1}{2}\ ;\ w_1,w_2\ ;\ \theta]$ b) The Games $[\frac{6}{10}\ ;\ w_1,w_2\ ;\ \theta]$

Figure 3.10: The Banzhaf Value for the Games $[\frac{1}{2}\ ;\ w_1,w_2\ ;\ \theta]$ and $[\frac{6}{10}\ ;\ w_1,w_2\ ;\ \theta]$

Source: Dubey, Shapley (1979), figure 2, p. 116

In the first case with the simple majority quota, either one of the two major shareholders is all-powerful, unless they happen to have exactly equal weight. Then neither of them has any power and the ocean is all-powerful in the balance of power situation that arises. It seems likely that such a situation would be very unstable and that a power struggle would soon arise, since one vote would be enough to change no power into full power.

The second case with a slightly higher controlling quota generates four possible power distributions. The dotted lines represent the same pitfalls as in the first case; the ocean commands all the power. In between the dotted lines the two major players share the power equally, and the ocean has no power at all. In region Z all power goes to the ocean. Finally, there are two regions where one of the two major players is all-powerful.

The pitfall points of the Banzhaf value are due to the inconsistent expectations of the Banzhaf players. At a pitfall point every minor player considers himself more likely to be pivotal than any other minor player. Just outside the pitfall points, all the minor players are pessimistic rather than optimistic. They all consider themselves less likely to be pivotal than their fellow minor players. Figure 3.10, example b, shows the implications of these inconsistent evaluations. For example, consider the game $[\frac{6}{10}; 40+\varepsilon, 20; \theta-\varepsilon]$, which generates very different values for the major players depending on ε. If $\varepsilon = 0$, the power of the players is (0,0,1), i.e. it is a pitfall point. For $\varepsilon>0$, the power distribution is (1,0,0), which is a maximum change in the value of the first player, when the ocean decreases by ε. But, if $\varepsilon<0$, i.e. the ocean increases slightly, the power distribution is $(\frac{1}{2},\frac{1}{2},0)$, which seems intuitively to be a strange result, since the ocean loses all power while increasing its weight. This weakness in the Banzhaf value, or any other value apart from the Shapley value is due to the inconsistent expectations of the players (Weber, 1979).

The <u>symmetry</u> axiom implies that only the percentage weight of a player can affect that player's evaluation of the game. A requirement is that there are no payoffs outside the game, which implies that the shareholders are neutral towards one another. That is, to say, there are no power relations between the shareholders.

French and Raven (1960) identify five types of power: reward, coercive, referent, expert, and legitimate power. Reward power means that individual A promises individual B some payoff outside the game if he votes in some specified manner. Coercive power imposes negative payoffs on B if he does not follow A's instructions. Referent power means that individual B votes like individual A, because he admires him for some reason. Expert power stems from differences in the ability to make production decisions. Legitimate power means using votes to enforce a production plan.

The symmetry axiom excludes the reward, coercive, and referent sources of power. Expert power is excluded by the general setting of the model. What will remain in the model will be legitimate power in the shape of votes and the simple majority rule. Nothing but votes can determine the choice of production plan.

The symmetry axiom is strong. A priori coalitions do form as a result of power relations. For example, family members can be expected to vote together on most occasions, or some shareholders are more friendly or hostile than others. Much of Chapter 5 is concerned with identifying asymmetric relations between shareholders in the empirical data. I think that the symmetry axiom is a major reason for a possible empirical failure of the model.

The aggregation axiom states that there are no interaction effects between games, so that it is possible to aggregate the values of several games. Voting games can be partitioned with respect to votes at different times, votes about subsets of issues, or votes in two or more firms. For all possible partitions the evaluations of each separate game must be independent of one another. Luce and Raiffa (1957) think that the aggregation axiom is strong, because an aggregated game may have a different structure from that of two component games. An example of this point occurs when two shareholders buy controlling blocks of shares in each other's firms. This is a kind of power struggle, starting when the second shareholder acquires shares in the first one's firm. The old controlling shareholder in the first firm responds by acquiring shares in the other firm in the hope of getting rid of his rival. In such a case the value derived from playing the two games is different from the value derived from playing each game separately.

3.7 Conclusions

The Shapley value is a model of the distribution of the value of control among the shareholders. Three implications can be empirically tested. The power ratios of the major shareholders predict the control premiums of large blocks of shares. The oceanic power ratio predicts the voting premium in the daily trading and the likelihood of a change in the shareholder structure.

Two assumptions - the minor shareholders participate in decision making, and the characteristic function has a constant value - imply that the predictions of the model refer to the value of a strategic position rather than to the choice between specific production plans. The price of the vote is then a speculation in the likelihood of a power struggle. The minor shareholders can vote indirectly by selling their shares at a high price in the power struggle. The price of the oceanic vote will reflect this threat of voting by way of share trading, and this may affect the decision making of the major shareholders. This last corresponds to Manne's (1964) hypothesis.

The Manne hypothesis requires the existence of competition for corporate control. Lack of competition can be a reason for the empirical failure of the model. Another empirical problem concerns the symmetry axiom, since it can be expected that there will be both friendly and hostile shareholders, i.e. there are a priori coalitions which occur with probabilities greater than zero but less than 1. This is a major empirical problem.

4. A Measure of Voting Inequality

The price of the vote is not observable unless there is differentiation in voting power. The price difference cannot be used directly for testing the game model, because the price of the vote depends on its percentage weight, which is a function of the voting differential and the fractions of the various classes of voting shares. These parameters define a differentiation structure which differs from firm to firm, so that cross-sectional comparison of the price premium cannot be made.

The purpose of this chapter is to derive a specific function which links two differentiation structures, so that the impact of the parameters can be eliminated. This function is designated voting inequality. The term stems from Levy (1982). Levy constructed a model which approximated the voting inequality function derived in this chapter.

4.1 Basic Definitions and Assumptions

The observable inputs are

P_A = the price of a share with high voting power, denoted A-share

P_B = the price of a share with low voting power, denoted B-share

N_A, N_B = the number of issued A- and B-shares respectively

V_A, V_B = the number of votes attaching to one A- and one B-share respectively

It is standard usage to call the shares with high voting power class A-shares, though there are exceptions on the Stock Exchange. There is no firm with more than two classes of voting share on the Stock Exchange. The model is generally applicable but will be derived for two classes of shares.

There are two parameters in the model.

$$\alpha \equiv \frac{N_A}{N_A+N_B} = \text{the fraction of A-shares}$$

$$\gamma \equiv \frac{V_B}{V_A} = \text{the voting differential}$$

The parameters (α,γ) define a differentiation structure. The parameter $\gamma \in [0,1]$ assumes all values between no differentiation at all ($\gamma=1$) and the extreme of non-voting shares ($\gamma=0$). The voting differential is not equivalent to the voting inequality function, which depends on both parameters (α,γ).

Manne (1964) introduced the term vote segment of a share to denote the part of the total price that is paid for the vote. The remaining part of the share price he called the investment segment.

I define the vote segment of a share as the price difference between a voting and non-voting share. The investment segment is thus defined as the price of a non-voting share. In line with the game model of the previous chapter, the vote segment should be the strategic value deriving from choosing future production plans. The investment segment may be worth less than the value of the current production plan, because there is a chance of the current production plan being exchanged for an undesired alternative.

Since voting is not without cost, votes are not cast unless they are aggregated into large blocks of shares. Thus the value of the oceanic vote should depend on the probability of votes being acquired by the major shareholders from the ocean. This probability can be expected to decrease with the absolute size of the controlling block,due to the cost of bearing diversifiable risk and the constraint of credit rationing. I call this the cost of control,which may reduce the value of the oceanic vote segment. It may happen that the cost of control is greater than the value of the vote segment of the B-share. The price of the B-share then equals the price of the investment segment. The price of the vote of the A-share is reduced by the full amount of the cost of control unless the cost of control is greater than the vote segment of the A-share, in which case all shares are priced as the hypothetical non-voting share.

When there is disagreement about specific production plans, the vote segment may be temporarily high (Manne, 1964). In a power struggle, the vote segment of the oceanic share may also reflect the marginal value of a vote for the major shareholders. The investment segment may be affected by disagreement about the production plan of the firm. For example, expectations on a takeover bid followed by a change in the production plan, may increase the value of the investment segment.

The firm without voting power differentiation, i.e. ($\alpha = 1, \gamma = 1:1$), is of particular interest as a reference point. The investment and vote segments in this particular firm are denoted

P_V = the vote segment in the firm without differentiation

P_I = the investment segment in this firm

P_S = $P_V + P_I$ = the share price in this firm

N_S = the issued number of shares in this firm

By definition P_I is equal for all shares independently of voting power differentiation. P_V is a function of the parameters (α, γ), which is the voting inequality function. P_V and P_I are not observable. As will be demonstrated, P_V(and P_I) can be explicitly defined by the voting inequality function on the observable inputs.

The derivation of an explicit expression for P_V requires an assumption as regards pricing. The assumption is that the cost of control is zero. Equation (4.1) is then a no-arbitrage condition.

$$\frac{P_A - P_I}{P_B - P_I} = \frac{V_A}{V_B} \tag{4.1}$$

The no-arbitrage condition states that for $\gamma = 1:10$ the vote segment of an A-share is priced at ten times the price of the vote segment of a B-share, because one vote attached to ten B-shares is a perfect substitute for one vote attached to a single A-share.

It is easy to rearrange equation (4.1) to get an explicit expression for the investment segment of a share.

$$P_A - P_I = \frac{1}{1-\gamma}\,(P_A - P_B)\,, \quad \gamma<1 \tag{4.2}$$

For $\gamma=1:10$ it can be seen that the vote segment of an A-share equals 10/9 of the price difference, because the B-share has a vote segment which is 1/10 of the vote segment of the A-share. Suppose that the cost of control is not zero. The maximum error is then $1/(1-\gamma)-1$, i.e. 1/9 for $\gamma = 1:10$. This is the maximum error, because the value of the B-share cannot go below the value of the investment segment of the A-share. Since the error is so small, the assumption of the no-arbitrage condition is very weak. An alternative assumption could have been that $P_B=P_I$, but that does not lead to the same nice results as equation(4.1),and the difference is anyway very small. It is therefore assumed that equation (4.1) holds.

4.2 Derivation of the Voting Inequality Function

The basic idea is to ask:other things being equal, what would be the price per vote in a firm with voting power differentiation compared to the price per vote in a firm without differentiation? It is easy to obtain a relation between the two differentiation structures (α,γ) and $(\alpha=1, \gamma=1:1)$. Consider equation (4.3).

$$N_S P_V = N_A(P_A-P_I) + N_B(P_B-P_I) \tag{4.3}$$

According to assumption (4.1) the value of the whole vote segment of the firm is the same, regardless of its distribution between A- and B-shares. The left-hand side is the value of the vote segment in the firm without differentiation, and the right hand side is the same value distributed unequally between the A- and B-shares. It is implicitly assumed that there are completely diffuse shareholdings without major shareholders. This is not a restrictive assumption, because equation (4.3) holds for any fraction of the total number of votes, e.g. a controlling block of 30 % can be analyzed by multiplying each side by 0.30.

Note that $N_S = N_A + N_B$ and use the shorthand α.

$$P_V = \alpha(P_A-P_I) + (1-\alpha)\ (P_B-P_I) \tag{4.4}$$

The price for the vote segment of a share in the firm without differentiation is a weighted average of the vote segment of the A- and B-shares respectively, where the weight is the fraction of equity of each class of shares. Now , use equation (4.1) to replace $(P_B - P_I)$.

$$P_V = \alpha(P_A - P_I) + (1-\alpha)\ \gamma\ (P_A - P_I)$$

or (4.5)

$$P_V = (\alpha - \alpha\gamma + \gamma)\ (P_A - P_I)$$

This is a price relation between the vote segments in the two firms. Equation (4.5) reveals that the vote segment of an A-share is inflated by $1/(\alpha - \alpha\gamma + \gamma)$, and it has to be scaled down accordingly if the equality is to hold. To obtain observability, use equation (4.2) and assume that $\gamma < 1$.

$$P_V = \frac{1}{(1-\gamma)}\ (\alpha - \alpha\gamma + \gamma)\ (P_A - P_B) \tag{4.6}$$

This equation tells us how to estimate the otherwise unobservable vote segment of a share from the price difference for shares carrying different voting power. In this way a cross-sectional analysis of the voting premium can be made without any influence from the technical factors (α, γ).

Equation (4.6) is dependent on the number of shares in the firm. For a cross-sectional analysis it would be better to express the price of the vote as a percentage of the total share price assuming that the value of control increases linearly in the market value of the firm. This is done in equation (4.7), which defines the percentage voting premium and the dependent variable in the statistical analysis.

$$VP \equiv \frac{P_V}{P_S} = \frac{\frac{1}{1-\gamma}\,(\alpha-\alpha\gamma+\gamma)\;(P_A-P_B)}{\alpha\;P_A+\;(1-\alpha)\;P_B} \tag{4.7}$$

The nominator is given by equation (4.6). The denominator is the total share price, which is a weighted average of the price for the A- and B-shares respectively, because the value of the firm is independent of its distribution between A- and B-shares (according to assumption (4.1)).

This measure of the voting premium has two properties. First, it is naturally interpreted cross-sectionally. It says what percentage of the total price is paid for the vote. Second, two degrees of freedom are retained in the statistical analysis, which is important in the case of a small sample.

4.3 Properties of the Voting Inequality Function

The interesting part of equation (4.7) is $(\alpha-\alpha\gamma+\gamma)$, which is the inverse of the voting inequality function. The voting inequality function has a nice geometric interpretation. Consider Figure 4.1.

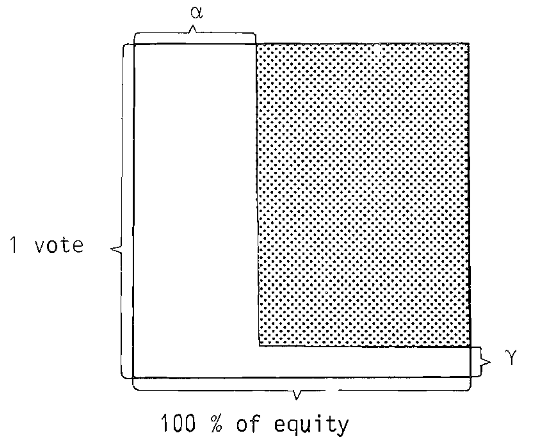


Figure 4.1: Geometric Interpretation of Voting Power

The whole square is a unit square. It represents 100 % of the voting power in a firm without differentiation. Every per cent of equity has precisely 1 % of the voting power, i.e. 1 % of the area of the unit square. Now, suppose that α % of equity get one vote per share, while the remaining shares get γ votes per share. It is clear that the total number of votes decreases with the amount of the shaded area, but the total voting power has to be 100 %. The reduced white area therefore has to be scaled up, or inflated, to the size of the unit square, keeping the relation γ constant between the two classes of shares. Let VI denote the scale factor.

$$VI \cdot (\text{reduced area}) = 1$$

or (4.8)

$$\alpha \cdot 1 \cdot VI + (1-\alpha) \cdot \gamma \cdot VI = 1$$

Solve for VI to find the scale factor and the voting inequality measure.

$$VI = \frac{1}{\alpha-\alpha\gamma+\gamma} = \frac{\text{unit square}}{\text{reduced area}} \tag{4.9}$$

Equation (4.9) tells us that an A-share with one vote has $1/(\alpha-\alpha\gamma+\gamma)$ units of voting power, or one vote in this firm has the same percentage weight as $1/(\alpha-\alpha\gamma+\gamma)$ votes in the firm without voting power differentiation.

This exercise reveals the intuition behind the voting inequality measure. Voting power differentiation reduces the total number of votes, thus letting each vote get a larger fraction of the total number of votes. The price of the vote attached to an A-share should reflect precisely this larger percentage weight.

It is easy to generalize the voting inequality measure to more than two classes of shares. It is merely a question of calculating and relating areas as in Figure 4.1. Generalization is also possible using equation (4.10).

$$VI = \frac{\text{A-shares' fraction of the votes}}{\text{A-shares' fraction of equity}}$$

$$= \frac{\frac{\alpha}{\alpha-\alpha\gamma+\gamma}}{\alpha} = \frac{1}{\alpha-\alpha\gamma+\gamma} \qquad (4.10)$$

The voting inequality measure is strongly convex in both α and γ. This is illustrated in Figure 4.2, with the voting inequality measure for various combinations of (α,γ). The boundaries are given by $\gamma=1$, the bottom line and the non-differentiation case, and by $\gamma=0$, the very convex curve and the case of non-voting shares. When $\alpha \to 1$, all shares get one vote except for a B-share which gets γ votes and γ units of voting power, and its vote is priced accordingly. As $\alpha \to 0$, all shares get one vote except for a single A-share, which gets $1/\gamma$ votes which are priced at $1/\gamma$ times the price for the vote of any other share.

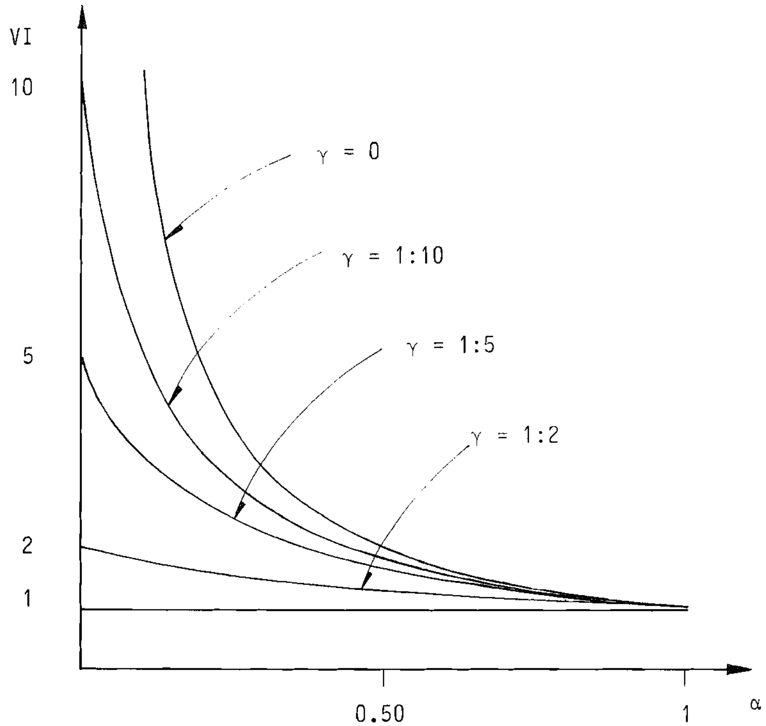


Figure 4.2 <u>The Voting Inequality Measure for Various Differentiation Structures</u>

Figure 4.2 reveals several interesting points about voting power differentiation.

First, voting power differentiation is a continuous variable, with the non-differentiation firm as a special case. If assumption (4.1) holds, there is basically no difference at all between various degrees of voting power differentiation. Thus, a study of the pricing of the vote can be limited to the non-differentiation case.

Second, the voting inequality function is a measure of the effect of voting power differentiation. It tells us how much the equity base of a block of shares can be reduced without reducing the percentage weight of the votes. For example, a voting inequality of 5 makes it possible to hold 50 % of the votes with 10 % of equity (provided there are sufficiently many A-shares to get 50 % of the votes). This could be useful in an event study concerning the introduction of low-vote shares. The stock market should consider the degree of voting inequality that is being introduced, not merely the fact that some B-shares are issued by the firm.

Third, α clearly dominates γ. For $\alpha \geq 0.50$, there is very little voting inequality independent of the voting differential. Thus, if a legislator wants to limit the effects of voting power differentiation, he should not(as in Sweden) set a limit on γ, but should limit α to a high number.

Fourth, the slope is very steep for small α. This implies that a new issue of A-shares without issuing any B-shares will have a strongly diluting effect on the shareholder structure, even if the issue of A-shares is very small, because the voting inequality falls dramatically even at a small change in α. On the other hand, a second issue of A-shares without any B-shares does not dilute the shareholder structure as much, not even in the case of a large issue of A-shares, because of the strong convexity of the voting inequality measure.

Fifth, voting inequality becomes very high for small α. This explains why the A-shares command a price premium far above 100 % in some firms. These firms usually have very high voting inequality. The value of control in these firms is not particularly high; it is just that the value of the control is concentrated to a few A-shares.

4.4 Conclusions

The voting inequality function adjusted for the vote segment of the B-share, $(1-\gamma) / (\alpha-\alpha\gamma+\gamma)$, is an almost deterministic predictor of the price difference for shares with different voting power. The primary use of the voting inequality function is to create the latent dependent variable VP, which is the price of a vote in a firm without voting power differentiation.

5. Empirical Data

Data has been collected for three empirical tests of the theory of oceanic games. The main test is to discover whether the oceanic power ratio can predict the price difference for shares with different voting power. This test requires data on prices and shareholders. The second test is to find out whether the oceanic power ratio can predict changes in the shareholder structure. This test requires shareholder data only. The third test is concerned with the relation between the power ratio of the major players and the control premium for blocks of shares. This requires a transaction price for the block with identified buyer and seller, and shareholder data to compute the power index.

This chapter is concerned with the collection and quality of the data. There are two major measurement problems. First, the theory to be tested is static, while the voting premium has to be estimated over a period of time. The period chosen is one year. Second, an empirical difficulty has been to identify pre-established coalitions in the shareholder data, and this occupies much of the chapter.

I start by presenting the Swedish legislation and then examine which firms can be included in the various tests. Section 5.3 is concerned with the use of voting power differentiation in Sweden. The price data is analyzed in Section 5.4. The chapter closes with a long analysis of the shareholder data with particular attention to the asymmetry problem. The data on block trades will be included in Chapter 6, together with the analysis.

5.1 Swedish Legislation

According to the Swedish legislation, the shareholders have the right to make the decisions for the firm, although the workforce also possesses limited decision rights (the Codetermination Act, MBL). The right to control is formally implemented at the corporate meeting, whose major decision is the election of the board of directors. The board is elected by a majority of the votes. The board can be replaced by the corporate meeting at any time and without cause. Thus neither the board nor management has any legitimate power, with the single exception that the corporate meeting cannot declare more dividends than approved by the board.

Most decisions by the corporate meeting require a simple majority of the votes, unless the articles of corporation call for super majority. Generally, super majority is required for changing the articles of corporation. There is a complex system of super majority rules, taking into account not only the percentage of votes but also the percentage of equity, with a view to protecting the minority in cases of differential voting rights. There are certain minority rights as well. For example, 10 % of equity or of votes can elect an extra auditor, or 10 % can call for an extra corporate meeting.

One principle is that votes should be distributed proportionately to equity,to the actual bearing of risk. The votes are thus attached to the shares and cannot be separated (Roos, 1969). However, the principle of proportionality can be violated within the law. One possibility is to authorize somebody else to vote. But as a proxy has to be renewed at least once a year, authorization is of limited use as a control device. A second possibility is to issue shares with differential voting rights. In Sweden, a maximum voting differential of 1:10 is allowed. An exception is made for shares issued before 1944 with a larger voting differential. These shares can still be issued with the same voting differential in new equity issues.

Shares may not have differential voting power depending on who owns them. Shares may not differ in face value, so that voting power differentiation cannot be created through issuing shares with different face values.

A special voting rule says that no shareholder can vote for himself or for others for more than 20 % of the equity represented at the corporate meeting. This means that a shareholder with 40 % of equity and votes can use at most half his voting power. The rule is not mandatory. It is disregarded by a clause in the articles of corporation in most firms; it is maintained in some firms and reinforced in a few. Skog (1981) reports that 63 % of the firms listed on the Stockholm Stock Exchange on 2 January 1981 did not restrict voting power, 20 % applied the legal clause, and the remaining 17 %, including all banks and insurance companies, employed some other stronger or weaker voting limit.

Voting limits cannot usually be expected to be effective, since it is possible to let a number of subsidiaries or other closely-related persons hold the shares and to vote with them when some conflict arises. The only problem is that a couple of people have to spend their time at the corporate meeting, since the votes cannot be proxied. But this is only necessary on the rare occasions when the actual voting at the corporate meeting can make a difference to the election of the board. The decisions of the corporate meeting can be expected to be made in advance and in accordance with the shareholders' relative power. The rules of limited voting rights have thus been ignored in testing the theory of oceanic games, except for five cases of severe limitation.

Tax law includes a special rule affecting the value of the vote. It says that 25 % of the votes allow for tax-free dividends for a corporation. This is a value of the vote which is not connected with control. Another such case is the 50 % limit which makes a firm the subsidiary of a corporation, which among other things affects the consolidated balance sheet. Also, 90 % of equity and votes is sufficient for a firm to be considered as wholly owned, so that the remaining minority shares can be subject to legally enforced acquisiton.

The theory of oceanic games is concentrated to the simple majority quota. Thus, neither super majority rules, minority rights, voting limits or the rule of tax-free dividends for 25 % of the votes are considered in the tests. However, for a test of the pricing of the vote this does not matter. All these special rules are important only when a shareholder wants to exceed a limit of, say 25 % for tax-free dividends. This occurs only rarely and can usually be ignored.

In Sweden all shares are registered by name, so that precise shareholder data can be obtained. As has been mentioned, shares can have differential voting rights. Shares can differ in their liquidation rights (preferred shares) which are rather infrequently used. Also, shares can be restricted to domestic ownership; these are called restricted shares, as opposed to unrestricted shares which can be held by foreign shareholders as well. Firms which want to own real estate in Sweden can issue unrestricted shares at a maximum of 40 % of equity and 20 % of the votes. Exceptions are possible. In some firms the 40/20 relation of unrestricted shares is the motive for voting power differentiation. Perhaps it is even the main reason for the survival of the system of voting power differentiation in the revised laws of 1944 and 1975 (Skog, 1981). Unrestricted shares often command a price higher than the restricted shares. This introduces a problem in estimating the voting premium between restricted high-voting shares and unrestricted low-voting shares.

To sum up, shares can be classified as

	A	B
Restricted	Abu	Bbu
Unrestricted	Afr	Bfr

The standard Swedish notation for restricted shares is bu (bundna), and for unrestricted shares fr (fria). A-shares usually carry high voting power, and B-shares have low voting power. Firms may issue all four classes of shares, or only one. Besides the classes of shares in the figure, there are shares with different dividend and liquidation rights, which are individually specified by the firm issuing the shares.

5.2 Basic Sample Requirements

The first requirement for any test of the theory of oceanic games is that precise shareholder data can be recorded. This requirement limits the sample to the period 1975-1985, since shareholder data are not easily available before 1975.

The second requirement for a firm to be included is that it is listed on a stock exchange, since the game model is constructed for the firm with an ocean of minor shareholdings. Only firms listed on the Stockholm Stock Exchange can therefore be included in the sample. These are the firms on the AI and AII lists. Firms on the Fondhandlarlistan (List of Swedish Association of Stock Brokers) are also included, because this list corresponded to the AII list before 1981. Firms listed on the Inofficiella listan (Unofficial List) are not included, since they do not meet the basic requirements for firms listed on the Stock Exchange, e.g. the requirement regarding ownership dispersion. Firms listed on the OTC market are not included either, because that market did not exist before 1984, and the inclusion of a large number of small OTC-firms at the end of the sample period would confuse the time serial comparisons.

There were six exceptions to these requirements. The firms Gotland and SÅA were listed on the Inofficiella listan at some point between the listing on Fondhandlarlistan and the AII-list and are thus included for that time. Four other firms, Fagersta, Parcon, Parlamentet, and Tresor, had listed both A- and B-shares on the Inofficiella listan so that the voting premium could be recorded. These firms were included to increase the sample of firms with an observable voting premium.

The theory presented in the preceding chapters is static. The theory will therefore be tested cross-sectionally at various points in time. The estimate of the voting premium will be very uncertain, however, if it is based on single transactions. Better estimates are obtained by averaging the voting premium in several transactions over a period of time. The period should be long enough to include a large number of observations, but it should not be so long that the shareholder structure changes too much.

A practical time period is one year. This allows for a maximum of 52 weekly observations of the voting premium. The shareholder structure can be estimated as the average of the two point estimates in February-March and August-September which are reported by VPC in the basic shareholder data. The errors in this averaging procedure are discussed in Sections 5.4 and 5.5.4 respectively.

There will be eleven point estimates of the voting premium and shareholder structure, one for each year from 1975 through 1985. A firm is included in any particular year if it is listed on at least one day during the period March 1-August 31. These dates have been chosen in light of the reporting of the shareholder data. A firm is always excluded from the day it becomes subject to a successful takeover bid, even if it continues to be listed for some time.

Shareholder data was collected for most of the firms which met the listing requirements. There were two kinds of exception: firms with very limited voting rights, and firms controlled by a large consortium of otherwise unrelated shareholders.

First, firms were excluded which limited voting rights to 5 % of the votes or equity, or less. For example, the insurance company Skandia imposed a maximum of 30 votes per shareholder out of 12 000 000 votes in the firm. This necessarily causes dispersed shareholdings. Firms excluded on these grounds included Jämtlands Folkbank, MEA, Skandia, Skandinaviska Enskilda Banken, and Svenska Handelsbanken. Firms using a maximum vote limit of 10 % of the votes or equity, or more, were included.

Second, in some firms it was found that a large consortium held the majority of the votes, but that the consortium contained numerous otherwise unrelated shareholders. In such a firm the power index describes the power distribution vis-ã-vis shareholders outside the consortium, but not within it. The shareholder structure is simultaneously both stable and unstable, due to the incentive to improve one's position within the consortium. Such incentives are not apparent among family members, for example, who are related to one another in other ways.

The power index does not capture the double nature of these shareholder structures very well. Firms have therefore been excluded, where a recognized consortium holds the majority but where consortium members are not related in any other way. These firms are Andersson, Ahlsell (1983-1985), Finnveden, Företagsfinans, Gullspång, Hexagon, NPL, Pronator (1981-1983), Skansen, and SILA (1982-1985). In these cases the shareholder structure is one of either majority control or dispersed ownership, depending on the treatment of the agreement. They are therefore excluded. In another firm, Alcro, there is a consortium of four. This group holds a minority position in the firm alongside the founding family. It is regarded as a single entity.

The exclusion of firms with limited voting rights or with large consortia did not affect the test of the voting premium, since none of the firms had listed A- and B-shares. The excluded firms were also too few for the missing observations to have any impact on the instability test.

Price data could be collected only for firms with separately listed A- and B-shares, which makes it possible to record price differences. Some firms practise the joint listing of A- and B-shares, which means that a buyer cannot bid explicitly for one or the other. A bidder may get only A-shares, only B-shares, or a mixture of the two. The reason for the joint listing of A- and B-shares could be that

- there is no price difference
- the A-shares are infrequently traded
- the A-shares are only traded outside the Stock Exchange.

It is not possible to distinguish between the three explanations, so the 'no price difference' explanation cannot be used.

Table 5.1 shows the maximum number of firms that meet the listing requirements, for which shareholder data was collected and for which a voting premium could be estimated.

Table 5.1: The Number of Firms which meet the Listing Requirements, for which Shareholder Data was collected and for which the Voting Premium was estimated.

	A	B	C
1975	133	125	18
1976	131	123	18
1977	134	126	20
1978	131	124	21
1979	134	127	19
1980	133	125	20
1981	126	119	20
1982	134	123	22
1983	142	131	25
1984	154	144	39
1985	165	154	41

A: The number of firms listed on AI, AII, or Fondhandlarlistan on at least one day during the period March 1 - August 31 in the respective year. Six firms on Inofficiella listan are also included: Gotland, SÅA, Fagersta, Parcon, Parlamentet, and Tresor. Firms are excluded from the day of a successful take-over bid.

B: The number of firms which meet the requirements of the A-column, and for which shareholder data was collected.

C: The number of firms which meet the requirements of the A- and B-columns and for which a voting premium could be estimated.

5.3 The Use of Differential Voting Rights

The firms which meet the listing requirements (column A in Table 5.1) can be classified in four categories with respect to voting power differentiation in their common shares.

Category

1) All common shares have equal voting rights. Preferred shares may have low voting power.
2) The firm has common shares with differential voting rights and the classes are listed on the Stock Exchange, but it is not possible to record a price difference because there is joint listing of the two classes.
3) This category differs from the preceding one in that the two classes of shares are listed separately, so that a price difference can be recorded.
4) Only the low-vote shares are listed, while the high-vote shares are closely held and not traded on the Stock Exchange.

Table 5.2 shows the frequency of firms in the respective categories. The right hand column corresponds to column A in Table 5.1. The frequencies in category 3 correspond to the numbers in column C in Table 5.1.

Table 5.2 : Sample of Firms listed on the Stockholm Stock Exchange or Fondhandlarlistan 1975 - 1985, distributed among the Four Categories*)

Year	Category						Sample
	1	(%)	2	3	4	(2+3+4 %)	
1975	79	(59)	20	18	16	(41)	133
1976	76	(58)	19	18	18	(42)	131
1977	70	(52)	22	20	22	(48)	134
1978	66	(50)	22	21	22	(50)	131
1979	67	(50)	23	19	25	(50)	134
1980	64	(49)	22	20	26	(51)	133
1981	58	(46)	24	20	24	(54)	126
1982	55	(41)	22	22	34	(58)	134
1983	55	(39)	21	25	41	(61)	142
1984	54	(35)	15	39	46	(65)	154
1985	59	(36)	12	41	53	(64)	165

*) A firm which moves between two categories during the year is recorded according to the old category if this persisted beyond July 1. Otherwise it is recorded in the new category. Firms entering category 3 during the year are always classified as category 3.

Table 5.2 shows that common shares with differential voting rights are relatively frequent on the Stockholm Stock Exchange. A few firms have no voting differential with respect to common shares but have preferred shares with low voting power. These firms constitute between 4 and 10 per cent of the firms in category 1, and are thus rather rare. Some of the firms in the other three categories have preferred shares as well.

An interesting point in Table 5.2 is that the proportion of firms with common shares with differential voting rights has increased from 41 % in 1975 to 64 % in 1985. This can be compared with a study from 1959, when only 13 % of the firms on the Stock Exchange had voting differentials for common shares (see Skog, 1981). The increase in the use of voting power differentiation is particularly marked in category 4, the firms which do not list their high-vote shares. Among the 76 firms which were introduced on to the Stock Exchange during the sample period, not less than 43 entered in category 4. It is thus usual that new firms list their B-shares only, while keeping the A-shares closely held outside the Stock Exchange.

The voting differentials range from 1:1000 to no differentiation at all, 1:1. The voting differentials are constant over time, except when the change is from no differentiation, 1:1, to some other voting differential. Table 5.3 shows the frequencies of voting differentials in 1975 and 1985.

Table 5:3 : Frequency of Voting Differentials in 1975 and 1985

	Frequency of Voting Differentials in			
Voting Differential	1975	(%)	1985	(%)
1:1000	8	(6)	7	(4)
1:100	1	(1)	1	(1)
1:10	48	(36)	96	(59)
1:5	2	(2)	5	(3)
1:2	1	(1)	0	(0)
1:1	73	(55)	56	(33)
	133		165	

Most firms use the voting differential 1:10, which is the maximum permitted by law. The firms with a large voting differential, introduced their B-shares before 1944.

It was argued in Chapter 4 that voting inequality rather than voting differential is a measure of the impact of voting power differentiation. This can be tested by establishing which firms have high voting inequality. If voting power differentiation provides a way of reducing the competition for corporate control, it can be expected that category 4 firms will have high voting inequality. In other words, if maintaining control with a low equity base is the major motive for using shares with differential voting rights, there is no need to list the A-shares. This supposition is tested in Table 5.4, which illustrates a t-test of the means of voting inequality across categories 2 + 3 and 4.

Table 5.4 : T-test of Means of Voting Inequality Across Categories 2 + 3 and 4

Year	Average Voting Inequality for firms in *)		T-value on	Sample
	Cat=2 + 3	Cat= 4	Difference**)	
1975	2.82	5.26	2.92	54
1976	2.99	5.15	2.50	55
1977	2.86	5.03	2.84	64
1978	2.89	5.06	2.66	65
1979	2.88	4.95	2.67	67
1980	2.94	5.00	2.38	68
1981	2.64	5.31	3.23	68
1982	2.66	5.04	3.33	78
1983	2.69	4.97	3.53	87
1984	2.60	5.09	4.03	100
1985	2.66	4.73	3.46	106

*) Cat = 2 + 3 means that both A- and B-shares are listed, while Cat = 4 means that the B-shares only are listed.

**) The t-test is performed with pooled variances.

The t-test shows that on an average voting inequality is between 2.6 and 3.0 in firms which list their A-shares. Voting inequality is close to 5.0 on an average in the firms which do not list their A-shares. This difference between the two groups is clearly significant, and it supports the supposition that voting inequality is a measure of the impact of voting power differentiation, and that dual-class common shares provide a way of reducing the competition for corporate control. Voting inequality of 5.0 means that one shareholder can hold 50 % of the votes with only 10 % of equity with a voting differential of 1:10. A voting inequality of 5.0 minimizes the equity base of a majority block for the maximum voting differential of 1:10, and is thus optimal in Sweden.

Firms with low voting inequality can be expected to have introduced B-shares as a result of the 40/20-rule, i.e. unrestricted shares up to 40 % of equity but only 20 % of the votes. Firms with listed B-shares and thus low voting inequality should have primarily unrestricted B-shares. This supposition is examined in Table 5.5, which shows the proportion of firms in each category which have unrestricted B-shares only. The figures exclude seven firms which have A- and B-shares which are all unrestricted.

Table 5.5 : Proportion of Firms within the Respective Categories which Have Unrestricted B-shares Only

Year	Proportion of the Firms in the Respective Categories with no Restricted B-shares (%)		
	Cat=2	Cat=3	Cat=4
1975	10	39	0
1976	10	39	0
1977	9	40	0
1978	9	43	0
1979	9	47	0
1980	9	45	0
1981	8	50	0
1982	9	45	0
1983	14	48	0
1984	13	36	0
1985	17	33	0

The figures in Table 5.5 support the supposition that many of the firms with listed B-shares have introduced voting power differentiation as a result of the 40/20-rule. The particularly high proportions for category 3 firms cause a problem of underestimation of the voting premium (Section 6.1.1).

To sum up: it has been shown that shares with differential voting rights have become increasingly common. The increase is due particularly to firms which do not list their A-shares. These firms have an average voting inequality of around 5, which supports the hypothesis that voting inequality is a measure of the impact of voting power differentiation.It also supports the hypothesis that dual-class common shares are often introduced as a means of reducing the competition for corporate control. The firms which introduce B-shares as a result of the 40/20-rule usually list their A-shares. It thus seems that the increasing use of a dual class of common shares during the sample period is an indication of greater competition for corporate control in Sweden.

5.4 Price Data

Price data was collected manually from the lists of the Stockholm Stock Exchange, Fondhandlarlistan, and from Svenska Dagbladet for the four firms on the Inofficiella listan. Price data was collected only for firms in category 3 for which it was possible to record a price for the A- and B-shares respectively.

The first principle for estimating the voting premium was to identify transaction prices for the A- and B-shares which matched as regards time. Both classes of shares had to be traded on the same day for the prices to be recorded. The final transaction prices of the day were used. When the A- and B-shares were both traded in the morning, but only one of them in the afternoon, the two morning transaction prices were used, rather than matching the afternoon transaction with another in the morning. This should have reduced the impact of variations in information during the day.

The last matching transaction prices of the week were registered. If one of the classes of shares was not traded on the last day of the week, matching transaction prices were looked for on the penultimate trading day of the week, and so on. If there were no matching transactions that week, the observation was omitted. Thinly traded A-shares traded with the same broker acting as seller and buyer, (inbördes), were omitted to reduce the risk of biased pricing. Transaction prices outside the Stock Exchange (efteranmälda affärer) were used when there were no matching transaction prices on it.

The second principle for estimating the voting premium was to take the arithmetic average of the weekly estimates during the year. This principle was used for two reasons. First, individual transaction prices were subject to interference for various reasons, and an average would reduce the noise. Errors could arise because different individuals traded in the two classes of shares, and different people evaluated the vote and the investment segment of the share differently. Errors could also arise due to variations in information during the day. There was a special risk of biased pricing for thinly traded A-shares, since it is possible to manipulate the price of shares which are traded only a few times a year. There was little problem in connection with side-payments in individual transactions in the case of small lots, as opposed to the trading of large blocks of shares, where side-payments may be important.

Second, the game model is static and the Shapley value is interpreted as the value of a purely strategic position without reference to particular issues (Section 3.6). It may well be that the estimate of the voting premium is affected by an ongoing power struggle, for example. It can be expected that the temporary value of the vote will be higher than its purely strategic value. It can also be expected that the price of the oceanic vote reflects the marginal value of the vote of the major shareholder during a power struggle. This price is much higher than the strategic value of the oceanic vote. An arithmetic average of a large number of point estimates over a year, may moderate the impact of temporarily high estimates of the voting premium. In Chapter 6 we shall see how ongoing power struggles increase the value of the oceanic vote.

Table 5.6 shows the number of observations for each estimate of the voting premium. For some very thinly traded A-shares no more than a single observation, or a few transactions only, were used to obtain the estimate of the voting premium. The A-shares of some firms were not traded every year.

Table 5.6 : Number of Observations for each Estimate of the Voting Premium*)

Firm	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGA	-	-	-	17	48	52	51	52	51	52	24
Alfa	51	51	50	52	51	52	52	51	52	52	52
ASEA	-	-	-	-	-	-	-	-	34	52	51
Beijer	-	-	-	-	-	2	-	-	-	-	-
Bilspedition	-	-	-	-	-	-	-	-	-	16	27
Bofors	-	-	-	-	-	-	16	50	49	50	49
Boliden	37	27	31	28	37	44	45	50	48	44	51
Bulten-Kanthal	-	-	-	-	-	-	49	44	38	23	34
Citadellet	-	-	-	-	-	-	-	-	-	34	28
Custos	46	43	47	48	47	44	51	51	50	51	51
DN	7	10	21	5	9	12	11	-	-	-	-
Electrolux	1	-	3	5	6	1	4	6	2	2	2
Ericsson	37	36	30	33	23	42	41	36	48	44	45
Esselte	-	-	19	45	-	-	-	-	-	10	48
Euroc	-	-	-	-	-	-	-	-	-	-	27
Fagersta	50	19	43	38	36	49	52	42	37	27	12
Gotland	-	-	-	-	-	-	-	-	-	17	14
Holmen	36	32	22	34	31	40	50	42	46	38	48
Incentive	-	-	-	-	-	-	-	-	-	11	48
Investor	-	-	-	-	-	-	-	-	-	15	52
Jonsered	8	13	15	27	-	-	-	-	-	-	-
Kema	-	-	-	-	-	-	-	-	9	33	-
Korsnäs	-	-	-	-	-	-	-	-	-	11	48
Marabou	4	3	3	1	-	3	9	9	8	10	10
MoDo	35	29	37	49	32	39	46	43	49	43	39
Monark	19	17	10	11	19	29	45	26	-	-	-
Munksjö	5	4	13	5	9	6	28	-	-	45	38
Nife	4	1	2	-	-	-	-	-	-	-	-
Parcon	-	-	-	-	-	-	-	-	-	21	29
Parlamentet	-	-	-	-	-	-	-	-	-	21	29
Pharmacia	-	-	-	-	-	-	-	-	-	52	50
PLM	-	-	-	-	-	-	-	-	-	26	49
Providentia	-	-	-	-	-	-	-	-	-	15	52
Rang Invest	-	-	-	-	-	-	-	-	-	-	20
Regnbågen	-	-	-	-	-	-	-	-	-	24	48
Saba	27	35	34	42	37	47	52	52	49	51	49
Sandvik	-	-	25	44	43	51	52	52	49	51	52
SCA	-	-	-	-	-	-	-	-	-	52	52
SKF	10	18	22	19	15	52	52	52	51	51	52
Skrinet	-	-	-	-	-	-	-	-	3	43	35
Skånegripen	-	-	-	-	-	-	-	-	-	-	26
Sthlms Badhus	-	-	-	-	-	-	-	17	45	43	26
Swedish Match	35	37	36	37	40	39	36	44	44	37	32
Sydkraft	34	35	47	47	44	48	49	50	51	52	50
SÅA	-	-	-	-	-	-	-	2	43	28	3
Tresor	-	-	-	-	-	-	-	-	21	29	25
Volvo	-	-	-	-	-	-	-	29	51	52	52

*) An observation is defined as the last pair of prices in the week for the A- and B-shares, for transactions occurring within one day of trading.

The voting premium was estimated according to equation (5.1).

$$VP = \frac{1}{T}\sum_{t=1}^{T} \frac{\frac{1}{1-\gamma_j}(\alpha_j-\alpha_j\gamma_j+\gamma_j)(P_{Ajt}-P_{Bjt})}{\alpha_j P_{Ajt}+(1-\alpha_j)P_{Bjt}} \tag{5.1}$$

where
- t = 1 ... T weeks in the year
- j = 1 ... J firms in the sample respective year
- P_A = price of A-share
- P_B = price of B-share
- α_j = fraction of A-shares in firm j
- γ_j = voting differential in firm j

Formula (5.1) was derived in Chapter 4. The nominator is the price difference adjusted for voting inequality. It is assumed that the price of the vote follows perfectly the voting inequality measure. A simple test of the assumption is a rank correlation test between the voting inequality measure $1/(\alpha-\alpha\gamma+\gamma)$ and the unadjusted voting premium, i.e.

$$VP_{Un} = \frac{1}{T}\sum_{t=1}^{T} \frac{P_{Ajt}-P_{Bjt}}{\alpha_j P_{Ajt}+(1-\alpha_j)P_{Bjt}} \tag{5.2}$$

where VP_{Un} = voting premium not adjusted for voting inequality

Table 5.7 shows the estimated rank correlation coefficients, which are clearly significant (despite all other independent variables, including the oceanic power ratio, left out from the test).

Table 5.7 : Rank Correlation between the Unadjusted Voting Premium and the Voting Inequality Measure

Year	Spearman's Correlation Coefficient	Significance Level	Sample*)
1975	0.36	0.072	18
1976	0.67	0.002	17
1977	0.70	0.000	20
1978	0.50	0.012	20
1979	0.35	0.083	17
1980	0.51	0.013	19
1981	0.65	0.001	20
1982	0.64	0.001	21
1983	0.53	0.004	24
1984	0.46	0.002	39
1985	0.63	0.000	41

*) Corresponds to column C in Table 5.1. Excluded are firms with no transactions in the A-shares during the year.Munksjö 1982 and 1983 are also excluded (cf. below).

The denominator of Formula (5.1) is the value of the share including the value of control. There is a problem connected with this denominator, since according to the theory firms in majority control have a low oceanic vote segment, while firms with a high oceanic power ratio have a large oceanic vote segment. Thus the denominator can be expected to be low for firms with low oceanic power ratio and high for firms with a high oceanic power ratio. This causes a downward bias in the tests.

However, there is no good alternative to the chosen denominator. The investment segment, for example, is also dependent on the value of control, since power struggles and takeover bids affect the value of non-voting shares. The main advantage of this denominator to the investment segment, is that a denominator that includes the vote segment is less affected by extreme observations of the price difference, since a high price of an A-share increases the denominator.

The estimates of the voting premium can be seen in Table 5.8.

Table 5.8 : Estimates of the Voting Premium, by Firm and Year, computed as the Arithmetic Means of Weekly Matching Transaction Prices in A- and B-shares

Firm	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGA	-	-	-	0.0	0.2	2.1	0.9	0.9	-0.3	3.6	6.2
Alfa	-0.1	-0.3	0.1	0.0	0.0	0.0	0.5	0.6	0.9	5.1	11.6
Asea	-	-	-	-	-	-	-	-	-25.6	-26.9	-25.5
Beijer	-	-	-	-	-	6.1	-	-	-	-	-
Bilspedition	-	-	-	-	-	-	-	-	-	4.6	9.9
Bofors	-	-	-	-	-	-	0.0	0.0	0.0	0.2	-0.1
Boliden	0.2	0.3	0.6	-0.6	1.7	5.9	3.3	-0.6	0.1	-0.4	1.8
Bulten-Kantahl	-	-	-	-	-	-	2.3	8.9	1.4	13.9	17.4
Citadellet	-	-	-	-	-	-	-	-	-	0.4	1.9
Custos	0.0	0.0	0.2	0.2	0.0	0.2	0.1	0.6	6.0	17.2	6.4
DN	4.1	3.7	6.1	11.7	4.5	6.2	3.5	-	-	-	-
Electrolux	1.1	-	1.1	0.9	0.9	1.2	2.8	2.9	1.9	0.8	1.5
Ericsson	-0.1	0.1	0.1	-0.1	-0.1	0.2	0.3	1.1	-0.1	0.6	0.9
Esselte	-	-	0.1	0.1	-	-	-	-	-	6.4	11.1
Euroc	-	-	-	-	-	-	-	-	-	-	0.7
Fagersta	0.7	1.7	1.3	0.3	0.4	0.7	4.5	6.9	6.3	0.7	0.5
Gotland	-	-	-	-	-	-	-	-	-	27.6	40.2
Holmen	0.4	0.9	1.5	0.2	0.3	0.6	3.8	3.7	8.0	8.3	19.8
Incentive	-	-	-	-	-	-	-	-	-	1.2	5.8
Investor	-	-	-	-	-	-	-	-	-	7.3	7.2
Jonsered	9.7	2.7	5.1	0.2	-	-	-	-	-	-	-
Kema	-	-	-	-	-	-	-	-	4.8	2.7	-
Korsnäs	-	-	-	-	-	-	-	-	-	8.0	5.3
Marabou	3.2	3.0	5.2	9.8	-	8.4	3.1	4.0	4.0	0.6	5.0
MoDo	0.5	0.6	2.3	1.4	2.2	2.2	2.4	6.6	6.3	10.1	17.3
Monark	3.4	1.1	-0.3	2.4	2.4	2.5	7.1	5.5	-	-	-
Munksjö	10.8	13.1	21.2	9.8	5.8	4.5	6.8	-19.5*	21.7*	1.0	2.2
Nife	0.2	1.7	2.1	-	-	-	-	-	-	-	-
Parcon	-	-	-	-	-	-	-	-	-	2.4	2.8
Parlamentet	-	-	-	-	-	-	-	-	-	0.9	1.5
Pharmacia	-	-	-	-	-	-	-	-	-	6.4	10.8
PLM	-	-	-	-	-	-	-	-	-	0.5	1.1
Providentia	-	-	-	-	-	-	-	-	-	8.9	7.5
Rang Invest	-	-	-	-	-	-	-	-	-	-	0.4
Regnbågen	-	-	-	-	-	-	-	-	-	2.1	1.4
Saba	0.6	0.5	1.3	2.4	2.1	3.1	0.6	1.2	2.5	4.7	2.4
Sandvik	-	-	0.3	0.1	0.1	0.2	-0.8	0.9	3.8	-2.3	-4.5
SCA	-	-	-	-	-	-	-	-	-	4.8	3.2
SKF	7.4	4.8	5.1	3.7	3.7	-0.5	0.0	1.9	1.2	1.9	3.2
Skrinet	-	-	-	-	-	-	-	-	5.1	13.6	22.9
Skånegripen	-	-	-	-	-	-	-	-	-	-	7.7
Sthlms Badhus	-	-	-	-	-	-	-	6.8	13.4	9.5	19.5
Swedish Match	0.6	1.0	1.5	0.4	0.3	3.2	3.6	4.5	3.6	7.0	14.1
Sydkraft	0.2	0.1	0.1	0.0	0.1	0.6	0.6	8.8	7.6	3.7	4.8
SÅA	-	-	-	-	-	-	-	9.5	4.0	2.3	0.0
Tresor	-	-	-	-	-	-	-	-	3.9	3.1	1.4
Volvo	-	-	-	-	-	-	-	1.9	2.3	5.1	3.9

* = excluded from all analysis

Where possible the voting premium is estimated between restricted A- and B-shares. For AGA 1985, restricted B-shares were introduced in June, so the voting premium was estimated on transactions during the second half of the year.

The negative voting premium of some firms results from computing the price difference between restricted A-shares and unrestricted B-shares.

A few firms have free A-shares as well. The estimated voting premium based on the difference for unrestricted A- and B-shares is usually underestimated. One reason is that unrestricted A-shares are usually in short supply, so the market pays less for the thinly traded unrestricted A-shares. This means that the price of the unrestricted A-shares often closely follows the price of the restricted A-shares. Another cause of underestimation is that unrestricted A- and B-shares can be listed on different foreign stock exchanges and this can also cause price differences unconnected with voting differential. For all these reasons the voting premium is never based on the price difference for unrestricted A- and B-shares, but always on the difference between restricted A-shares and unrestricted B-shares when there are no restricted B-shares.

One case, Munksjö 1982 and 1983, has been excluded from the analysis. It represents a strange exception with a very large discount for the shares with high voting power. The discount has been computed between restricted A- and B-shares. In 1984 the discount disappeared, and the A-shares were priced at a premium of roughly 2 %. The discount cannot be explained in terms of the theory presented in the present dissertation. A possible explanation could be biased pricing. The B-shares are in very short supply (3 % of equity). It is therefore possible to manipulate the price of the B-share for some unknown reason.

Biased pricing could be expected in other cases as well. Munksjö (1975-1978) and DN both had a very large voting premium for their A-shares in relation to the market. There were very few A-shares scattered through the market, since most of them were closely held by the majority shareholder in the respective firms. The majority shareholder may have wanted to inflate his balance sheet, or to increase the leverage potential of the block of A-shares.

The prices of Bofors shares were obviously biased in 1984 and 1985. The A- and B-shares were traded every day, but at a fixed price. For example, the price of both the A- and B-shares was fixed at 315 kronor from November 14 1984 until May 9, 1985. It is likely that the majority shareholder, holding more than 60 % of equity and votes, was trading with himself.

The voting premium in MoDo has been estimated between restricted A- and B-shares. This firm also had unrestricted B-shares which were traded at a substantial premium against the restricted B-shares. This was strange, since there was very limited foreign demand for unrestricted shares in MoDo. This suggests that the price of the restricted B-shares was systematically too low, possibly due to the low liquidity of the restricted B-shares. MoDo had a shareholder structure approaching majority control, so the relatively high voting premium may have been due to a liquidity discount for the unrestricted B-shares. (Cf. Section 6.3, on the power struggle in MoDo.)

The cross-sectional mean of the voting premium can be seen in Table 5.9. All observations are included, except for Munksjö 1982 and 1983.

Table 5.9: The Cross-sectional Mean of the Voting Premium

Year	VP (%)			Sample
	Mean	Min	Max	
1975	2.4	-0.1	10.8	18
1976	2.1	-0.3	13.1	17
1977	2.8	-0.3	21.2	20
1978	2.1	-0.6	11.7	20
1979	1.4	-0.1	5.8	17
1980	2.5	-0.5	8.4	19
1981	2.3	-0.8	7.1	20
1982	3.6	-0.6	9.5	21
1983	2.5	-25.6	13.4	24
1984	4.3	-26.9	27.6	39
1985	6.1	-25.5	40.2	41

Excluded:

Munksjö	VP
1982	-19.5
1983	-21.7

The mean is between 2 and 6 %. This means that the investment segment represents 98 % of the share price and the vote segment 2 %, when the voting inequality is taken into account.

Some previous studies on the voting premium of shares with high voting power have estimated 5.44 % for the USA (Lease et al., 1983), and 45.5 % for Israel (Levy, 1982). These estimates are computed as $(P_A-P_B)/P_B$. They are based on samples of similar size (20 firms), but for longer time periods than one year. Unfortunately, the figures are not adjusted for voting inequality, which may explain a great deal of the high percentage of 45.5 for Israel. Levy (1982), reported in Table II the A-shares' proportions of votes and equity, so that the voting inequality can be computed. Dividing the estimated premiums in his sample by the voting inequality measure gave an average voting premium of 23.5 % (i.e. Premium/Voting Inequality, and averaged cross-sectionally). This is very high, compared with the average voting premium on the Stockholm Stock Exchange.

It is interesting to see whether there is any relation between the voting premium and the trading frequency of the A-shares, because there is a risk of biased pricing in the case of very thinly traded shares. Firms were therefore classified as thinly traded if their A-shares were traded less than 24 times a year, i.e. there were less than two transactions a month. These firms are listed in note 1. For these firms the number of matching transactions in Table 5.6 corresponds to the greater part of the total transactions in A-shares. In the case of more frequently traded A-shares, we find transactions which do not match a transaction in B-shares, or matching transactions occurring on more than one day in the week.

The frequency of the voting premium for thinly and frequently traded A-shares can be seen in Table 5.10.

Table 5.10 : Frequency of the Voting Premium for Frequently and Thinly Traded A-shares*)

Frequency of the Voting Premium (%) for Firms which are

	Frequently traded			Thinly traded			
	Low-1.99	2-5.99	6-High	Low-1.99	2-5.99	6-High	Sample
1975	10	1	1	2	2	2	18
1976	11	1	0	1	3	1	17
1977	11	3	0	1	3	2	20
1978	12	3	0	2	0	3	20
1979	10	4	0	1	2	0	17
1980	8	6	0	1	1	3	19
1981	9	6	1	0	3	1	20
1982	10	3	6	0	2	0	21
1983	8	7	6	1	1	0	24
1984	12	12	12	2	0	1	39
1985	14	9	15	1	1	1	41

*) Shares are classified as thinly traded if there are less than 24 transactions in the year.

In Table 5.10 it can be seen that all frequently traded A-shares were traded at a very small premium in the 1970's. Nearly all observations come into the "less than 2 % premium" category. From 1982, there are frequently traded A-shares in the "high" category. This suggests that any statistical analysis of the voting premium is unreliable for data from the 1970's, because the voting premium is indistinguishably small for most firms with certain estimates of the voting premium. This can also be seen in Table 5.11, which shows the cross-sectional mean of the voting premium, from which the thinly traded A-shares and the negative observations have been omitted.

Table 5.11 : The Cross-sectional Mean of the Voting Premium excluding Thinly Traded A-shares and Negative Observations*)

Year	Mean VP(%)	Max	Sample
1975	1.4	7.4	10
1976	1.1	4.8	11
1977	1.1	5.1	13
1978	1.2	3.7	13
1979	1.0	3.7	13
1980	1.7	5.9	13
1981	2.0	7.1	15
1982	3.9	9.5	18
1983	4.3	13.4	19
1984	5.1	17.2	33
1985	6.7	22.9	35

*) Shares are classified as thinly traded if there are less than 24 transactions in the year.

To sum up : the voting premium was estimated as the arithmetic average of weekly transaction prices in A- and B-shares at matching times. This reduced noise and the impact of temporary fluctuations on the value of the vote. The voting premium was generally very small during the 1970's, at least for the frequently traded A-shares with reliable estimates of the voting premium. Since 1982 the voting premium has increased in several firms, and there has also been wide cross-sectional variation in the voting premium for frequently traded A-shares with reliable estimates.

5.5 Shareholder Data

This section describes the shareholder data. Fairly precise shareholder data can be collected, because all shareholders are registered by name and all shareholdings exceeding 500 shares are kept publicly available by the central authority VPC. It is not compulsory to register shareholders with VPC, but most listed firms do so. The data does not cover warrants and convertible bonds.

The shareholder data from VPC is available from 1975 onwards. Shareholder data is produced twice a year in February-March and August-September. There are two lists. The main one contains most of the shareholders, while a complementary list includes those shareholders who prefer to register their shares in the name of a broker (förvaltarregistrerad). A combination of the two lists gives a relatively clear picture of the shareholder structure of the firm.

There is one problem in using the VPC-data: the shareholders are reported in alphabetical order and not in order of size.

For this reason I started not with the VPC-data but with ready-prepared shareholder data, in order to identify the major shareholders. Such prepared shareholder data based on the VPC-data was available in Forsgren (1972, 1977), SIND 1980:5, and Sundqvist (1985). With the help of these studies, it was possible to set up four frames for 1971, 1976, 1979, and 1985 with identified shareholder structures. Several shareholder structures proved to be constant throughout. Changing shareholder structures were checked from several sources of information. The main source was a prepared list of shareholders, produced by Aktiemarknadsbevakning (AMB)[2]. The AMB-data rearranged the shareholders in the VPC-data in order of size at each measurement point, beginning in August 1978. Unfortunately only equity was reported and not votes, so the data could not be used for firms with high voting inequality. For those firms, complementary data was obtained direct from the VPC-data, from Öhmans Börsguide, and from the business journal Affärsvärlden, which reported block transactions and takeover bids for the whole sample period and disclosed shareholdings from 1985(changes in shareholdings in accordance with the disclosure rules of the Stock Exchange). Before 1984 the reporting of events was unfortunately somewhat incomplete. Other sources of information used for the last two years were the annual reports of the firms, and a computer tape produced by Arbetslivscentrum containing shareholder data from August 1983, both votes and equity.

5.5.1 Measurement Principles

What was needed was precise shareholder data matching the recorded transaction prices in the A- and B-shares for each day. The power index could then be computed as an arithmetic average of the power indices of the shareholder structures which matched the price data time-wise. But this solution was not possible.

Since shareholder data is reported only twice a year, the estimate of the power index had to be based on the two point estimates. For computational convenience the shareholder data was averaged before the power index was computed, i.e. an average of the shareholder structures in February-March and August-September was chosen to represent the shareholder structure of the firm for that year. This led to errors in the shareholder data for firms with changing shareholder structures. When there was a dramatic change in the shareholder structure, such as a shift from the balance-of-power region to majority control, the shareholder structure which lasted longest during the year was chosen. For example, the balance-of-power structure was chosen as the representative shareholder structure if it lasted longer than the majority structure in the particular year. For firms in category 3, the shareholder structure was always chosen which best matched the price data as regards time, i.e. if there were price data available from September, the chosen shareholder structure would be the one reported in August-September that year. These rules were preferred to the idea of averaging the vote distribution in two completely different shareholder structures.

A major measurement problem arises in connection with the game theory assumption of symmetry, i.e. that shareholders are neutral vis-à-vis one another. There are in fact relations between shareholders which do affect the power distribution. The solution to this problem is identical with the solution of interfirm shareholdings described in Section 3.4. The power index is computed for each coalition of players in a coalition structure. An individual player assumes the value of the coalition to which he belongs. The values a player assumes in various coalition structures are averaged with the probabilities of these coalition structures. In Section 3.4 it was argued that the game model can be used in identifying the probability of interfirm shareholdings. It is not easy, however, to establish the probabilities of coalition structures for individual shareholders.

There is only one feasible solution: a coalition structure has to be assigned a probability of one or zero. In other words it is assumed either that a group of shareholders, e.g. family members, will cooperate in all issues, or that they will remain completely neutral towards one another. The problem of identifying the most likely coalition structure, and which can be assigned a probability of one, will be discussed at length in the next section.

Quite arbitrarily a shareholder or group of shareholders has been classified as a major player if the holding exceeds 5 %. Less than 5 % of the votes classifies a shareholder as oceanic. This limit can be motivated by Theorem 2 in Chapter 3, which states that absolute size is required to distinguish a major player's power ratio from the oceanic power ratio. For two cases at the upper end of the balance-of-power region an exception is made: a shareholder of 2 % makes a big difference to the oceanic power ratio in the shareholder structures in Stockholms Badhus ($[\frac{1}{2}\ ;\ 45, 42, 2\ ;\ 9]$) and in Swedish Match ($[\frac{1}{2}\ ;\ 47, 33, 5, 3\ ;\ 12]$).

Finally, institutional investors such as insurance companies and various funds are regarded as independent shareholders. One problem here is that there are restrictions on their portfolios. For example, the banks' pension funds may not hold more than 5 % of the votes in another firm. The same limit regulates the portfolio choice of insurance companies. The Fourth Pension Fund is restricted to 10 %, and the four collective wage-earner funds or Löntagarfonder cannot hold more than 8 % of the votes each. In spite of the regulations, these institutions are likely to behave like other investors holding, say 8 % of the votes. They have therefore been treated as major shareholders.

5.5.2 The Grouping Principles

In this section the principles for identifying the most likely coalition structures are set out. The analysis is based on earlier studies of the coalition structures in Swedish Industry: Koncentrationsutredningen (SOU 1968:7), SIND 1980:5 and Sundqvist (1985). The last two update the first one and include a discussion of changes in the coalition structures. These studies employ certain common grouping principles, which will also be presented and used here. Briefly, the idea is to group together the holdings of family members, the holdings of family foundations with family holdings, and the holdings of entrepreneurial partners; further, the Investor-Providentia-Exportinvest are taken together and so are the Industrivärden-Handelsbanken group; there are then some special cases, such as the circular shareholdings of ABV-Balken-Företagsfinans and Skanska-Opus-Protorp-Euroc.

The first grouping rule is to add together the holdings of the various members of a family. These holdings have usually originated from the founder, whose children inherited the shares. After two or three generations such holdings may actually be dispersed among a number of people of varied beliefs and preferences. Nonetheless the holdings of family members are still added together into one assumed coalition. Conflicts do arise between family members, but only rarely are they solved by way of voting power. A power struggle within the family will probably be seen as a last resort.

Formal agreements between family members are probably common. Such agreements specify that the family member who wants to sell his shares should first offer them to the other members of the family, perhaps at a price also specified in the agreement. This serves to keep together the dispersed holdings of family members, or of some other group of shareholders. The agreements have to be specified in the articles of corporation. The use of such agreements further strengthens the grouping principle that the shareholdings of various family members can be regarded as a single entity.

Shareholdings widely dispersed within the family were observed in Alcro, Algots, Broströms, Geveko, IRO, Ljungdahls, Perstorp, Ratos, Skånegripen (Kockums), Weibulls and Wigral. In these cases, it can be questioned whether the grouping of family holdings really captures the power of the family in the firm.

In other cases control is maintained within the family in the shape of a family foundation. The entrepreneur creates a foundation to hold the shares, often for tax reasons but also to serve as a controlling entity. Such foundations are to be found in the Barkman, Bonnier, Crafoord, Dunker,Edstrand, Kempe, Söderberg, and Wallenberg families. The holdings of the foundations are grouped with the personal holdings of the family members, on the assumption that the family controls its own foundations.

The next grouping principle concerns the case of partnership. Sometimes there may be two partners who split control of the firm equally between them. This grouping is based not on blood relations but on long friendship and cooperation. Note 3 provides a list of shareholders grouped together for this reason. In nine of the fourteen listed cases of grouped partners, the grouping makes a difference to the distribution of power. For example, in Bergman & Beving the grouping of the two entrepreneurs gives us the coalition structure $[\frac{1}{2}\ ;\ 54,\ 6,\ 5\ ;\ 35]$. If they were not grouped together, the coalition structure would be $[\frac{1}{2}\ ;\ 28,\ 26,\ 6,\ 5\ ;\ 35]$, i.e. the shareholder structure moves from majority control to its opposite in the center of the balance-of-power region. However, it is more realistic to group the two partners in the firm together: they split the A-shares equally, and only the B-shares are listed on the Stock Exchange. Furthermore it seems likely that there is a formal agreement between them to regulate a possible power struggle.

In Sweden there is a long record of relations between the banks and their customer firms. The two major banks divided the lending market between them by assuming a controlling interest in their customer firms. After the Kreuger bankruptcy in the 1930's banks were no longer allowed to hold shares, and their holdings were moved into investment companies. These firms were created for the purpose of holding the controlling blocks of shares.

The largest group of such related firms is the Wallenberg group, which grew out of Stockholms Enskilda Bank. The investment companies of the group are Investor, Providentia and Exportinvest, which are owned with a minority interest by the Wallenberg family and the family foundations. The three investment companies of the group are considered as a single entity although they are listed firms and the Wallenberg family only have minority control. The reason for grouping these three firms together lies in their common history and in the fact that they have the same management. Their holdings are therefore included with holdings of the Wallenberg family and their foundations. These holdings are regarded as one coalition.

A special problem concerns the holdings of the Wallenberg bank. There are three pension funds, which together may own 5 % of the votes in other firms. Apart from the pension funds, other open-end funds are also run by the bank.

Skandinaviska Enskilda Banken (SEB) evolved from a merger between Stockholms Enskilda Bank, which is the old Wallenberg bank, and Skandinaviska Banken. These two banks had their own investment companies and pension funds.

Skandinaviska Banken's investment companies are Custos and Säfveån. Their holdings are not added to the Wallenberg group, nor is Skandinaviska Banken's pension fund, which is in line with SIND 1980:5 and Sundqvist (1985). However, the holdings of Stockholms

Enskilda Bank's pension fund are added to the Wallenberg group, as they are in SIND 1980:5 but not in Sundqvist (1985). The holdings of the open-end funds are not added to the Wallenberg group, since Wallenberg cannot be said to control the SEB bank, which has severely limited voting rights. The grouping of one of the pension funds is based on historical relationships, which seem to govern the election of the board of the pension fund. Since the pension funds cannot hold more than 5 % of the votes altogether, this grouping solution is not critical.

The second major group centers on Svenska Handelsbanken (SHB), with its investment companies Industrivärden and Promotion. The holdings of the investment companies and of the pension funds of the bank are grouped together for the same reasons as in the Wallenberg case. The SHB bank and Industrivärden have dispersed ownership with no major shareholders except for smaller crosswise shareholding. Promotion is almost under majority control. The management of the group thus has to serve an ocean of shareholders, and no particular major interest. The holdings of the open-end funds of the bank are therefore added to the other holdings, in contrast to the open-end funds of the SEB bank in the Wallenberg case.

Other firms apart from banks have large pension funds. These are also regarded as independent players, albeit controlled by corporate management. Such funds occupy a strategic position in Alcro and Swedish Match. In ABV, Table 5.13, the holdings of the pension funds are grouped with the holdings of the firms in the group of cross-wise shareholding, because the group is considered as a case of management control.

One firm, Säfveån, has all its A-shares in various foundations controlled by Skandinaviska Banken. These foundations are regarded as a single entity. In Asken, the Johannes Johanssons Minnesfond (memorial foundation) is grouped with the largest shareholders, Penser. The foundation is regarded as being controlled by Penser.

In late 1984 Skanska and Volvo started building up common shareholdings in several firms. In Custos the two firms shared equally a large controlling block of shares from Lundberg. In Pharmacia, Volvo acquired a large block of shares. Half the block was placed in an investment company, Staven, which is owned 1/3 each by Custos, Cardo and Skanska. These holdings were not grouped together. The reason was the very recent nature of the relations between the firms.

Sydkraft represents a tricky case. Six towns own the majority, but the towns have nothing in common apart from belonging to the public sector. They may have diverging interests and so should not be grouped together. It might throw rather a bad light on them if they were to solve a conflict by means of share acquisitions and voting power. I have chosen not to group the towns together, which suggests dispersed ownership rather than majority control.

An exception to the grouping principles has been made for Electrolux. The shareholder structure in February 1985 is shown in Table 5.12.

Table 5.12 : The Shareholder Structure of Electrolux in February 1985
Shareholder data from Sundqvist (1985)

	Percentage Shareholdings in	
Firms / Shareholders	Electrolux	ASEA
ASEA	49	x
Wallenberg	46	11

The game [$\frac{1}{2}$; 49, 46 ; 5] predicts an extremely unstable shareholder structure ($\Phi / \Theta = 6.40$). Instead, Electrolux is regarded as enjoying majority control for two reasons. First, voting inequality in Electrolux runs at 26.34, such that ASEA holds 49 % of the votes with less than 2 % of equity. If Wallenberg wants to outvote ASEA in Electrolux, it will be necessary to acquire nearly 100 % of the firm to get enough votes. Second, Wallenberg is the major shareholder in ASEA, which is the second largest firm on the Stock Exchange. It is not easy to acquire 11 % of such a large firm, which means that the model underestimates the power of Wallenberg in ASEA. Electrolux is therefore regarded as being under majority control by Wallenberg.

5.5.3 A Study of Crosswise Shareholding

Special grouping solutions were adopted when three or four firms were involved in crosswise - or perhaps we should say circular - shareholding. There were two such cases on the Stockholm Stock Exchange, which had to be classified as management controlled firms due to the construction of crosswise shareholding.

The first case is the ABV, Balken and Företagsfinans group, which appeared in 1982 and disappeared again in late 1985.

Table 5.13 : ABV - Balken - Företagsfinans
Shareholder data from Sundqvist (1985), February 1985.

	Percentage shareholdings in					
Shareholders \ Firms	ABV		Balken		Företagsfinans	
ABV	x		46		25	
Balken	16		x	69	30	
Företagsfinans	28	51	23		x	58
Pension funds of the firm	9		-		3	
Argentus	-		-		14	
4:e AP-fonden	6		-		-	

The columns show the percentage shareholdings of the major shareholders in the three firms. It can be seen that the three firms have majority control of each other, i.e. management controls the three firms (and thus their pension funds). It is easy to compute the power index for the players: 1 for the group, and 0 for the ocean or other major players in the respective firms.(Cf. Section 3.4.)

The second case is the Skanska, Opus, Protorp and Euroc group. Opus and Protorp are investment companies, which were created merely to hold controlling blocks in Skanska and Euroc. Later Opus and Protorp became listed firms with shareholders outside the group.

Table 5.14 : Skanska - Opus - Protorp - Euroc
Shareholder data from Sundqvist (1985), February 1985.

	Percentage shareholdings in			
Firms / Shareholders	Skanska	Opus	Protorp	Euroc
Skanska	x	27	21	27
Opus	19	x	-	5
Protorp	15	-	x	10
Euroc	-	27	21	x
Volvo	-	-	21	-
Cardo	-	-	7	-
Carnegie	-	17	13	-
Norcem	-	-	-	13
Trygg-Hansa	-	-	5	-

This case also has to be regarded as one of management control, despite the existence of other major shareholders in the firms. The holdings by the four firms are thus aggregated in each firm, so that the group holds 34 % in Skanska, 54 % in Opus,etc. This represents a deviation from strict application of the game model, since the firms are not in majority control. However, it is an easy way of avoiding complicated calculations, and one which only slightly overestimates the stability of the shareholder structures in the four firms.

Table 5.15 lists the main cases of crosswise shareholding.

Table 5.15 : Main Cases of Crosswise Shareholding

Group	Appeared in	Disappeared in
Skanska-Opus-Protorp-Euroc	1974	-
Asken-Carnegie	1981	1985
ABV-Balken-Företagsfinans	1982	1985
Citadellet-Parcon-Parlamentet	1983	1985
Kinnevik-Korsnäs	1984	-
Argentus-Beijer-Munksjö	1985	-
MoDo-Iggesund	1985	-

All the examples of crosswise shareholding first appeared during the 1980's, with the exception of Skanska-Opus-Protorp-Euroc. This is consistent with the claim that voting power differentiation has become increasingly popular in recent years. In Section 3.4 we found that crosswise shareholding, like shares with differential voting rights, have the effect of reducing equity while maintaining the relative number of votes. They thus provide a way of reducing the competition for corporate control so the appearance of crosswise shareholding during the 1980's also indicates an increase in the competition for corporate control in Sweden.

5.5.4 Errors in the Shareholder Data

There are four sources of errors in the shareholder data:

1. The shareholder data at VPC are imprecise.
2. While the voting premium is measured as an arithmetic average of weekly matching transaction prices, the power index is based on a representative shareholder structure which is measured as an arithmetic average of two point estimates in February-March and August-September. This is a problem of mismatch.
3. There are failures in identifying the most likely coalition structure (the asymmetry or grouping problem).
4. The probability of the most likely coalition structure is less than unity.

For some firms the shareholder data are imprecise. This is revealed when various sources of information on the shareholder structures record different percentages. I believe that most estimates of the percentage weight of blocks of shares err within a range of ± 2 % of the votes.

The second source of error is due to a mismatch between shareholder data and price data. There is no problem in the case of firms with a constant shareholder structure, but there may be errors regarding firms with changing shareholder structures. Table 6.8 shows the prevalence of firms with changing shareholder structures.

The third source of error appears to be the most serious one. The grouping of two shareholders into a single pre-established coalition can mean turning a shareholder structure from the balance-of-power region to majority control, which completely reverses the prediction as regards voting premium. The grouping principles described in Sections 5.5.2 and 5.5.3 have been chosen with caution, so as not to group shareholders together who are not in fact very likely to cooperate. This cautions approach disregards formal agreements between shareholders. Agreements of this kind are often secret and cannot be allowed for in this study. The problem is that the market is probably well-informed about such agreements, and about their ability to bind shareholders into coalitions. Even if the agreements are publicly known, it is difficult to judge their strength, i.e. the probability that a shareholder will not go against the coalition.

The fourth source of error is due to the existence of more than one coalition structure. There can be errors, if the true probability of the most likely coalition structure equals 0.80, for example. If the second most likely coalition structure is a very different one, there will be non-trivial errors in the estimate of the oceanic power ratio, because the probability of the most likely coalition structure is held to be equal to one.

It should be clear from this discussion that there are a lot of possible errors in the independent variable. But how seriously do these errors affect the reliability of the estimates of the oceanic power ratio?

Obviously errors have no impact at all on the oceanic power ratio, if a single shareholder holds the majority of the votes. It is also evident from Figure 3.6, that the oceanic power ratio is completely insensitive to errors so long as there is no major shareholder with more than 25 % of the votes. Therefore, provided that the most likely coalition structure is correctly identified in all firms, none of the sources of error will have any serious impact on the oceanic power ratio of 70-75 % of the firms. It will be seen in Table 5.18 that 70-75 % of the observations belong to the intervals, majority control ($\Phi/\Theta=0$) and diffused ownership ($0.80 \leq \Phi/\Theta \leq 0.99$). In the remaining 25-30 % of the observations, errors may affect the power ratio, particularly where there are one or two very large shareholders (>40 % of the votes).

The conclusion that most of the estimates of the oceanic power ratio come close to their true value depends on the assumption that the most likely coalition structure is correctly identified. This source of error still has to be analyzed, before we can judge the quality of data.

A sensitivity analysis of the asymmetry problem can be limited to the firms included in the test of the voting premium, since this is the main test. The sensitivity analysis can also be limited in time to the period 1982-1985, since the voting premium was so small for all firms before 1982.

The following experiment has been designed. The oceanic power ratio is held constant for all cases in which a consolidation of the blocks of the two largest shareholders cannot lower the power ratio by more than 0.30. This includes firms in which there is a single majority shareholder, and those in which the holdings of the two largest shareholders together cannot exceed 35 % of the votes. Agreements between the two largest shareholders in these firms can only slightly change the oceanic power ratio. The power ratio is also held constant if there have been press reports of a power struggle between the two major shareholders in a firm. This is taken as sufficient evidence of the absence of binding agreements. The firms which meet those criteria are shown in Table 5.16.

Table 5.16 : Firms Included in the Test of the Voting Premium for which the Oceanic Power Ratio is held Constant in the Sensitivity Analysis of the Asymmetry Problem

A	B	C
Bofors	AGA	Bulten-Kanthal (1982)
Bulten-Kanthal*)	Alfa (1982,1983,1984)	Fagersta (1982,1983)
Citadellet	ASEA	Korsnäs (1984)
Electrolux	Boliden	MoDo (1985)
Fagersta (1984,1985)	Custos(1982,1983,1984)	Skrinet (1985)
Korsnäs (1985)	Esselte	Swedish Match
Marabou	Investor	
Parcon	Munksjö	
Parlamentet	Providentia	
Regnbågen	Sandvik(1982,1983,1985)	
Saba	Skrinet (1983)	
Stockholms Badhus(1985)	Skånegripen	
SÅA	Volvo	

A: Firms with a single majority shareholder, or very close to majority control $\Phi/\Theta \leq 0.30$, which requires at least 47 % of the votes.

B: Firms with dispersed shareholdings such that the sum of the holdings of the two largest shareholders cannot exceed 35 % of the votes. This keeps the oceanic power ratio within the interval [0.70, 0.99] , whatever the grouping may be.

C: Firms which were subject to a power struggle between the two largest shareholders.

*) Two shareholders hold the majority, but 30 % of the votes are held by a firm which is owned 50-50 by the two shareholders. There will certainly be an agreement regulating conflicts between these two shareholders.

Table 5.17 : The Effect on the Oceanic Power Ratio of adding the Holdings of the Two Largest Shareholders to Form a Single Coalition

Firms	The oceanic power ratio for the most likely coalition structure and for the coalition structure with a binding agreement between the two largest shareholders (in parentheses).			
	1982	1983	1984	1985
Alfa (1985)	-	-	-	0.98(0.00)
Bilspedition	-	-	0.45(0.00)	0.61(0.31)
Ericsson	1.05(0.00)	0.99(0.00)	0.99(0.00)	0.99(0.00)
Euroc	-	-	-	0.65(0.00)
Gotland	-	-	0.92(0.62)	0.92(0.62)
Holmen	1.27(0.00)	1.25(0.00)	1.10(0.00)	1.05(0.00)
Incentive	-	-	0.79(0.00)	0.86(0.00)
Kema	-	1.32(0.00)	1.29(0.00)	-
MoDo (1982,1983,1984)	0.39(0.00)	0.39(0.00)	0.52(0.00)	-
Monark	0.73(0.00)	-	-	-
Pharmacia	-	-	0.88(0.48)	0.84(0.47)
PLM	-	-	0.69(0.43)	0.69(0.43)
Rang	-	-	-	0.91(0.74)
Sandvik (1984)	-	-	0.71(0.45)	-
SCA	-	-	0.90(0.21)	0.92(0.00)
SKF	0.90(0.60)	1.06(0.00)	1.03(0.00)	0.95(0.00)
Skrinet (1984)	-	-	0.90(0.08)	-
Stockholms Badhus(1982,1983,1984)	2.47(0.00)	1.77(0.00)	3.44(0.00)	-
Sydkraft *)	0.84(0.00)	0.83(0.00)	0.83(0.00)	0.86(0.00)
Tresor	-	0.93(0.00)	0.93(0.00)	-
No. of firms	7	8	16	13
Sample of firms with estimated voting premium	21	24	39	41
Fraction of regrouped shareholder structures	0.33	0.33	0.41	0.32

*) The holdings of six towns were grouped into one majority block (cf.page 114)

In the case of the remaining firms, a binding agreement between the two largest shareholders can seriously change the oceanic power ratio. Usually the prediction is reversed, since firms in the balance-of-power region are reclassified as firms in majority control. The worst that can happen is that there is a binding agreement in all those firms, i.e. I have failed to identify the most likely coalition structure in all firms where asymmetry between the shareholders can affect the estimate of the oceanic power ratio. Hence, if the results still hold for the worst case of misidentification, we may have reasonable confidence in the results based on the conservative grouping principles chosen.

Table 5.17 shows the oceanic power ratio before and after the grouping of the two major shareholders. The power ratio after the grouping is given in parentheses. It can be seen that in most of those firms, which constitute 1/3 of the observations, the power ratio drops from the high to the low interval, because all firms in the balance-of-power region are transformed into cases of majority control. In Chapter 6, the analysis of the voting premium will be applied to both the most likely coalition structures (values notin parentheses) and the extreme case that there is a binding agreement in all these firms (values in parentheses). It will be seen in Section 6.1.2, Table 6.4, that the extremely unfavorable instance of a binding agreement in all these firms, lowers the estimated coefficients and the t-values, but that the results are still valid.

5.5.5 The Distribution of Shareholder Structures

Table 5.18 shows the frequencies of the oceanic power ratio in four intervals. The relative frequencies are given in parentheses. The low interval corresponds to majority control and the high interval to firms in the center of the balance-of-power region. The interval [0.80, 0.99] corresponds roughly to firms with dispersed shareholdings, in the center of the interior oceanic games. The remaining firms have one dominant shareholder, but not in majority control. The average power and the size of the ocean are also reported. These are measures of the degree of concentration in the shareholder structures.

Table 5.18 : The Distribution of the Oceanic Power Ratio for the Full Sample

Year	Absolute (Relative) Frequencies of the Oceanic Power Ratio, Φ/Θ								Max Φ/Θ	$\bar{\Phi}$	$\bar{\Theta}$	Sample*)
	0		0.01 - 0.79		0.80 - 0.99		1.00 - High					
1975	33	(26)	21	(17)	57	(46)	14	(11)	1.98	0.41	0.55	125
1976	36	(29)	19	(15)	58	(47)	10	(8)	1.43	0.39	0.54	123
1977	39	(31)	20	(16)	56	(44)	11	(9)	1.47	0.38	0.52	126
1978	40	(32)	19	(15)	55	(44)	10	(8)	1.54	0.37	0.51	124
1979	41	(32)	24	(19)	52	(41)	10	(8)	1.54	0.36	0.51	127
1980	40	(32)	27	(22)	49	(39)	9	(7)	1.79	0.34	0.49	125
1981	42	(35)	20	(17)	49	(41)	8	(7)	1.39	0.32	0.46	119
1982	46	(37)	21	(17)	46	(37)	10	(8)	2.47	0.29	0.43	123
1983	54	(41)	23	(17)	44	(34)	10	(8)	1.77	0.26	0.40	131
1984	63	(44)	27	(19)	42	(29)	12	(6)	3.44	0.22	0.37	144
1985	73	(47)	34	(22)	40	(26)	7	(4)	1.76	0.18	0.34	154

*) Corresponds to column B in Table 5.1.

There are three interesting points in Table 5.18. First, all shareholder structures are represented in the sample, even the balance-of-power structures. These shareholder structures are possible due to voting power differentiation, which allows for the combination of strongly concentrated shareholder structures with the dispersed shareholdings of listed firms.

Second, most firms are either in majority control or in the center of the interior oceanic game. Figure 3.7, helps to explan this by showing the strong incentive that exists to increase the size of a block of shares when it exceeds 30-35 % of the votes. It may not cost very much to increase a 35 % command of the votes to achieve a majority position, but it means a considerable increase in the share of the value of control. For firms in the center of the interior oceanic game, the additional cost of acquiring a majority of the votes may often exceed the value of enhanced control.

Third, on an average shareholder structures are much more concentrated in 1985 than they were in 1975. This can be seen in the falling arithmetic average of Φ and Θ. It can be questioned, however, whether shareholdings really became more concentrated, or whether the falling Θ is due to highly concentrated shareholdings in recently introduced firms. To find the answer to this, we can exclude any firms which are not listed during the whole sample period. We can then compute the differences in equations (5.3) and (5.4) for each firm.

$$\Delta(\Phi) = \Phi(1975) - \Phi(1985) \tag{5.3}$$

and

$$\Delta(\Theta) = \Theta(1975) - \Theta(1985) \tag{5.4}$$

Table 5.19 shows the frequencies of firms in three intervals of the measures $\Delta(\Phi)$ and $\Delta(\Theta)$. The intervals are chosen to represent roughly more dispersed shareholdings, no change, and more concentrated shareholdings.

Table 5.19 : Frequencies of Firms with More Dispersed Shareholdings, Unchanged, and More Concentrated Shareholdings 1975-1985

Change in Shareholder Structure		Absolute (Relative) Frequencies of Firms $\Delta(\Phi)$	$\Delta(\Theta)$
Dispersion	$\Delta < -0.10$	10 (12)	4 (5)
No change	$\lvert\Delta\rvert \leq 0.10$	28 (32)	29 (33)
Concentration	$\Delta > +0.10$	49 (56)	54 (62)
		113	113

Approximately 60 % of the firms have experienced more concentrated shareholdings during the eleven-year period. Very few firms moved towards greater dispersion. This is another indication of what appears to be an increase in the competition for corporate control.

Table 5.20 : Estimates of the Oceanic Power Ratio by Firm and Year for Observations included in the Test of the Voting Premium

Firm	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGA	-	-	-	0.96	0.96	0.96	0.96	0.96	0.96	0.95	0.91
Alfa	0.98	0.98	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.98
ASEA	-	-	-	-	-	-	-	-	0.98	0.98	0.98
Beijer	-	-	-	-	-	0.93	-	-	-	-	-
Bilspedition	-	-	-	-	-	-	-	-	-	0.45	0.61
Bofors	-	-	-	-	-	-	0.18	0.13	0.11	0.11	0.02
Boliden	0.99	0.99	0.99	0.99	0.99	0.89	0.89	0.97	0.97	0.96	0.84
Bulten-Kanthal	-	-	-	-	-	-	1.19	1.01	0.00	0.00	0.00
Citadellet	-	-	-	-	-	-	-	-	-	0.00	0.00
Custos	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.89	0.91
DN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-
Electrolux	0.00	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ericsson	1.13	1.13	1.13	1.13	1.13	1.09	1.07	1.05	0.99	0.99	0.99
Esselte	-	-	1.00	1.00	-	-	-	-	-	0.98	0.90
Euroc	-	-	-	-	-	-	-	-	-	-	0.65
Fagersta	0.56	0.56	0.56	0.56	0.56	0.56	0.56	1.04	0.96	0.59	0.00
Gotland	-	-	-	-	-	-	-	-	-	0.92	0.92
Holmen	0.95	0.94	1.00	1.08	1.27	1.27	1.27	1.27	1.25	1.10	1.05
Incentive	-	-	-	-	-	-	-	-	-	0.79	0.86
Investor	-	-	-	-	-	-	-	-	-	0.90	0.73
Jonsered	0.00	0.00	0.00	0.00	-	-	-	-	-	-	-
Kema	-	-	-	-	-	-	-	-	1.32	1.29	-
Korsnäs	-	-	-	-	-	-	-	-	-	0.94	0.00
Marabou	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	0.00
MoDo	0.00	0.00	0.54	0.57	0.39	0.39	0.39	0.39	0.39	0.52	0.69
Monark	0.82	0.82	0.73	0.73	0.73	0.73	0.73	0.73	-	-	-
Munksjö	0.45	0.27	0.30	0.32	0.32	0.32	0.25	-	-	1.00	0.94
Nife	0.00	0.00	0.00	-	-	-	-	-	-	-	-
Parcon	-	-	-	-	-	-	-	-	-	0.00	0.00
Parlamentet	-	-	-	-	-	-	-	-	-	0.00	0.00
Pharmacia	-	-	-	-	-	-	-	-	-	0.88	0.84
PLM	-	-	-	-	-	-	-	-	-	0.69	0.69
Providentia	-	-	-	-	-	-	-	-	-	0.93	0.89
Rang Invest	-	-	-	-	-	-	-	-	-	-	0.91
Regnbågen	-	-	-	-	-	-	-	-	-	0.00	0.00
Saba	0.92	0.86	0.85	0.82	0.80	0.77	1.37	1.21	0.00	0.08	0.01
Sandvik	-	-	0.94	0.94	0.94	0.93	0.93	0.93	0.92	0.71	0.89
SCA	-	-	-	-	-	-	-	-	-	0.90	0.92
SKF	0.94	0.93	0.94	0.94	0.93	0.93	0.89	0.90	1.06	1.03	0.98
Skrinet	-	-	-	-	-	-	-	-	0.90	0.90	0.93
Skånegripen	-	-	-	-	-	-	-	-	-	-	0.89
Sthlms Badhus	-	-	-	-	-	-	-	2.47	1.77	3.44	0.00
Swedish Match	1.06	1.10	1.14	1.18	1.18	1.28	1.39	1.40	1.46	1.44	1.76
Sydkraft	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.84	0.83	0.83	0.86
SÅA	-	-	-	-	-	-	-	0.00	0.00	0.00	0.00
Tresor	-	-	-	-	-	-	-	-	0.93	0.93	0.00
Volvo	-	-	-	-	-	-	-	0.99	0.96	0.98	0.98

Table 5.20 exhibits the oceanic power ratio by firm and year for all observations included in the test of the voting premium. It can be seen that there is very little time serial variation in the oceanic power ratio. This confirms that most estimates of the oceanic power ratio are insensitive to errors in the shareholder data. Another conclusion is that a time series regression on the voting premium is meaningless. The little time serial variation cannot be used to estimate the regression coefficients. Thus, pooling of time series and cross-sectional data is not an appropriate econometric method (cf. Section 6.1.1).

The final Table 5.21 summarizes the frequencies of the oceanic power ratio for firms belonging to category 3, for which a voting premium is estimated. Firms for which no transactions in A-shares are recorded, and the case of Munksjö 1982 and 1983, are not included in these figures.

Table 5.21 : The Distribution of the Oceanic Power Ratio for Firms in Category 3 with an Estimated Voting Premium*)

Year	Absolute (Relative) Frequencies of the Oceanic Power Ratio, Φ/Θ: 0	0.01 - 0.79	0.80 - 0.99	1.00 - High	Max Φ/Θ	Sample
1975	6 (33)	2 (11)	8 (44)	2 (11)	1.13	18
1976	5 (29)	2 (12)	8 (47)	2 (12)	1.13	17
1977	5 (25)	4 (20)	7 (35)	4 (20)	1.14	20
1978	4 (20)	4 (20)	8 (40)	4 (20)	1.18	20
1979	2 (12)	4 (23)	8 (48)	3 (17)	1.27	17
1980	3 (16)	5 (26)	8 (42)	3 (16)	1.28	19
1981	3 (15)	5 (25)	7 (35)	5 (25)	1.29	20
1982	3 (14)	3 (14)	8 (39)	7 (33)	2.47	21
1983	5 (21)	2 (8)	12 (50)	5 (21)	1.77	24
1984	8 (20)	8 (20)	17 (44)	6 (16)	3.44	39
1985	12 (29)	7 (17)	20 (49)	2 (5)	1.76	41

*) Firms with no transactions in A-shares are excluded. Munksjö is also excluded in 1982 and 1983.

The figures in Table 5.21 confirm that all kinds of shareholder structures appear in the test of the voting premium, and that the frequencies are roughly the same for the small sample as for the full sample of firms in Table 5.18. There are not perhaps quite so many firms in majority control in the limited sample, and the numbers of firms in the balance-of-power region are slightly overrepresented, because firms in category 4 tend to be in majority control.

5.6 Conclusions

In this chapter I have described the data used for testing the predictions of the theory of oceanic games. The most interesting finding is that there seems to have been an increase in the competition for corporate control during the sample period. The average voting premium has increased. Shareholder structures have become much more concentrated, i.e. the major shareholders have increased the size of their holdings. Shares with differential voting rights have become increasingly popular, in particular among firms which have recently become listed and which do not list their high-vote shares. Finally, crosswise shareholding has emerged as a new control device in reducing the competition for corporate control.

Note 1: Firms with thinly traded A-shares

Beijer
DN
Electrolux
Gotland
Jonsered
Marabou
Munksjö 1975-1981
Nife

Note 2: Permission was obtained from AMB to use their data.

Note 3: Grouping of shareholders based on a history of friendship or partnership.

Bergman et Beving	:	Säve + Stenberg
Broströms, Bofors etc.	:	Adielsson + Penser +Thulin
Carnegie	:	Ekman + Langenskiöld
Eldon	:	Randholm + Skeppner
Fagersta, Korsnäs	:	Klingspor + Stenbeck (but not Stig Klingspor)
Forsheda	:	Sporre + Tedenstad
Kanthal, Regnbågen	:	Eliasson + Lindén + von Kantzow
Korsnäs	:	Hjelm + Eriksson + Stig Klingspor
MoDo	:	Carlgren + Kempe
Nisses	:	Källkvist + Palm + Rodret
Persöner	:	Månsson + Raihle
Pronator	:	Jacobsson + Larsson + Wattin
Scansped	:	Carstam + Harnell + Lindholm + Ohm + Pedersen-Flyckt
Scapa	:	Conradsson + Hultman
Tresor	:	Arnhög + Jeansson + Roos + Wall

Note 4: Data is stored in a computer tape at the Stockholm School of Economics and is available from the author.

6. Statistical Analysis

This chapter is concerned with the statistical analysis. There are three tests. First, it is predicted that the voting premium is proportional to the oceanic power ratio. Second, block trade premiums are predicted by the power ratios of the major shareholders. Third, it can be tested whether the likelihood of a change in the shareholder structure is related to the oceanic power ratio. The tests are presented in this order. Beside the tests, four examples are also used to show how the price of the vote is affected by ongoing power struggles.

6.1 The Test of the Voting Premium

The main test is the test of the voting premium. There are three independent variables: the oceanic power ratio, a variable representing the cost of control, and an adjustment for the underestimation of the voting premium as a result of unrestricted B-shares. The statistical method will be regression analysis, because the theory predicts that the voting premium increases linearly in the oceanic power ratio.

Difficulties in estimating the voting premium and the oceanic power ratio were discussed in the previous chapter. The estimation problems connected with the other two independent variables and some econometric details will be discussed in the present section.

6.1.1 The Choice of Independent Variables

The analysis should include an independent variable representing the cost of control, which has been defined as the reduced probability that votes are aggregated into controlling blocks as a result of diversifiable risk and credit rationing (Section 4.1). Such a variable is relevant, because in view of the value of control all firms could be expected to have a single majority shareholder. But such is not the case. Many firms are not subject to majority control. Instead shareholders let firms issue shares with differential voting rights, to be able to exert control with a reduced equity base. The existence of other control devices such as crosswise shareholding also supports the view that considerable costs are associated with the holding of large blocks of shares. A variable is therefore included representing the cost of control.

The cost of control can be expected to increase with the size of the investment in a controlling block of shares. Therefore, the market value of the firm can be used as a proxy variable for the cost of control. The variable has to be adjusted for voting inequality, since voting power differentiation reduces the required size of the investment in the controlling block. For time serial comparison of the coefficient, the market value is multiplied by the inverse of the stock market index. This maneuver assumes that relative rather than absolute size determines the cost of control. The variable is thus defined as

$$\mathrm{SIZE} \equiv \frac{\text{Market Value}}{\text{Index}} \cdot (\alpha-\alpha\gamma+\gamma) \tag{6.1}$$

The use of the SIZE variable in a regression equation emanates from the assumption that the cost of control is proportional to the proxy variable. The SIZE variable is supposed to reflect the cost of holding a controlling block of shares in one firm compared with holding a block with the same percentage of the votes in another firm. It is assumed that only A-shares are acquired, and that there are sufficiently many A-shares in the firm to reach the percentage size of the block.

The market value is computed on the ask price for the most frequently traded class of shares in the firm. It is estimated on 31 December each year. It is taken from the FINDATA tape. The stock market index is Affärsvärldens general index which was 100 on 31 December 1979. Table 6.1 shows the mean and range of the SIZE variable for the firms with an estimated voting premium. The largest observation is 2 657 million kronor, which may seem small, but all values are deflated to the 1979 index level and all firms have voting inequality larger than unity.

Table 6.1 : The Mean and Range of the SIZE Variable

The SIZE Variable in 1000 Million Kronor Deflated by the Stock Market Index as at 31 December 1979

Year	Mean	Min	Max	Sample
1975	0.268	0.020	1.332	18
1976	0.254	0.020	0.893	17
1977	0.301	0.009	1.500	20
1978	0.359	0.011	1.802	20
1979	0.391	0.011	1.736	17
1980	0.378	0.006	1.334	19
1981	0.346	0.004	1.167	20
1982	0.342	0.020	1.391	21
1983	0.416	0.029	2.538	24
1984	0.416	0.008	2.657	39
1985	0.362	0.006	2.154	41

Two independent variables are thus identified: the oceanic power ratio and the SIZE variable. A third independent variable is required when the voting premium has to be estimated between restricted A-shares and unrestricted B-shares. A premium for unrestricted shares causes an underestimation of the voting premium in measuring the price difference between the restricted A-shares and unrestricted B-shares.

The most sophisticated solution to this problem is to estimate the premium for the unrestricted shares, and deduct the estimated premium from the price of the unrestricted B-shares, to obtain an estimated price of a hypothetical restricted B-share. However, this requires a theory about what determines the premium for unrestricted shares, something which is outside the range of the present dissertation.

The least sophisticated way of solving the problem is to use an ordinary dummy variable, which assumes a value of 1 if the voting premium is based on unrestricted B-shares, and otherwise a value of zero. However, at least three improvements on a dummy variable can be made without much trouble. The dummy variable can be adjusted for voting inequality and for the relative supply of unrestricted shares. The dummy variable can also be modified for differences in the demand for the shares of various firms.

To start with the impact of voting inequality: consider equation (6.2) which is the difference between the voting premium estimated on restricted B-shares or unrestricted B-shares.

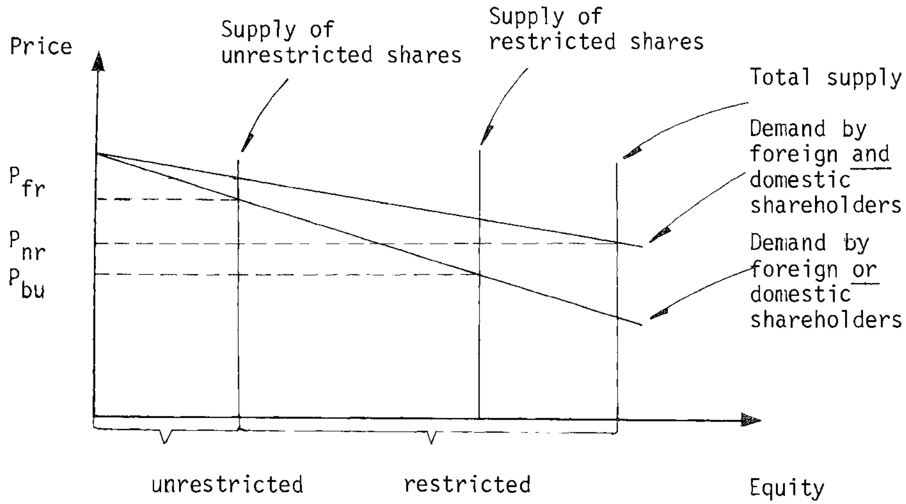
$$\frac{\frac{1}{1-\gamma}(\alpha-\alpha\gamma+\gamma)\left(P_{Abu}-P_{Bbu}\right)}{\alpha P_{Abu}+(1-\alpha)P_{Bbu}} - \frac{\frac{1}{1-\gamma}(\alpha-\alpha\gamma+\gamma)\left(P_{Abu}-P_{Bfr}\right)}{\alpha P_{Abu}+(1-\alpha)P_{Bfr}} \geq 0 \qquad (6.2)$$

The difference is non-negative because the unrestricted B-shares are not to command a price below that of the restricted B-shares. If we disregard the fact that the denominator is slightly higher for the second half of equation (6.2), some terms can be eliminated.

$$\frac{1}{1-\gamma}(\alpha-\alpha\gamma+\gamma)\left(P_{Bfr}-P_{Bbu}\right) \geq 0 \qquad (6.3)$$

Equation (6.3) shows that the underestimation decreases with the size of voting inequality. With high voting inequality, the underestimation due to unrestricted B-shares can be disregarded. In firms where voting inequality is low, it may be important to predict the premium $(P_{Bfr}-P_{Bbu})$.

Suppose that foreign demand is identical with domestic demand for the shares in a particular firm. Suppose, further, that domestic shareholders buy restricted shares only, i.e. there is no speculation in shifting foreign demand, which can increase the price of unrestricted shares. There is then a price premium for the unrestricted shares, if the unrestricted shares are in limited supply. Consider Figure 6.1.



where P_{fr} is the price of an unrestricted share
P_{nr} is the price of a share when there are no restricted shares
P_{bu} is the price of a restricted share

Figure 6.1 : The Impact of Limited Supply on the Premium for Unrestricted Shares

There are three supply curves: the supply of unrestricted shares, the supply of restricted shares, and the total supply of equity. Domestic demand for the shares is represented by the lower downward-sloping demand curve. The demand curve of foreign shareholders is assumed to be identical with the demand curve of domestic shareholders. The upper demand curve is the aggregated foreign and domestic demand for shares in the firm.

Given these assumptions we can see from Figure 6.1 that the unrestricted shares command a premium because of the limited supply and the decreasing marginal utility. Thus, a dummy variable should take into account the relative supply of unrestricted shares. (It can be noted that a very thin supply of unrestricted shares will reduce foreign demand for them, because there will be a price for liquidity. This conflicts with the assumption that foreign demand equals domestic demand.)

Retaining the assumption that foreign demand equals domestic demand, we can regard the premium as a function of relative supply only, $f(\kappa) = P_{Bfr} - P_{Bbu}$, where κ is the percentage of unrestricted shares in the firm. The function $f(\kappa)$ will be zero when all shares in the firm are unrestricted. When there are no unrestricted shares apart from a single one, the function can assume the value of 1. For lack of better information, the function can be assumed to be linear in the argument. If the premium is proportional to this function, the underestimation will be proportional to $\frac{1}{1-\gamma}(\alpha-\alpha\gamma+\gamma)(1-\kappa)$, provided that the assumption of identical foreign and domestic demand holds.

Foreign demand may vary quite a lot between firms, and it is not easy to model what it is that determines foreign demand. However, it can be expected that foreign demand for large multinational firms listed on a foreign stock exchange is higher than it is for small firms not listed abroad. Listing on a foreign stock exchange is therefore used as a way of selecting the firms which have a significant premium for the unrestricted shares. Thus, I suggest using the following dummy variable to solve the underestimation problem:

$$\text{FREE} = \begin{cases} \frac{1}{1-\gamma}(\alpha-\alpha\gamma+\gamma)(1-\kappa) & \text{, if the voting premium is estimated on unrestricted B-shares listed on a foreign stock exchange} \\ 0 & \text{, otherwise} \end{cases} \qquad (6.4)$$

The dummy variable is approximately equal to α^2 and it reaches a maximum of $1/(1-\gamma)$. The data cannot be used to test the model of supply and demand in Figure 6.1, because the two components of the FREE variable, $(\alpha-\alpha\gamma+\gamma)/(1-\gamma)$ and $(1-\kappa)$, are highly correlated (since both are approximately equal to α).

Table 6.2 contains the frequencies of the scores of the FREE variable. It can be seen that the variable is non-zero for a relatively high proportion of the firms in the sample.

Table 6.2 : The Frequencies of the FREE Variable

Year	Absolute (Relative) Frequencies of the FREE Variable				
	FREE = 0		FREE > 0		Max
1975	14	(78)	4	(22)	0.93
1976	13	(76)	4	(24)	0.93
1977	15	(75)	5	(25)	0.93
1978	14	(70)	6	(30)	0.93
1979	11	(65)	6	(35)	0.93
1980	12	(63)	7	(37)	0.93
1981	13	(65)	7	(35)	0.93
1982	14	(67)	7	(33)	0.93
1983	16	(67)	8	(33)	0.93
1984	32	(82)	7	(18)	0.93
1985	35	(85)	6	(15)	0.93

The SIZE and the FREE variables are added to the oceanic power ratio to define the regression model on the voting premium, equation (6.5).

$$VP = \beta_0 + \beta_1 \frac{\Phi}{\Theta} + \beta_2 \text{ SIZE} + \beta_3 \text{ FREE} + \varepsilon \qquad (6.5)$$

What variables are perhaps missing? There is no value-of-control variable. The little theory presented in Chapter 2 on the value of control does not predict the kind of firms in which control is particularly valuable. Disagreement about the shape of the production function may arise in all kinds of firms. For example, there is no reason to expect that the value of the vote is large in firms with low performance (cf. Manne, 1964), because there may be agreement or disagreement in both profitable and unprofitable firms.

It will be shown in Section 6.3 that the value of the vote increases during power struggles, while the model allows only for static predictions. But no dummy variable is included, which would assume a value of 1 for power struggle and otherwise a value of zero. The reason is that the oceanic power ratio predicts the likelihood of a power struggle. Thus, a dummy variable cannot add information which is not already included in the oceanic power ratio, i.e. a dummy variable for power struggles would be highly collinear with the oceanic power ratio.

A regression analysis is adopted because the theory predicts that the voting premium increases linearly in the oceanic power ratio. The regression equation (6.5) will be run with ordinary least squares, one for each year. This methodology calls for a comment, since there are some econometric problems, there are few degrees of freedom, and there is some possibility of heteroscedasticity.

The first problem is due to the small size of the sample and the presence of several independent variables. This introduces a risk of dependence on single observations. A possible way of increasing efficiency would have been to pool the cross-section and time-serial data. Pooling cannot be used, however. As was seen in Table 5.20, there is almost no time-serial variation in the oceanic power ratio. This means that the coefficient of the oceanic power ratio cannot be estimated in a time series regression, i.e. a time series regression contains little information about the coefficient of the oceanic power ratio.

The second econometric problem is heteroscedasticity. According to the theory, the oceanic vote outside a majority block should have a zero price, because it commands no power. In a majority controlled firm the expected voting premium is small, regardless of the value of control. Thus it is expected that the residual will be small for firms with a low oceanic power ratio. However, cross-sectional variation in the value of control will cause a residual error for observations with a high oceanic power ratio, because there is no value-of-control variable in the regression equation (6.5). To put it another way, missing variables should induce a residual error when the oceanic vote possesses decisional power but not when the oceanic vote has no power.

I tried allowing for the expected heteroscedasticity with the help of weighted least squares, but it did not improve the predictability of the model. Thus, the expected heteroscedasticity was not observed in the data.

6.1.2 The Results

Table 6.3 shows the estimated coefficients of the regression analysis. T-values are in parentheses. It can be seen that the model has good explanatory power for the years 1983, 1984, and 1985, but not before. The Shapley value can predict the voting premium for this period. The coefficients have similar size and significance in all three regressions. (The slightly lower coefficient and t-value in 1984 are increased to $\beta_1 = 6.5$ and $t = 2.6$ by removing the observation for Stockholms Badhus.)

Statistically, it is not surprising to find that the model has little explanatory power for the period 1975-1982, because the voting premiums were so small for all firms, at least for those firms with frequently traded A-shares and reliable estimates of the voting premium (Table 5.10). Economically, the explanatory power of the Shapley value coincides in time with the death of the industrialist Marcus Wallenberg in September 1982. Wallenberg held controlling blocks in firms which corresponded to 40 % of the market value of the whole Stock Exchange (Affärsvärlden 1981:5).

The death of Marcus Wallenberg released a serie of power struggles. Suddenly a large number of new actors ($\sim$ 20) appeared on the market for corporate control. These actors operated with high leverage in a bullish stock market.

The increase in the competition for corporate control was mentioned in the previous chapter. The shareholder structures have become more concentrated (Table 5.18). The voting premium has increased in magnitude (Table 5.11). Shares with differential voting rights are increasingly popular (Table 5.2), and crosswise shareholding has appeared as a new defense weapon (Table 5.15). It will also be seen in Table 6.7 that the frequency of control-related events dramatically increased in 1983-1985.

The coincidence in time between the predictability of the Shapley value and the increase in activity in the control market reveals the role of competition in control. Without competition, the minor shareholders have no power and do not pay for the vote. With competition, the minor shareholders possess power as a collective, and they pay for the vote since they know the value of the vote to a potential raider. The pricing of the vote may therefore have been efficient and rational both before and after 1983.

The coefficient of the SIZE variable is significant for the same period. The magnitude of the coefficient and the significance are strongly affected by one observation with a very large discount for the A-shares ($\sim$ - 25 % ; ASEA in table 5.8). The removal of that observation reduces both the magnitude and the significance level of the coefficient of the SIZE variable, but it is still significant and the coefficients of the other variables are unaffected.

The SIZE variable can be decomposed into the deflated market value (Market Value/Index) and the inverse of the voting inequality measure (α-$\alpha\gamma$+γ). A regression with these two components as independent variables shows that they are both significant, but the market value component explains more of the variation of the voting premium.

Table 6.3 : The Regressions on the Voting Premium

Year	Constant	Φ/Θ	SIZE	FREE	$\bar{R}^2$	Sample
	The Estimated Regression Coefficients (t-values within parentheses)					
1975	3.6	-3.0	2.8	-2.1	-0.01	18
	(2.6)	(-1.4)	(0.9)	(-0.6)		
1976	3.7	-2.7	0.4	-1.1	-0.03	17
	(2.7)	(-1.3)	(0.1)	(-0.4)		
1977	5.8	-4.2	-1.0	-0.6	0.04	20
	(3.0)	(-1.4)	(-0.3)	(-0.2)		
1978	6.1	-5.2	-0.5	-0.9	0.30	20
	(4.3)	(-2.7)	(-0.2)	(-0.4)		
1979	3.6	-2.3	-1.1	0.4	0.23	17
	(4.1)	(-2.1)	(-0.8)	(0.3)		
1980	5.1	-1.7	-6.8	7.1	0.41	19
	(5.2)	(-1.3)	(-2.8)***	(2.7)		
1981	4.2	-0.6	-4.7	1.0	0.42	20
	(5.4)	(-0.7)	(-3.6)***	(0.7)		
1982	5.1	0.4	-3.7	-4.1	0.27	21
	(4.2)	(0.4)	(-1.9)**	(-1.9)**		
1983	3.9	4.4	-9.5	-5.5	0.74	24
	(2.9)	(3.0)***	(-6.1)***	(-2.1)**		
1984	5.4	3.2	-6.2	-9.9	0.35	39
	(3.2)	(2.0)**	(-2.7)***	(-2.3)**		
1985	5.9	8.0	-10.3	-10.5	0.35	41
	(2.8)	(2.8)***	(-3.2)***	(-1.8)**		

* = sign. 10 % (one-tailed test)

** = " 5 %

*** = " 1 %

The coefficient of the FREE variable is significant from 1982. An examination of foreign trade statistics reveals that foreign demand for Swedish shares increased considerably in 1982 (e.g. Aktiv Placering, 1984, p. 364).

The constant term is large in all regressions, while the Shapley value predicts a zero constant. The large positive constant is partially explained by the SIZE variable (the linearity of the regression model necessitates a positive constant, though the voting premium should be zero both in large and small firms controlled by a majority shareholder). The positive constant is also explained by some notable exceptions.

In the 1970's the largest voting premiums were observed in firms with majority control but very thin trading in the A-shares (DN, Jonsered, Munksjö, Marabou). In 1984 and 1985, the voting premium in Bulten-Kanthal reached 13.9 and 17.4 % respectively in spite of majority control. The reason was a power struggle between Bulten-Kanthal and Höganäs, each of which bought shares in the other. The struggle ended in a takeover of Höganäs by Bulten-Kanthal. (This is an example of abuse of the aggregation axiom.) In Stockholms Badhus 1985 the voting premium was estimated at 19.5 % despite majority control. The A-shares were very thinly traded. These exceptions increase the constant and lower the R-square.

In Section 5.5.4 an experimental design was set up in order to examine the sensitivity of the chosen grouping principles and the possible impact of secret agreements between shareholders. The oceanic power ratio was kept constant in firms where a regrouping of the two largest shareholders could not change the power ratio. The oceanic power ratio was also kept constant in firms with a known power struggle between the two largest shareholders. For the remaining 1/3 of the firms a regrouping of the two largest shareholders into one coalition usually reversed the prediction of the voting premium.

The experiment tests whether the regression results of Table 6.3 are still valid for the worst possible case of misidentification of the most likely coalition structure. We can then be sure that the results are not dependent on the choice of coalition structure. The regression model (6.5) is therefore rerun with unaltered scores for the oceanic power ratio for 2/3 of the observations (Table 5.16) and altered scores for the remaining firms (the scores in parentheses in Table 5.17). The estimated coefficients and the t-values are shown in Table 6.4 for the years 1982-1985. The scores of the other variables are unchanged.

Table 6.4 : <u>The Regressions on the Voting Premium Consolidating the Shareholdings of the Two Largest Shareholders According to Tables 5.18 and 5.19</u> *)

The Estimated Regression Coefficients
(t-values within parentheses)

Year	Intercept	Φ/Θ	SIZE	FREE	$\bar{R}^2$	Sample
1982	5.7	-0.5	-3.4	-3.8	0.27	21
	(5.6)	(-0.4)	(-1.8)*	(-1.7)*		
1983	6.6	1.3	-9.0	-5.6	0.63	24
	(5.6)	(0.7)	(-4.8)***	(-1.7)*		
1984	6.1	6.5	-7.6	-12.2	0.40	39
	(4.5)	(2.6)***	(-3.3)***	(-2.8)***		
1985	7.9	6.6	-9.6	-11.8	0.31	41
	(4.4)	(2.2)**	(-2.9)***	(-1.9)**		

* = sign. 10 % (one-tailed test)
** = " 5 %
*** = " 1 %

*) The oceanic power ratio is unchanged for firms in majority control, diffused ownership, or where a power struggle took place between the two largest shareholders. For remaining firms the oceanic power ratio is calculated in a shareholder structure where it is consolidated the holdings of the two largest shareholders. The scores of the other variables are unchanged.

The estimated coefficients in Tables 6.3 and 6.4 are stable. The coefficients and t-values of the oceanic power ratio have decreased slightly in Table 6.4, but the estimated coefficients are still significant, except in 1983. The intercept has increased, which is also to be expected in this experiment, provided that the coalition structures in Table 6.3 are more likely than the coalition structures in Table 6.4.

The experiment supports the supposition that the validity of the Shapley value is not dependent on my grouping of shareholders. I tend to believe that full knowledge of the true coalition structures and agreements between shareholders would improve the predictability of the Shapley value.

6.2 Block Trades

Before 1 July 1984 most large transactions took place outside the Stock Exchange. From that date brokers were obliged to report all their trading to the Stock Exchange, including their large transactions.

Thus for the last eighteen months there is a small sample of block trades which are large enough to identify both the seller and the buyer from the anonymous price data on the Stock Exchange. It is not possible to get a complete sample of the block trades, since some large transactions take place without a broker being involved.

A test of the controlling premium for large blocks can be based on the difference $\frac{\varphi}{W} - \frac{\Phi}{\Theta}$ which is a predictor of the total price of the block minus the total price of an oceanic share. This independent variable can be used, because the model predicts that the value of the vote increases linearly in the power ratios. The difference in power ratios belongs to the interval $(-\infty, 2.00]$, where majority control has a score of 2.00, dispersed ownership 0.00, and the center of the balance-of-power region has negative values. The SIZE variable is not included since the cost of control should reduce the value of the vote inside or outside the block by the same amount. The cost of control may affect the dependent variable in firms with majority control but not otherwise. This non-linearity can be ignored. Thus, equation (6.6) is a natural test of the premium for large blocks of shares.

$$\frac{(\alpha-\alpha\gamma+\gamma)\left[P_A\ (\text{Block}) - P_A\ (\text{Ocean})\right]}{\alpha\ P_A\ (\text{Ocean}) + (1-\alpha)P_B\ (\text{Ocean})} = \gamma_0+\gamma_1\left[\frac{\varphi}{w} - \frac{\Phi}{\theta}\right] + \xi \qquad (6.6)$$

Equation (6.6) is a regression model. The dependent variable is adjusted for voting inequality. The model can be applied to block transactions in firms without voting power differentiation, i.e. voting inequality is equal to unity. For this case, the denominator on the left-hand side equals the price of the oceanic share (100 % A-shares with 1 vote each and 0 % B-shares).

The regression model (6.6) requires that the block trade does not change the shareholder structure. Otherwise the independent variable cannot be computed. Unfortunately this severely reduced the sample size, since block trades often change the shareholder structure.

The control premium was estimated on the final transaction prices of the day of the block trade, i.e. the day before the block trade turned up on the list of the Stock Exchange. If there were no transactions that day, an average of the bid and ask prices was used as an estimate of the oceanic price.

For block trades in firms where the A-shares are not listed, the control premium was estimated against the price of the oceanic B-share. These firms are usually under majority control, so that the price of a hypothetical oceanic A-share will probably be very close to the price of an oceanic B-share.

Sometimes only B-shares were traded in the block. It is possible to use these transactions analogously with equation (6.6). However, the adjustment for voting inequality is $(\alpha-\alpha\gamma+\gamma)/\gamma$, which is a high figure. It means that the residual of such an observation is multiplied by a large number, which introduces a lot of uncertainty into the estimation. Such observations were not therefore included.

Some block trades took place in firms with joint listing. The prices in those firms were treated as the price of shares without voting power differentiation.

Errors in the data could arise, because block trades take place at various points in time. This is not serious if the relation between the power ratio and the percentage premium of the block is fairly constant over time.

Another problem is that block trades are individually negotiated over a period of time. The price of the block may be negotiated at an early stage, so that there will be a mismatch in time when comparing the price of the block with the price of the oceanic share. Individual transactions may also involve important side-payments. This introduces uncertainty.

Table 6.5 contains the sample of block trades which could be included in the test. We can see the date on which the block trade turns up on the list of the Stock Exchange, the estimated premium according to the left-hand side of equation (6.6), and the percentage weight of the block trade. The average percentage weight of the 22 block trades is 32.2 %, ranging from 8 to 77 % of the votes. The average premium is 10.3 %.

Table 6.5 : Sample of Block Transactions

Date *)	Firm	Premium (%) **)	w (%)
83 01 11	Hevea	- 6.0	12
84 06 13	Hevea	17.2	16
84 08 30	Höganäs	11.1	16
84 10 03	Jacobsson et Widmark	11.1	15
84 10 12	Garphyttan	4.2	8
85 02 04	Pharmacia	5.1	27
85 02 13	Götabanken	20.6	12
85 03 07	Electrolux	0.3	19
85 04 17	Skaraborgsbanken	22.0	27
85 04 22	Badhus	2.4	32
85 04 23	Fagerhult	2.3	8
85 05 07	Öresund	7.8	10
85 05 28	Faluhus	13.8	74
85 06 04	Hasselblad	31.2	58
85 10 04	Munksjö	11.3	16
85 11 05	Hevea	5.0	49
85 11 05	Herakles	23.6	51
85 11 11	Barkman	11.9	70
85 11 18	Beijer	5.8	12
85 12 04	Barkman	14.7	70
85 12 05	Kabinettet	7.6	77
85 12 10	Skånegripen	3.1	30

*) The date when the block trade turns up on the list of the Stock Exchange

**) Computed according to equation (6.6)

Table 6.6 contains the estimated coefficients of equation (6.6) and t-values.

Table 6.6 : The Estimated Coefficients of Equation (6.6)

Estimated Coefficients (t-values within parentheses)		$\bar{R}^2$	Sample
Constant	$\frac{\varphi}{w} - \frac{\Phi}{\Theta}$		
6.7	6.0	0.20	22
(3.0)***	(2.5)***		

*** = sign. level 1 %

The results show that the premium increases in the power ratio of the block. The coefficent 6.0 is similar in size to the coefficients of the oceanic power ratio in Table 6.3. The intercept is significantly positive. It means that the blocks in the sample may be overpriced compared with the oceanic shares. The overpricing can be due to the advantage of being an insider, such that blocks of shares have more power than indicated by the model, because voting the oceanic shares is not without cost. The small sample makes it difficult to base any conclusions on these estimates. Within a few years it may be possible to collect a larger sample of block trades on the Stockholm Stock Exchange.

6.3 Four Power Struggles

In this section we will look at four recent power struggles, all of which can be illustrated by time-series of the voting premium. The examples show that the price of the vote increases dramatically during a power struggle.

The four cases all appeared between 1 January 1983 and 31 December 1985. The time axes are therefore standardized to that period for all four cases. The voting premium is based on weekly matching transactions in the two classes of shares. If observations are missing for one week, the voting premium is intrapolated from the immediately neighbouring estimates. The vertical axes are also standardized so that the voting premium of the four cases can be compared. The size measure is the market value on 31 December 1984.

In each figure there is a line representing the voting premium predicted by the model. The predictions are based on an average of the estimated coefficients for 1983, 1984, and 1985 in Table 6.3. The average of the regression coefficients was obtained from a pooled regression of all 104 observations in 1983-1985.

$$\hat{VP} = 5.7 + 4.5\ \Phi/\Theta - 8.2\ \text{SIZE} - 9.2\ \text{FREE} \qquad (6.7)$$

Inserting the firms' specific scores on each variable produced the line of the predicted voting premium. The oceanic power ratio is computed according to the shareholder structures below each figure. The market values on 31 December 1983, 1984, and 1985 respectively are used to obtain the score of the SIZE variable.

The case of Custos is characterized by the entry of a new major shareholder from the ocean in a firm with dispersed shareholdings. One year later, the incumbent controlling shareholders started acquiring votes to counteract the raider. The power struggle ended with the sale of the raider's shares to the incumbent controlling shareholders - a greenmail.

The second case, MoDo, is another greenmail, which ended with the establishment of crosswise shareholding between MoDo and Iggesund.

The third case, Sandvik, is a typical case of raiding, where 38 % of the votes were aggregated within a few weeks to outvote the major incumbent shareholder. The Sandvik case is referred to in Chapter 2.

The final case is Swedish Match, where one of the two major shareholders changed his position in order to get control of the board. Success came at the corporate meeting on April 25 after a few months of intensive share acquisitions.

The four figures have in common that the price of the vote increases during periods of vote acquisition, and in particular toward the end of the power struggle. This fact, and the dramatic decrease in the value of the vote on the day after the end of the power struggle, suggests that to a large extent the price of the oceanic vote reflects the marginal value of a vote for the major shareholders. Naturally this strongly affects the estimated regression coefficients in Table 6.3. Thus the predicted voting premium cannot be interpreted as an estimate of the strategic value of the oceanic vote, in contrast to a strict interpretation of the game model (cf. Section 3.6).

The cases can help to interpret some recent event studies of the entry of a new major shareholder, and of greenmails.

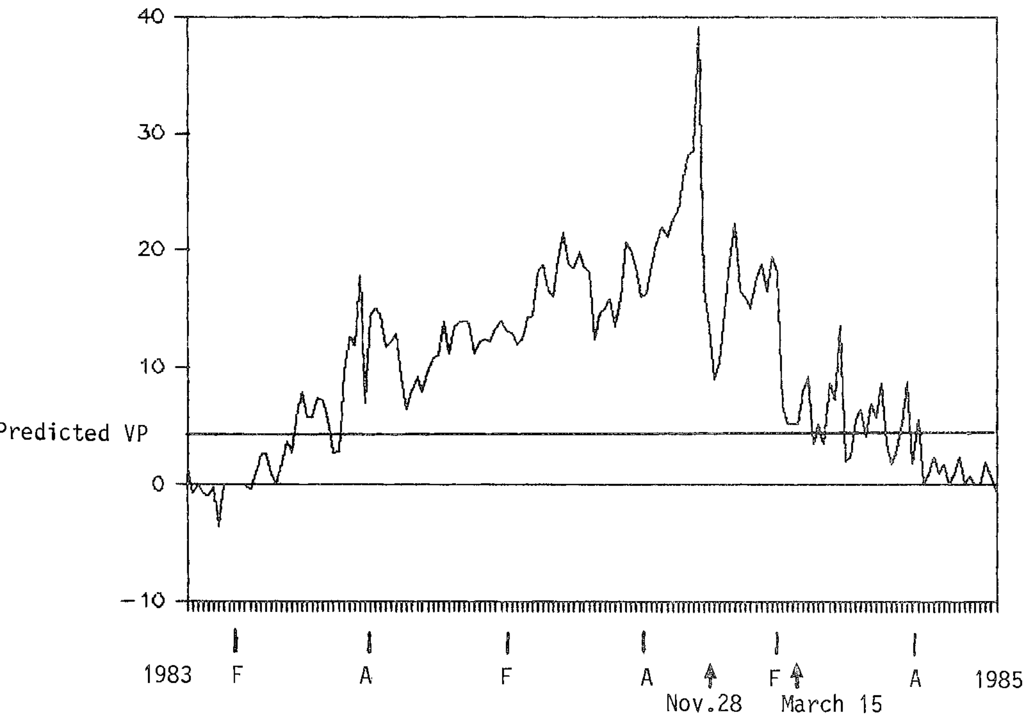
Two American studies of the stock market reaction to the announcement of the entry of a new major shareholder in the firm,found that stock prices go up by roughly 6 % (Mikkelson and Ruback, 1985, and Holderness and Sheehan, 1985). The Custos and MoDo cases suggest that the 6 % may be entirely due to an increase in the value of the vote, since the new major shareholder bids up the price of the vote when aggregating shares from the ocean.

Case 1: Custos

Industry: Closed-end fund with major controlling blocks in Hufvudstaden, SCA, Alfa-Laval, SIAB, Swedish Match, etc.

Size : 3 446 MSEK

Equity : 72 % restricted A-shares 1 vote
3 % free A-shares 1 vote
25 % free B-shares 1/10 vote



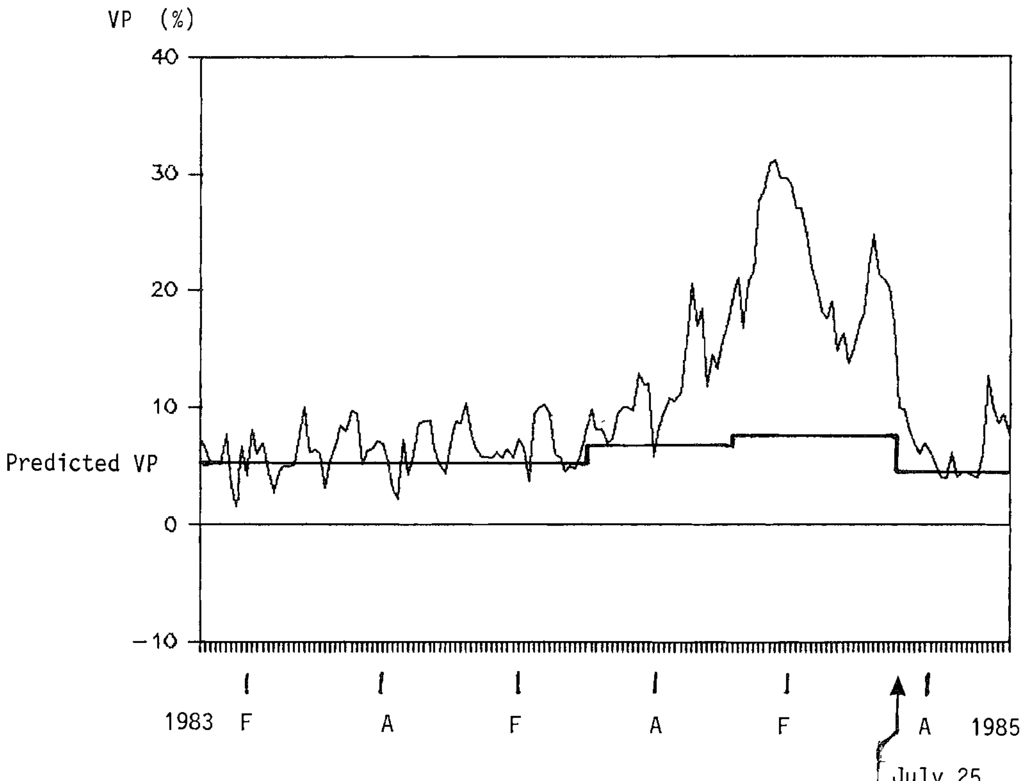
Shareholders (%)

Lundberg	0	11	16	26	0	0
Skanska	5	5	5	9	23	23
Cardo 1/	3	3	5	8	8	8
Volvo	0	0	0	0	12	18
Ratos	6	6	6	6	6	0
SEB	5	5	5	5	5	5
Skandia	5	5	0	0	0	0

1/ Volvo [illegible]

Case 2: MoDo

Industry: Paper
Size : 1 563 MSEK
Equity : 45 % restricted A-shares 5 votes
17 % restricted B-shares 1 vote
38 % free B-shares 1 vote

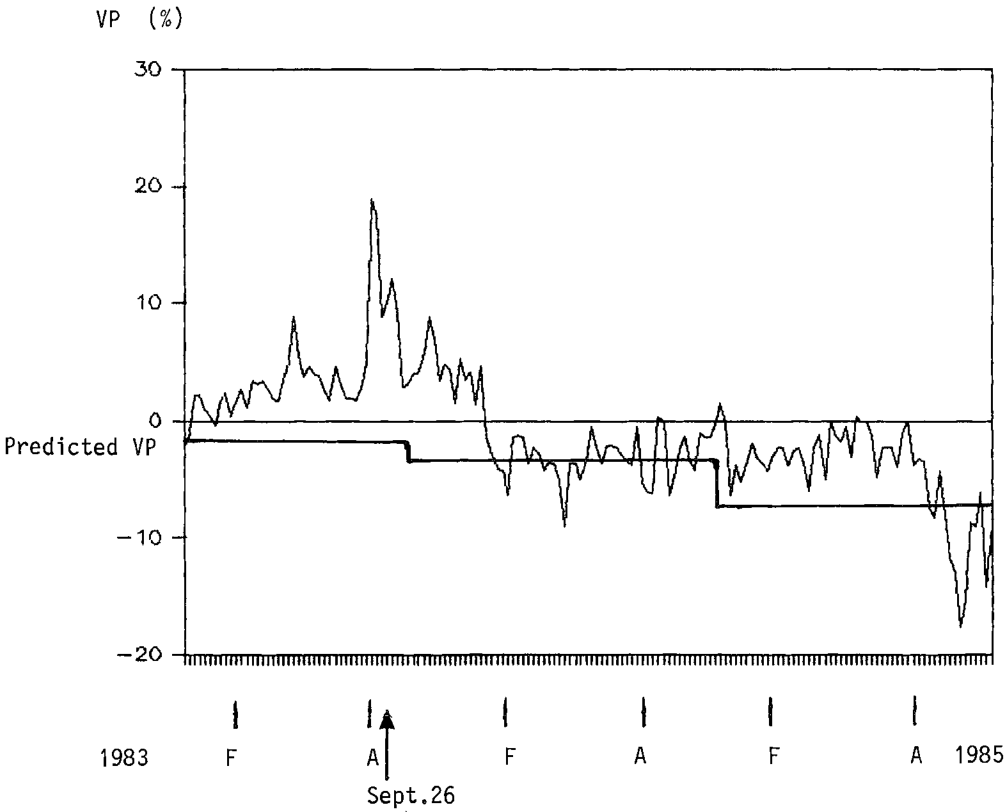


Shareholders (%)

Kempe + Carlgren	47	47	44	38	41	41
Iggesund	0	0	0	0	0	12
Björkegren	0	0	0	0	12	0
4:e AP	6	6	6	6	6	6
SHB	7	7	7	7	8	8
Svensson	0	0	6	6	0	0

Case 3: Sandvik

Industry: Steel
Size : 2 941 MSEK
Equity : 80 % restricted A-shares 1 vote
3 % free A-shares 1 vote
17 % free B-shares 1/10 vote

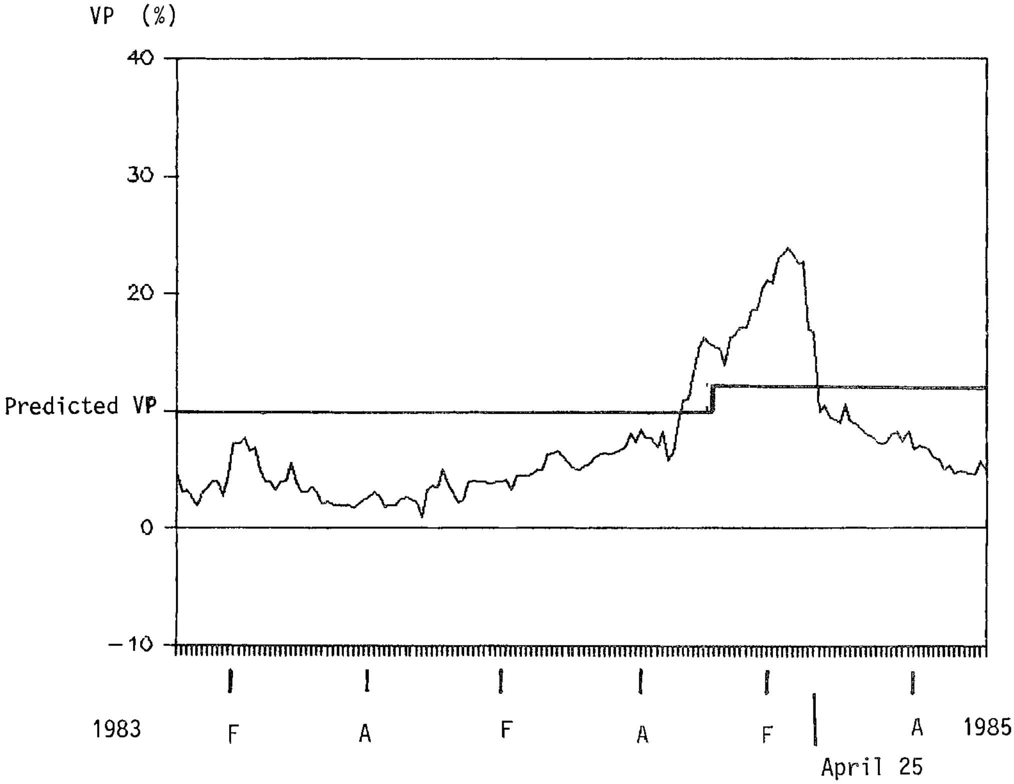


Shareholders (%)						
Kinnevik	13	13	0	0	0	0
Korsnäs [1/]	13	13	6	5	4	4
Skanska	8	22	38 28	30	25	25
SHB	5	5	6	6	6	6
4:e AP	0	0	7	7	7	7
Beijer	4	4	4	5	6	6

[1/] Kinnevik was the single major shareholder in Korsnäs with 34 % of the votes.

Case 4: Swedish Match

Industry:	Conglomerate		
Size :	2 410 MSEK		
Equity :	15 % restricted	A-shares	1 vote
	4 % free	A-shares	1 vote
	81 % free	B-shares	1/1000 vote



Shareholders (%)

Wallenberg	39	40	40	41	46	47
Custos	31	31	31	32	33	33
SEB	5	5	5	5	5	5
Pension fund of Swedish Match	2	2	3	3	3	3

Three studies (Dann and DeAngelo (1983), Bradley and Wakeman (1983), and Mikkelson and Ruback (1985)) report that share prices decrease by roughly 4 % on the day of the announcement of a greenmail. The cases of Custos and MoDo are greenmails, such that the dissidents sell their controlling blocks of shares to the incumbents. The price of the vote decreases on the final day because the power struggle has ended. Thus the decrease in the share price due to greenmails may be due to a drop in the price of the vote, because the greenmail signals an end to the power struggle.

6.4 Test of Instability

This section describes a methodology for predicting the likelihood of a power struggle. It is the final test of the theory of oceanic games to be performed in this dissertation.

The idea is to test the hypothesis that the oceanic power ratio is a measure of the instability of the shareholder structure. The dependent variable is the likelihood of a change in the shareholder structure, which is not observable. However, it it possible to estimate the likelihood of a change with the help of a logit analysis. This requires that a shareholder structure can be classified as changing or constant, whereas the dependent variable assumes a value of 1 for a changing shareholder structure and a value of zero for a constant structure.

6.4.1 Classifying Constant and Changing Shareholder Structures

The hypothesis to be tested is that the oceanic power ratio can predict the firms in which one of the following three events will occur:

- The major shareholders increase the percentage weight of their blocks by acquiring votes from the ocean, e.g. there is a power struggle.
- A new major shareholder is extracted from the ocean.
- One major shareholder acquires a block of shares from one of the other major shareholders.

These are events which increase the concentration of the shareholder structure. The idea is that aggregations of votes into the holdings of major shareholders are likely to be induced by a wish for control, because these transactions are likely to increase the cost of holding the blocks. One kind of event is not included: takeover bids of 100 % of equity are not related to the instability of the shareholder structure.100 % takeover bids are motivated rather by a need for restructuring the firm and moving assets between firms, which by law requires full ownership.

The test requires a precise definition of what is an event and what is not. To start with the first of these, there are two requirements for qualifying as an event: one, the share acquisitions have to exceed a certain limit in size in order to be classified as a power-induced share acquisition, and two, the share acquisitions have to take place within a reasonably short time period to be classified as control-motivated. The short time period is also needed for technical reasons. A long period introduces the risk of a mismatch between the event variable and the lagged independent variables.

I suggest the following requirements as to size for a share acquisition to be classified as control-motivated.

- At least 8 % of the votes are acquired from the ocean for a shareholder structure in which $\Phi/\Theta < 1.00$ when the acquisitions begin.
- At least 5 % of the votes are acquired from the ocean for a shareholder structure in which $\Phi/\Theta \geq 1.00$ when the acquisitions begin.
- A block trade between two major shareholders in the firm accounting for at least 5 % of the votes.

The limit of 8 % for the major part of the shareholder structures is chosen arbitrarily, to represent a major change in the shareholder structure. It is a minimum requirement and actual events may involve higher percentages. The 5 % limit is used for the center of the balance-of-power region, since the incremental power of

1 per cent in such shareholder structure is a lot larger than in the case of dispersed shareholdings.

An alternative principle is to use differential minimum requirements based on the model, such as high requirements for low scores on the oceanic power ratio and low requirements for high scores. There are two drawbacks to this, however. First, measurement errors in the basic VPC data require a relatively high percentage. Errors in the order of magnitude ± 2 % of the votes for a block of shares do not classify events as non-events, or vice versa. Second, if there is no relation between the shareholder structure and the likelihood of an event, a differential requirement will identify by pure chance more events when the oceanic power ratio is high than when it is low. This introduces a bias toward rejecting the null hypothesis, i.e. that there is no relation between the oceanic power ratio and the likelihood of an event.

The second point also applies to the differential requirement of 5 % of the votes for the center of the balance-of-power region and 8 % of the votes for the other firms. This is not serious, however, since the requirements are minimum requirements, and most acquisitions will involve higher percentages.

One objection may be that for some firms the ocean as a whole does not hold as much as 8 % of the votes, on account of extreme voting inequality. In the case of these observations, it is physically impossible for an event to occur. This introduces a positive bias toward rejecting the null hypothesis, but this is not a serious problem either, since such cases are rare.

The second requirement for qualification as an event is that the share acquisitions take place within a relatively short period of time. I suggest the following scheme with respect to the available shareholder data. See Figure 6.2.

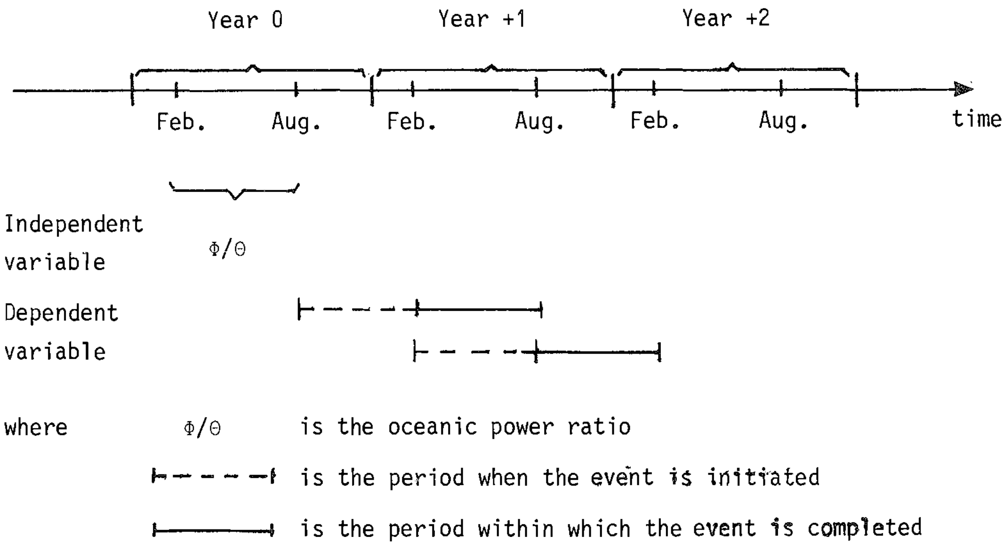


Figure 6.2 : The Time Requirements for Classifying a Shareholder Structure as Either Changing or Constant

The oceanic power ratio is computed for year 0. The share acquisitions have to start before August year +1, and the acquisitions have to be completed between the day when acquisitions were initiated and the second next recording of the shareholder structure by VPC.

Thus a shareholder structure was classified as changing

- if there were share acquisitions which met the size requirements, and
- if the share acquisitions were initiated within 12 months from August year 0 and completed between the day the acquisitions were initiated and the second subsequent recording of shareholder data from VPC.

The opposite problem is to classify a shareholder structure as constant. Some firms experience changes in the shareholder structure which are not control-motivated. This might be the sellout of a large percentage of a block of shares. Another event is a non pro rata stock issue to one shareholder. Such events have to be excluded, so as not to introduce a mismatch between the oceanic power ratio year 0 and the dependent variable year +1.

The following list indicates the events that lead to the exclusion of an observation, if the event occurs during the period between August year 0 and August year +1. An observation is not excluded, if it is classified as a changing shareholder structure before one of the listed events takes place.

- A non pro rata equity issue of at least 8 % to one shareholder, new or old. It is 5 % for the shareholder structure $\Phi/\Theta \geq 1.00$. A case is not excluded if the shareholder structure is one of majority control before and after the equity issue.

- A successful takeover bid for the whole firm. A partial tender offer is classified as a control event, i.e. a changing shareholder structure.

- Sellout of shares from the blocks reversing the criteria for classifying a changing shareholder structure. An exception is a sellout within a majority block, i.e. there is majority control before and after the sellout.

Thus a shareholder structure is classified as constant if it is not changing, and if it is not excluded due to one of the events listed above.

Table 6.7 shows the frequencies of changing and constant shareholder structures in the data. It also shows the number of excluded cases.

Table 6.7 : Frequencies of Constant and Changing Shareholder Structures

Year of Event	Absolute (Relative) Frequencies of Shareholder Structures				Sample	No. of Firms Excluded
	Constant		Changing			
1976	111	(96)	5	(4)	116	3
1977	108	(93)	8	(7)	116	4
1978	118	(97)	4	(3)	122	0
1979	115	(96)	5	(4)	120	2
1980	111	(90)	12	(10)	123	1
1981	99	(90)	11	(10)	110	5
1982	97	(87)	14	(13)	111	4
1983	90	(82)	20	(18)	110	6
1984	99	(80)	25	(20)	124	7
1985	85	(70)	37	(30)	122	8

The sample size is smaller than in Table 5.1 because a firm has to be listed in August year 0 to be recorded as changing or constant in year +1. Otherwise, quite a few observations are excluded due to changes in the shareholder structure which are not classified as control-motivated.

The most interesting information in Table 6.7 is the low frequencies of events in the 1970's and the dramatic increase in 1983. This is highly consistent with the regression results on the voting premium in Table 6.3. It is also consistent with the phenomenon noted in Chapter 5, namely that competition for corporate control has increased during the sample period.

6.4.2 Econometric Problems

The method for testing the instability hypothesis is a logit regression model. There is a drawback to running yearly logit regressions, since at least before 1983 there are so few events. A natural solution would be to perform a pooled logit, which in turn creates other econometric problems.

Pooling is a possible solution in this case, but not in the test of the voting premium. The idea of a logit model is that an event takes place when the independent variables reach a certain level of intensity. Only when the intensity is high enough, can we observe an event. When the intensity of the independent variables is too low, it is not possible to observe anything except "no change", even though the intensity or the likelihood of a change is positive. A time series of zeros and ones is just as informative for the estimation procedure as a cross-section of zeros and ones for the same number of firms with similar characteristics. Pooling is therefore an appropriate method in this case, although there is just as little time-serial variation in the independent variables in this test as in the test of the voting premium.

Several other econometric problems also arise in connection with pooling. The first problem is that the coefficients are not very constant over time, because of the increase in activity on the control market in the recent years. The simple solution is to use dummy variables for various years. However, this underestimates the significance, because a greater likelihood of change in the 1980's does not apply to firms subject to majority control, for which even in the 1980's the likelihood of a power struggle is still very small. Dummy variables are used in spite of this drawback.

A second problem concerns the serial correlation which can be expected because of missing variables for the value of control. Some firms may score high on missing variables, which means they get more "ones" than the scores of the included variables would imply. This is the problem of heterogeneity which has been discussed in Heckman (1981). The problem may not be a very serious one.

Serial correlation also arises as a result of structural state dependence, i.e. a historical record of power struggles implies a high likelihood of further share acquisitions in the future. The data appears to suggest this. Good relations between two shareholders in the past is a good indication that there will be peace. However, a power struggle during the preceding year which did not end in one shareholder leaving the firm, may be a good indication that the struggle will continue.

Heckman (1981) proposes some possible solutions. The idea is to specify the stochastic processes that may generate the time series of zeros and ones. Heckman (1981: 144-145) presents a model known as the renewal model. Consider the following scheme. A conflict about an issue in year 0 leads to share acquisitions in year +1. The conflict may not be solved and there is an event in year +2 as well. After this the conflict may be solved and there are no more events until a new conflict arises some years later. This scheme suggests the use of a variable assuming a value of 1 if there is an event in the preceding period, and a value of zero if there is peace, i.e. a one-year, lagged, dependent, dummy variable. The lag should not be more than one year, since conflicts have to be solved within a reasonable period of time.

Two other econometric problems are possibly heteroscedasticity and the double counting of events. Heteroscedasticity can be expected on the same grounds in the case of the voting premium. The residuals are large for firms with high oceanic power ratio, but low for firms subject to majority control because there may be missing variables. The scores of the missing variables do not apply to firms under majority control, since the likelihood of an event is low regardless of these scores. For firms with dispersed ownership, the missing variables create larger residuals. This has not been taken into account and is of little importance.

The double counting of events occurs if the share acquisitions continue for more than one year. However, the dependent variable is the likelihood that an event is initiated within one year from August year 0. In August year +1 it is not easy to tell, whether the power struggle will continue during year +2. A continued event is thus regarded as a new event, if the change criteria are fulfilled.

6.4.3 The Statistical Model and the Results

The dependent variable is the likelihood that an event is initiated within one year from August year 0. The likelihood is estimated from the observed zeros (constant shareholder structures) and ones (changing shareholder structures) with the help of a pooled, logit, regression model.

The independent variables have to be the same as in the case of the voting premium described in Section 6.1.1. The oceanic power ratio is a measure of the value of the oceanic vote and at the same time a measure of the instability of the shareholder structure. It is the main independent variable. There has to be a variable which represents the cost of control. The SIZE variable is used as defined in equation (6.1). Beside these two variables, a lagged dummy dependent variable is included in accordance with the argument presented in the previous section. Two dummy variables account for the increased activity on the control market in 1983-1984 and 1985 respectively. This leads to the following logit regression model.

$$\log \frac{p}{1-p} = \beta_0+\beta_1 \frac{\Phi}{\Theta} +\beta_2 \text{ SIZE} +\beta_3 \text{ LAG} +\beta_4 \text{D1} +\beta_5 \text{D2} + \varepsilon \qquad (6.8)$$

where p = the likelihood that a change in the shareholder structure is initiated within one year from August, year 0

Φ/Θ = the oceanic power ratio

SIZE = the market value of the firm as defined by equation(6.1)

LAG = a one-year, lagged, dummy, dependent variable

D1 = a dummy variable with ones for 1983 and 1984 and zeros otherwise

D2 = a dummy variable with ones for 1985 and zeros otherwise

In Section 3.5, it is hypothesized that the measure Δ in equation (3.9) can predict the birth of a new major shareholder in the ocean. This is not tested, because the solution of interfirm shareholdings in Section 3.4 cannot be applied to the calculation of Δ. It would exclude many observations. However, the measure Δ is highly correlated with the oceanic power ratio.

Equation (6.8) is thus a pooled logit model. It is run for events during the period 1977-1985. For an observation to be included the firm has to have been listed for at least three years: the first year on which to base the lagged dependent variable, the second year to measure the oceanic power ratio and the SIZE variable, and finally the year of the event. A firm listed during the eleven-year period can be included in the pooled sample nine times at most. Table 6.8 breaks down the events of the whole sample over various shareholder structures.

Table 6.8 : The Pooled Sample Broken Down over Various Shareholder Structures

Shareholder Structures	A Constant	(%)	A Changing	(%)	Subtotal	B	(%)	Total
$\frac{\Phi}{\Theta} = 0$	308	(96)	13	(4)	321	10	(3)	331
$0 < \frac{\Phi}{\Theta} < 1.00$	491	(85)	90	(15)	581	44	(7)	625
$\frac{\Phi}{\Theta} > 1.00$	60	(78)	17	(22)	77	7	(12)	84
Total	859	(88)	120	(12)	979	61	(6)	1 040

A: Absolute frequencies of included observations. The frequencies in relation to the subtotal for each range of shareholder structures are in parentheses.

B: Absolute frequencies of observations which are excluded due to the absence of values for the dependent variable or for the lagged dependent variable. The frequencies in relation to the total are in parentheses.

Some observations have been lost, compared to Table 6.7, due to the inclusion of the lagged dependent variable. The sample of valid observations amounts to 979 observations, of which 88 % are constant shareholder structures (zeros) and 12 % are changing (ones). The breakdown of events over shareholder structures shows that the frequency of events increases in the oceanic power ratio. This supports the theory.

The B-column of excluded observations shows that there is some sample selection bias. The frequency of excluded observations in the center of the balance-of-power region is much higher than the exclusion of observations in firms with majority control. The number of excluded observations is relatively low and should not distort the validity of the test.

Events were distinguished from non-events by a minimum requirement of 8 % of the votes. This figure was chosen arbitrarily. If the limit was reduced from 8 to 7 % of the votes, and from 5 to 4 % in the balance-of-power region, the number of events increased by six and in the balance-of-power region by none. If the limit was raised from 8 to 10 % and from 5 to 6 % of the votes respectively, only four and two events were excluded in the respective regions.

Thus, only a few of the events lay close to the limit. The results are not therefore dependent on arbitrariness in choosing the 8 and 5 % limits.

The results of the regression equation (6.8) are presented in Table 6.9. Asymptotic t-values are shown in parentheses.

Table 6.9 : The Estimated Logit Regression Coefficients

The Estimated Logit Coefficients (Asymptotic t-Values)

Constant	Φ/Θ	SIZE	LAG	D1	D2
- 3.5	1.7	-1.1	1.1	1.1	1.6
(-13.9)	(6.4)	(-3.0)	(4.0)	(4.5)	(5.7)

Sample	979
No. of Events	120
Durbin-Watson	1.99
R-Square between Observerd and Predicted	0.15

The results in Table 6.9 confirm that there is a relation between the oceanic power ratio and the likelihood of an event, as indicated by the frequencies in Table 6.8. Much of the significance comes from the difference between firms under majority control vis-ã-vis firms lacking any majority shareholder. However, the t-values are high, even if the great number of firms with majority control are excluded.

As a whole the model performs quite well. The R-square between observed and predicted scores for the dependent variable is 0.15. There is no serial correlation at all due to the lagged dependent variable, which is significant. The dummy variables pick up the increased activity on the control market in the recent years. The size variable assumes the expected coefficient. All coefficients are large enough to have a significant impact on the dependent variable. Most important, the results and the estimated coefficients are consistent with the regressions on the voting premium.

6.5 Conclusions

Three tests have been carried out. It has been shown that the oceanic power ratio can predict the voting premium for the years 1983, 1984, and 1985, but not before. This coincides with the increase in competition for corporate control. A test of 22 block trades supports the supposition that the model can predict the control premium of large blocks. Finally, it is shown that power struggles and other control-related events are more likely in firms with a high score for the oceanic power ratio.

References

Alchian A. and Demsetz H. (1972), "Production, Information Costs and Economic Organization", American Economic Review, Vol. 62 no. 5, pp. 777-795

Allingham M.G. (1975), "Economic Power and Values of Games", Zeitschrift für Nationalökonomie, Vol. 35, pp. 293-299

Amihud Y. and Barnea A. (1974), "Portfolio Selection for Managerial Control", Omega, Vol. 2 no. 6 1974, pp. 775-783

Arrow K. (1951), "Social Choice and Individual Values", Edinburgh

Ashton D. and Atkins D. (1984), "A Partial Theory of Takeover Bids", Journal of Finance, Vol. 39 no. 1 March 1984, pp. 167-183

Aubin J. (1981), "Cooperative Fuzzy Games", Mathematics of Operations Research, Vol. 6, pp. 1-13

Aumann R.J. and Drèze J. (1974), "Cooperative Games with Coalition Structures", International Journal of Game Theory, Vol. 3 no. 4, pp. 217-237

Bachrach P. and Baratz M. (1962), "Two Faces of Power", American Political Science Review, Vol. 56, pp 947-952

Banzhaf J.F. (1965), "Weighted Voting Doesn't Work: A Mathematical Analysis", Rutgers Law Review, Vol. 19, pp. 317-343

Baron D. (1979), "Investment Policy, Optimality, and the Mean-Variance Model", Journal of Finance, Vol. 34 no. 1, pp. 207-232

Baron D. (1983), "Tender Offers and Management Resistence", Journal of Finance, Vol. 38 no. 2, pp. 331-347

Berle A. and Means G. (1932), "The Modern Corporation and Private Property", Macmillan, New York

Bhagat S. and Brickley J. (1984), "Cumulative Voting: The Value of Minority Shareholder Voting Rights", Journal of Law and Economics, Vol. 27 October 1984, pp. 339-365

Bradley M. and Wakeman M. (1983), "The Wealth Effects of Targeted Share Repurchases", Journal of Financial Economics, Vol. 11, pp.301-327

Brams S. (1975), "Game Theory and Politics", Free Press 1975

Coleman J.S. (1973), "Loss of Power", American Sociological Review, Vol. 38, pp. 1-17

Cubbin J. and Leech D. (1983), "The Effect of Shareholding Dispersion on the Degree of Control in British Companies: Theory and Measurement", The Economic Journal, Vol, 93 June 1983, pp. 351-369

Daems H. (1978),"The Holding Company and Corporate Control", Leiden Boston

Dahl R. (1957), "The Concept of Power", Behavioural Science, Vol. 2, pp. 201-215

Dann L. and DeAngelo H. (1983), "Standstill Agreements, Privately Negotiated Stock Repurchases, and the Market for Corporate Control", Journal of Financial Economics, Vol. 11, pp. 275-299

DeAngelo H. (1982), "Competition and Unanimity", American Economic Review, Vol. 71 no. 1

DeAngelo H. and DeAngelo L. (1985), "Managerial Ownership of Voting Rights: A Study of Public Corporations with Dual Classes of Common Stock", Journal of Financial Economics, Vol. 14, pp. 33-69

Demsetz H. and Lehn K. (1985), "The Structure of Corporate Ownership: Causes and Consequences", Journal of Political Economy, Vol. 93 no. 6, pp. 1.155-1.177

Diamond P. (1967), "The Role of a Stock Market in a General Equilibrium Model with Technological Uncertainty", American Economic Review, Vol. 57

Dodd P. and Warner J. (1983), "On Corporate Governance: A Study of Proxy Contests", Journal of Financial Economics, Vol. 11, pp. 401-438

Drèze J. (1974), "Investment Under Private Ownership: Optimality, Equilibrium and Stability" in Drèze J., Allocation Under Uncertainty: Equilibrium and Optimality, London, pp. 129-166

Dubey P. (1975), "Some Results on Values of Finite and Infinite Games", PhD. Thesis Cornell University, Ithaca, New York

Dubey P. and Shapley L. (1979), "Mathematical Properties of the Banzhaf Power Index", Mathematics of Operations Research, Vol. 4 no. 2 May 1979, pp. 99-131

Dubey P., Neyman A. and Weber R.J.(1981), "Value Theory without Efficiency", Mathematics of Operations Research, Vol. 6 no. 1, pp. 122-128

Easterbrook F. and Fischel D. (1982), "Corporate Control Transactions", The Yale Law Journal, Vol. 91 1982, pp. 698-737

Easterbrook F. and Fischel D. (1983), "Voting in Corporate Law", Journal of Law and Economics, June 1983, Vol. 26, pp. 395-427

Ekern S. and Wilson R. (1974), "On the Theory of the Firm in an Economy with Incomplete Markets", Bell Journal of Economics, Vol. 5 Spring, pp. 171-180

Fama E. (1980), "Agency Problems and the Theory of the Firm", Journal of Political Economy, Vol. 88 1980, pp. 288-307

Fama E. and Jensen M. (1983), "Separation of Ownership and Control", Journal of Law and Economics, Vol. 26 June 1983, pp. 301-325

Fama E. and Jensen M. (1983), "Agency Problems and Residual Claims", Journal of Law and Economics, Vol. 26 June 1983, pp. 327-349

French J. and Raven B. (1960), "The Bases of Social Power", in Group Dynamics: Research and Theory, ed.D. Cartwright and A.F. Zander, New York, pp. 607-623

Forsgren O. and B. (1972), "Vem äger vad i svenskt näringsliv?", Second edition, Stockholm

Forsgren O. (1977), "Vem äger vad i svenskt näringsliv?", Third edition, Stockholm

Gambarelli G. (1980), "The Control Quota Component in the Price of Shares", Journées Internationales de l'AFFI, Strassbourg University L. Pasteur

Gambarelli G. (1982), "Portfolio Selection and Firms Control", Finance, Vol. 3, pp. 69-83

Gambarelli G. (1983), "Common Behaviour of Power Indices", International Journal of Game Theory, Vol. 12 no. 4, pp. 237-244

Gambarelli G. and Szegö G. (1982), "Discontinuous Solutions in n-Person Games", in New Quantitative Techniques for Economic Analysis, Szegö (ed)

Gevers L. (1974), "Competitive Equilibrium of the Stock Exchange and Pareto Efficiency", in Drèze, Allocation Under Uncertainty: Equilibrium and Optimality, London, pp. 167-191

Grossman S. (1977), "A Characterization of the Optimality of Equilibrium in Incomplete Markets", Journal of Economic Theory, Vol. 15, pp. 1-15

Grossman S. and Hart O. (1979), " A Theory of Competitive Equilibrium in Stock Market Economics", Econometrica, Vol. 47 no. 2, pp. 293-329

Grossman S. and Hart O. (1980), "Takeover Bids, the Free-Rider Problem and the Theory of the Corporation", Bell Journal of Economics, Vol. 11 (1) Spring, pp. 42-64

Grossman S. and Hart O. (1981), "The Allocational Role of Takeover Bids in Situations of Asymmetric Information", Journal of Finance, Vol. 36 no. 2 May 1981, pp. 253-270

Grossman S. and Stiglitz J. (1980), "Stockholder Unanimity in Making Production and Financial Decisions", Quaterly Journal of Economics, May, pp. 543-566

Hakansson N. (1966), "Optimal Investment and Consumption Strategies for a Class of Utility Functions", Dissertation University of California, Los Angeles

Hart O. (1975), "On the Optimality of Equilibrium when the Market Structure is Incomplete", Journal of Economic Theory, Vol. 11, pp. 418-443

Hart O. (1977), "Takeover Bids and Stock Market Equilibrium", Journal of Economic Theory, Vol. 16, pp. 53-83

Hart O. (1979), "On Shareholder Unanimity in Large Stock Market Economies", Econometrica, Vol. 47 September, pp. 1057-1083

Heckman J. (1981), "Statistical Models for Discrete Panel Data" in Manski C. and McFadden D., "Structural Analysis of Discrete Data with Econometric Application", London

Herman E. (1981), "Corporate Control, Corporate Power", Cambridge University Press 1981

Hirschleifer J. (1970), "Investment, Interest and Capital", Prentice-Hall, Englewood, Chapter 3

Holderness C. and Sheehan D. (1985), "Raiders or Saviours? The Evidence on Six Controversial Investors", Journal of Financial Economics, Vol. 14, pp. 555-559

Jensen M. and Meckling W. (1976), "Theory of the Firm: Managerial Behaviour, Agency Costs and Ownership Structure", Journal of Financial Economics, Vol. 3,pp. 305-360

Jensen M. and Ruback R. (1983), "The Market for Corporate Control: The Scientific Evidence", Journal of Financial Economics, Vol. 11, pp. 5-50

Johnston A. (1980), "The City Takeover Code", Oxford University Press

Lease R., McConnel J. and Mikkelson W. (1983), "The Market Value of Control in Publicly-Traded Corporations", Journal of Financial Economics, Vol. 11 1983, pp. 439-471

Lease R., McConnel J. and Mikkelson W. (1984), "The Market Value of Differential Voting Rights in Closely Held Corporations", Journal of Business 1984, Vol. 57 no. 4, pp. 443-467

Leland H. (1974), "Production Theory and the Stock Market", Bell Journal of Economics, Vol. 5 Spring, pp. 125-144

Levy H. (1982), "Economic Evaluation of Voting Power of Common Stock", Journal of Finance, Vol. 38 no. 1 March 1982, pp. 79-93

Luce D. and Raiffa H. (1957), "Games and Decisions", New York 1957

Lukes S. (1974), "Power: A Radical View", London, The Macmillan Press

Makowski L. (1983), "Competition and Unanimity Revisited", American Economic Review, pp. 329-339

Manne H. (1962), "The Higher Criticism of the Modern Corporation", Columbia Law Review, Vol. 62, pp. 399-432

Manne H. (1964), "Some Theoretical Aspects of Share Voting", Columbia Law Review, Vol. 64, pp 1426-1445

Manne H. (1965), "Mergers and the Market for Corporate Control", Journal of Political Economy, Vol. 73, pp. 110-120

Meeker L. and Joy M. (1980), "Price Premiums for Controlling Shares of Closely Held Bank Stock", Journal of Business, Vol. 53 no. 3, pp. 297-314

Mikkelson W. and Ruback R. (1985), "An Empirical Analysis of the Interfirm Equity Investment Process", Journal of Financial Economics, Vol. 14, pp. 523-553

Milnor J. and Shapley L. (1961), "Values of Large Games II: Oceanic Games", Mathematics of Operations Research, Vol. 3 no. 4 1978, pp. 290-307

Mossin J. (1966), "Merger Agreements: Some Game-Theoretic Considerations", Journal of Business, pp. 460-471

Mossin J. (1977), "The Economic Efficiency of Financial Markets" Lexington, Massachusetts, Chapter 16, pp. 143-156

Myerson R. (1977), "Graphs and Cooperation in Games", Mathematics of Operations Research, Vol. 2 no. 3 August 1977, pp. 225-229

Olson M. (1965), "The Logic of Collective Action", Cambridge Mass.

Owen G. (1976), "Values of Games with A Priori Unions", Mineo Rice University, Houston

Partch M. (1985), "Limited Voting Securities and Shareholder Wealth", Working paper, University of Oregon

Rae D. (1969), "Decision Rules and Individual Values in Constitutional Choice", American Political Science Review, Vol. 63, pp. 40-56

Riker W. (1959), "A Test of the Adequacy of the Power Index", Behavioural Science, Vol. 4 pp. 120-131

Rodhe K. (1950), "Vem bestämmer i de stora aktiebolagen?", Ekonomisk Revy 1950, pp. 287-300

Rodhe K. (1978), Aktiebolagsrätt 9:e upplagan, Stockholm 1971

Roos C.M. (1969), "Avtal och rösträtt", Stockholm 1969

Roth A. (1977), "The Shapley Value as a von Neumann-Morgenstern Utility", Econometrica, Vol. 45 no. 3, pp. 657-664

Rubinstein M. (1974), "An Aggregation Theorem for Securities Markets", Journal of Financial Economics, Vol. 1,pp. 225-244

Shapiro N. and Shapley L. (1961), "Values of Large Games I: A Limit Theorem", Mathematics of Operations Research, Vol. 3 no. 1, 1978, pp.1-9

Shapley L. (1953), "A Value for n-Person Games ", Annals of Mathematical Studies, Vol. 28, pp.307-317

Shapley L. and Shubik M. (1954), "A Method for Evaluating the Distribution of Power in a Committee System", American Political Science Review, Vol. 48, pp. 787-792

Shenoy P. (1979), "On Coalition Formation: A Game-Theoretical Approach", International Journal of Game Theory, Vol. 8 no. 3, pp. 133-164

Shubik M. (1982), "Game Theory in the Social Sciences", MIT Press, Cambridge

Skog R. (1981), "Röstvärdesdifferenser i Svenska Börsbolag", Särtryck ur SOU 1981:78

Stiglitz J. (1972), "Some Aspects of the Pure Theory of Corporate Finance: Bankruptcies and Takeovers", Bell Journal of Economics, Vol. 3, pp. 458-482

Stiglitz J. (1982), "The Inefficiency of the Stock Market Equilibrium", Review of Economic Studies, Vol. 49, pp. 241-261

Straffin P. (1977), "Homogeneity, Independence and Power Indices", Public Choice, Vol. 7, pp. 107-118

Sundqvist S-I. (1985), "Ägarna och makten", Halmstad

Wallander J. (1986), "Mellan Skylla och Charybdis - röstvärden, korsägande och makten över företaget", Handelsbankens småskriftserie, nr 25

Weber R.J. (1979), "Subjectivity in the Valuation of Games", in Game Theory and Related Topics, eds. O. Moeschlin and D. Pallaschke, North-Holland

Affärsvärlden 1981:5, 1984:7, 1985:45

A-listan 1975-1985, Stockholms Fondbörs

AMB-listan, Affärsvärlden

Fondhandlarlistan

Företagsanalyser 1984, Aktiv Placering AB

SIND 1980:5, "Ägandet i det privata näringslivet"

SOU 1968:7, "Koncentrationsutredningen"

Svenska Dagbladet (Inofficiella listan)

Volume 11 of the _Journal of Financial Economics_

Öhmans börsguide 1976-1986

Reports published by EFI since 1983

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---

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---

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