Doctoral Thesis

Ownership and Firm Behavior

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Barcelona, May 19, 2007 Carsten Sprenger

Foreword

The allocation of ownership and control rights among shareholders affects to an important degree firm governance and behavior. There has been an increasing interest in issues of corporate governance in economics over the past two decades, triggered in part by the large-scale privatization in the former centrally planned economies. Privatization was expected to impose hard budget constraints, provide better management and access to external finance, and enhance restructuring with the ultimate goal of improving the overall performance of firms. However, post-privatization restructuring was often slow. In most countries of the former Soviet Union, company insiders managed to control a majority of firms also after privatization, and prevented any restructuring measures that would put their jobs at risk. External investors were reluctant to provide finance since their rights as minority shareholders or creditors were only poorly protected. Hence, ownership and corporate governance arrangements turned out to be important factors determining real economic outcomes.

In this thesis we investigate aspects of the ownership structure of firms, in particular its determinants and evolution, as well as its impact on firm behavior. Chapter 1 provides an empirical analysis of the large-scale privatization in Russia in the 1990s. Chapter 2 presents a theoretical model of investment and share trade in a firm where shareholders have different interests. The model can be applied to post-privatization firms in transition countries such as Russia, both because the model assumptions correspond with the environment of those firms, and since the conclusions in terms of the evolution of ownership are in line with the empirical observations in chapter 1.

Chapter 1 studies in depth the privatization process in Russia and the resulting ownership structure of firms. We distinguish three types of owners — the state, company insiders (i.e. managers and workers) and outsiders (domestic individuals and legal entities as well as foreign owners). There is evidence from a large number of studies[1] that outside ownership entails the largest restructuring gains in post-privatization firms. In the light of this result, we are interested in the factors that are conducive to outsider, insider, or continued state ownership,

[1] See the survey of Djankov and Murrell (2002).

and to more or less ownership concentration. For our study we use a comprehensive data set of 530 Russian manufacturing firms for the years 1990-1999. We estimate determinants of the decision to privatize a firm, of the choice among different options of privatization, the resulting initial ownership distribution, and its further evolution. In estimating the determinants of ownership stakes, we control for sample selection due to the decision whether to include a firms in the privatization program or not.

The chapter provides empirical tests for predictions of the model of ownership choice in insider privatization by Aghion and Blanchard (1998) and hypotheses from related empirical research. For example, workers are found to hold higher stakes if the fraction of union members is higher. We take union membership as an indication of the ability of workers to collude, in particular in the decision on selling shares to outsiders. In our sample, we observe that insiders mostly choose a privatization option that leads to majority insider ownership. Interestingly, they do it more frequently if the firm is in financial distress, as measured by the amount of wage arrears. This can be explained by the desire of insiders to insure against unemployment. The likelihood of being laid-off in a restructuring initiated by outside investors would presumably be higher in worse-performing firms. Social benefits provided by the firms tend to increase the ownership stakes of the state and firm insiders. Using our empirical results we draw conclusions on how entrenchment of company insiders could be limited by a proper design of a privatization program.

Chapter 1 also contributes to the corporate finance literature on the relation between ownership and firm performance. Most of the studies deal with the effect of ownership structure, in particular the degree of managerial ownership and the concentration of ownership, on performance. Only a few focus on the reverse causation — the impact of firm quality (performance measures) and other firm characteristics on the structure of ownership.[2] All of them suffer from the problem that ownership structure and performance measures are simultaneously determined, which leads to biased results in simple regression analysis.[3] For the purpose of identifying determinants of ownership, privatization gives a unique opportunity to overcome the simultaneity problem since firm characteristics prior to privatization can be treated as exogenous. We find significant effects of new explanatory variables for managerial ownership and ownership concentration. For example, a higher degree of unionization tends to lower managerial ownership, and higher capital intensity increases outside ownership and ownership concentration. The latter result seems sensible since outside investors are most likely to provide the necessary funds to

[2]See for example Demsetz and Villalonga (2001), which also contains a survey of previous studies on the ownership - performance relationship.

[3]See Himmelberg et al. (1999) for examples how third variables affecting both performance and managerial ownership can generate a spurious correlation.

restructure capital-intensive firms.

In the aftermath of large-scale privatization in Central and Eastern Europe there was a large number of corporate conflicts. In Russia and other countries of the former Soviet Union there was almost no limitation to the expropriation of minority shareholders by dominant owners since legal rules of corporate governance were lacking or were not properly enforced. Managers had become powerful owners, and often used the ownership stakes of workers as a shield against potential takeovers. But also proxy fights in Western firms are evidence of conflict and disagreement among shareholders.

In chapter 2 of this thesis we study the effects of conflicting interests of shareholders on investment decisions and share trade in a simple model. To address this question, neither corporate finance theory, which focuses on the agency conflict between managers and shareholders, nor traditional general equilibrium theory provide a suitable framework. In the latter, the objective of a firm is uniquely defined as value maximization, and leaves therefore no room for different interests of the owners. However, dropping one assumption of traditional general equilibrium theory, namely the completeness of markets, makes the objective of the firm again dependent on individual characteristics of its owners, such as their wealth and preferences.[4] The assumption of incomplete markets means for instance that a firm cannot insure against demand fluctuations by selling its products at future markets, or cannot buy insurance contracts against supply fluctuations caused by a strike or low effort of managers. As a consequence, there are no unique prices for future output in any contingency, such that owners have to make their own judgement and discount the forecasted profits using their personal marginal rates of substitution. It is evident that shareholders will rank possible investment plans in different ways.

We choose a model where owners prefer different investment plans even in the absence of uncertainty. The basic model is a one-period model with one firm, two owners and incomplete financial markets. The latter assumption means in our setting that borrowing and lending are impossible. The investment decision is made by the majority owner. In addition, shareholders are allowed to trade shares among each other. Shareholders can be different in their wealth, initial stake in the firm, or their preferences with respect to the intertemporal allocation of consumption. We study the effects shareholder heterogeneity on the amount of investment, the firm value and after-trade ownership stakes. For instance, a higher relative wealth of the controlling owner (and anything else equal) increases the amount of investment, while a higher initial stake decreases investment.

Two extensions of the basic model allow for an analysis of corporate governance arrangements

[4]Some of the main contributions in the literature on the objective of the firm under incomplete markets are Drèze (1974, 1985), Grossman and Hart (1979), and DeMarzo (1993).

on investment decisions and ownership structure. First, we consider an outside option (or participation constraint). This protects the minority shareholder from particularly unfavorable investment decisions of the majority owner. When the constraint becomes binding, it does not only change the investment level, but also decreases the concentration of ownership. This is consistent with cross-country studies that found that minority shareholder protection and ownership concentration are substitutes (La Porta et al., 1998).

Second, we incorporate the notion that the controlling owner can extract resources from the firm to the expense of the non-controlling owner, i.e. we assume the presence of private benefits of control. When we further amend the model by a second time period, the identity of the majority owner in the second period is endogenously determined in the model. That complicates the model solution because the investment decision in the second time period depends on the identity of the majority owner. We study several cases for the allocation of control over investment and private benefits among the initial dominant owner and the new majority owner. If control goes to the new majority owner, we observe a kind of anti-takeover measure by the initial controlling owner close to the point where the transfer of control occurs — she "manipulates" the level of investment in order to keep control over the firm. The model also generates interesting dynamics of ownership. Typically, the initial controlling owner uses her private benefits to accumulate shares over time.

The assumptions of our model correspond with the environment of firms in the transition countries of Eastern Europe after privatization: they had almost no access to external finance, shares were typically not traded on public stock markets with outsiders, and managers were able to extract large private benefits of control. In the nearly representative data set of Russian firms used in chapter 1, we observe a declining ownership stake of workers during the five years following privatization, while managers are able to increase their stake slightly (not counted their affiliated legal entities). Workers often received large ownership stakes during privatization, and the econometric analysis shows that the reduction of their stake was more pronounced in those firms where they held a high stake initially. This is consistent with the prediction of the model if we assume that workers are among the less wealthy shareholders, which is certainly not unrealistic. The increase in the stake of managers is consistent with the finding from the two-period model with private benefits.

In a nutshell, we argue in this thesis that it matters for the decision-making in business firms *who* owns it, which corporate governance arrangements are in place, and that the structure of ownership itself is the result of economic forces. We hope that out work contributes to the understanding of these important issues.

Chapter 1

The Determinants of Ownership After Privatization – the Case of Russia

1.1 Introduction

Most studies on the outcomes of privatization in transition countries focus on the impact that ownership structure has on firm performance and indices of restructuring. Brown et al. (2006) find that the effect of privatization on productivity is large and positive in Hungary and Romania, but small or even negative in Ukraine and Russia. However, privatization to foreign investors had large positive effects in all four countries under investigation. Furthermore, Djankov and Murrell (2002), conducting a meta-analysis of a large number of studies on the subject, came to the conclusion that privatization to outsiders is associated with largest restructuring gains, while privatization to workers has no effect in Central and Eastern Europe and is detrimental in the CIS. In this type of studies, performance is the variable to be explained by a variety of factors, among them ownership.

Equally important, yet less investigated are the following questions: What determines the choice of inclusion of firms in the privatization program, what determines the privatization option that a firm chooses, and last but not least, what determines the distribution of ownership and its change over time? In this study, we address these questions. In particular, we aim to explain the ownership structure using as explanatory variables pre-privatization characteristics of the firm. Privatization is a unique opportunity for overcoming the problem of simultaneity in the relation between performance and ownership structure. Usually the causation between both variables runs in both directions, but in our situation where all industrial assets were state-owned before, pre-privatization performance (the quality of the firm) determines exogenously the post-privatization ownership structure.

We concentrate on the case of Russia, both because of the importance of Russia as a country and because lessons for other countries can be learned from the failure of the Russian privatization policy to promote restructuring of old state enterprises — the main goal of economic reforms in transition countries. To give an example why our research question is an interesting one, one might ask why the Russian mass privatization program gave such huge benefits to firm insiders to purchase shares instead of using vouchers for all citizens more broadly. The answer is two-fold. First, insider privatization aimed to legalize the previous spontaneous privatization where, for example, directors of state-owned firms had established related private companies to siphon-off profits or simply had started the physical transfer of assets to these newly founded companies. Second, insider ownership was seen as an insurance against unemployment. While the first hypothesis is difficult to test directly, we find (indirect) evidence for the second hypothesis: employees choose the privatization option which facilitated outsider ownership less often when a firm is in financial distress, thereby trying to avoid job losses associated with restructuring.

We investigate two dimensions of the ownership structure: the types of owners and the concentration of ownership. As for the types of owners, we distinguish between all private (non-state) owners, insiders (disaggregated into workers and managers) and outsiders. We find a high degree of insider ownership at the end of the mass privatization program in 1994. Between 1994 and 1999, the structure of ownership was quite stable, contrary to the hope of the designers of the privatization program that secondary markets would lead to a fast ownership transfer to presumably more efficient outside owners. The initial distribution of corporate ownership after privatization was mainly influenced by privatization policy, and by the absence of effective legal rules regulating the relations between minority, majority shareholders and managers. However, we still observe a considerable variability of ownership patterns in Russian firms given this common environment.

We estimate determinants of

- the decision whether to privatize a firm or not
- the choice among different privatization options that predetermined the ownership structure to some extent,
- the initial ownership distribution after the end of the mass privatization program and
- the ownership change between 1994 and 1999.

In the privatization decision, state interests (price controls, the firm being part of the military-industrial complex) are particularly important. The privatization option designed to

lead to more outside ownership was chosen less frequently in firms in financial distress. Our interpretation is that the decision of insiders to acquire shares was driven by their motivation to insure against unemployment. As for the ownership stakes, the ability to collude among workers (as measured by the degree of unionization) matters for the decision to sell shares to outsiders and affects positively the share of insiders, in particular of workers. We also find that outside blockholders and other outside owners own higher stakes in capital-intensive firms since these owners are most likely to provide the necessary funds for restructuring such firms. Presumably for the same reason, insiders hold fewer shares in large firms and decrease their share more rapidly over time. In contrast, outsiders increase their share more rapidly in larger firms. There is only weak evidence of insider cherry picking, i.e. leaving worse-performing firms to outsiders.

This paper contributes to the literature in several ways:

1. The object of our study is the reverse causality going from firm characteristics including pre-privatization performance to the evolution of ownership. As mentioned before, this important issue was often neglected in the existing literature on the impact of privatization. It is also an opportunity to overcome the problem of simultaneity between ownership and performance in previous studies on Western firms.

2. A part of the hypotheses for our empirical research is derived from a theoretical model on ownership change under conditions of insider ownership by Aghion and Blanchard (1998). To our knowledge, our paper is the first direct test of the predictions of this model.

3. The quality and size of the data set are unique. We use a comprehensive data set of 530 Russian manufacturing firms that is representative for the whole industrial sector of the Russian economy. All information on ownership is available at two points in time: mid 1994, right after the end of the mass privatization program, and at the beginning of 1999. The survey contains rich panel data on all the main characteristics of the firm.

4. Our estimation methodology for the determinants of ownership stakes uses a two-limit tobit model with selection due to the privatization decision. That is a non-standard model and has not been applied in this context before. The model is able to account both for the particularity of the ownership variables and the sequencing of the privatization process.

In the following section we summarize the theoretical literature on the choice of the ownership structure of a firm and the empirical literature closely associated with our question. This literature motivates a part of our hypotheses for the empirical research. Section 1.3 gives an overview over the institutional features of the Russian privatization program. Section 1.4 describes the

sample properties and provides descriptive statistics for the post-privatization ownership structure of the sample firms. This section also describes the econometric methodology. In section 1.5 we derive the hypotheses that we want to test, and the empirical results are given in section 1.6. Section 1.7 concludes.

1.2 Related Literature

1.2.1 Theoretical literature

We draw part of our hypotheses from the theoretical literature on the choice of ownership structure, in particular ownership concentration and insider ownership. This choice is driven by the agency problem between managers and shareholders. We argue that the situation of managers with already considerable autonomy before privatization is actually comparable to a going public. Managers can either privatize to outsiders, which allows them to diversify and to get new capital, or keep hold of control. Furthermore, Jones (1998) provides evidence that managers exercise the votes of worker-shareholders, in particular in decisions on strategic matters such as the introduction of new technologies or sales and production plans. Workers are passive (as long as managers implicitly guarantee job security) even though their ownership stake is much higher than direct stakes of managers (36 vs. 11 per cent on average in our sample).

The model of Bebchuk (1999) shows that concentrated managerial ownership may persist due to private benefits of control even if dispersed ownership would be more efficient. Several models try to rationalize the existence of outside equity: In Gomes (2000), managers can build up a reputation not to extract high levels of private benefits, and therefore outside investors may be confident not to be expropriated. Myers (2000) assumes insiders to be cash-constrained and the value of assets to be unverifiable in an uncertain environment. Then these assets cannot be financed with debt, but with equity only. In general, concentrated outside ownership may overcome the problem of collective action between shareholders in monitoring the management.

However, there are costs to concentrated ownership. In Burkart et al. (1997) there is a trade-off between monitoring by the large outside shareholder and managerial incentives since successful monitoring reduces the managers' private benefits and therefore their effort. Zwiebel (1995) points out the possibility of coalitions of shareholders that hold less than a majority block. Individual investors (including manager-owners) may be wealth-constrained, and for reasons of diversification they want to hold assets in not only one company. Also, in the presence of illiquid capital markets, it could be difficult to sell large stakes (Becht et al., 2002).

DeMarzo and Urošević (2006) develop a dynamic model of ownership to analyze the trade-

off between the need for diversification on the side of the large shareholder and efficiency gains when the large shareholder manages or monitors the firm. They can explain the observation of Mikkelson et al. (1997) who show that the ownership share of the top management in U.S. companies engaging in an IPO is large before the IPO, decreases significantly right after the IPO and keeps decreasing considerably over the next ten years. Edelstein et al. (2005) extend this model by incorporating private benefits of control, and Urošević (2002) analyzes the strategic interaction between several large shareholders.

The theoretical work, which is most closely related to our empirical analysis, is a model by Aghion and Blanchard (1998). It states conditions for resale of shares under the conditions of insider ownership. Hence, its focus is on the change of ownership patterns after a privatization of the Russian type. The main assumption is that outsider ownership facilitates restructuring and raises output per worker. However, restructuring leads to layoffs for some proportion of the workforce.

The model predicts that under reasonable assumptions insider ownership will be persistent. Insider ownership is essentially an insurance for workers and managers against becoming unemployed. Higher reservation wages (unemployment benefits, presence of other potential employers) make a transfer of control more likely. If workers are able to collude in the decision to sell their shares, they will ask for a higher price since they internalize the probability of becoming unemployed. That makes the control transfer less likely. However, there is certain mobility of workers across firms, especially into the new sectors such as services (see Brown and Earle, 2003). In order to reconcile persistent insider ownership and worker flows we need to consider also the illiquidity of the equity markets and the ability of managers to obstruct share sales to outsiders (Filatotchev at al., 1999). In our data, managers increase their ownership stake between 1994 and 1999, presumably buying up shares from workers.

1.2.2 Empirical literature

There is a large literature on the impact of ownership variables on performance for Western firms.[1] One recent example is Demsetz and Villalonga (2001). They take possible endogeneity of the ownership structure, in particular the ownership concentration, into account. Using a sample of U.S. firms, their main finding is that there is no systematic relation between ownership structure and firm performance. The authors interpret this as the outcome of market forces in the market for corporate control, which drive ownership concentration and managerial ownership towards their optimal level where shareholder expected returns are maximal. This, however,

[1] For an extensive survey see www.encycogov.com, and for a survey of recent studies see Demsetz and Villalonga (2001).

need not to be true in a transition economy like Russia where ownership structures are much influenced by the political process of privatization.

In the context of transition economies, most studies concerned with the ownership structure of privatized enterprises were focusing on its impact on performance and different indices of restructuring.[2] In the case of Russia, Earle and Estrin (1997) and Earle (1998) found managerial ownership, ownership of investment funds and concentrated outsider shareholdings to have a positive impact on performance. Kuznetsov and Muravyev (2001) use a sample of Russian blue chip companies and find no consistent effects of the categories of owners on performance. Interestingly, ownership concentration increases technical efficiency but this is not reflected in higher profitability and market valuation of those companies, suggesting that large shareholders extract private benefits of control. All these authors are aware of the problem of simultaneous causation between ownership and performance — for example, better-performing firms may be privatized to certain types of owners, or they may have been privatized earlier (Gupta et al., 2001). Usually instrumental variables techniques are applied, but it seems to be difficult to find good instruments for ownership.[3]

In this paper, we concentrate on the reverse causation and do a more careful analysis of what determines ownership structures after privatization. A good starting point for the empirical analysis is the seminal study of Demsetz and Lehn (1985). They investigate empirically systematic variations in the concentration of ownership of U.S. corporations and consider firm size (the need for diversification), potential gains from, systematic regulation and the amenity value of output to owners.

Earle and Estrin (1997) extend significantly this set of explanatory variables taking into account the specific environment after privatization in Russia. They do not only look at ownership concentration, but also at the type of owners suggesting that different types of owners have different objectives and budget constraints that make a particular firm more or less attractive to them. In our empirical analysis, we draw upon their hypotheses for possible determinants of the ownership structure, and in addition we extend them, use more recent data and more appropriate estimation techniques.

Bishop et al. (2002) investigate determinants of the post-privatization ownership structure in Hungary, but the applied estimation methods[4] are not efficient since they do not take into

[2]Carlin et al. (2001), Angelucci et al. (2002), Frydam et al. (1999) and Grosfeld and Tressel (2002), to name a few. For a comprehensive survey see Djankov and Murrell (2002).

[3]As Himmelberg et al. (1999) argue, unobserved firm heterogeneity may affect both performance and the instruments.

[4]Logit and multinomial logit regressions on dummies for five ownership levels for domestic and foreign outsider owners: 0, between 0 and 50, between 50 and 90, between 90 and 100 and 100 per cent.

account the full information contained in the reported ownership shares.

The paper that is most closely related to our study is by Jones and Mygind (1999). It provides econometric evidence for the determinants of ownership after privatization in Estonia. The authors observe a high degree of inertia in ownership distributions. They also find that big and capital intensive firms are more likely to be owned by outsiders and that that economic performance is not a decisive factor for ownership.

1.3 The Privatization Process in Russia

The process of privatization is with no doubt the main determinant of the current distribution of ownership in Russia. During the *perestroika* era, especially between 1989 and 1991, control of the branch ministries over the enterprises ceased and gave rise to intents of spontaneous privatization. In 1989, employees were given the opportunity to lease the assets of state enterprises with the right of later buyout. In our sample, 16 per cent of firms were finally privatized by a lease-buyout, which usually resulted in 100 per cent insider (employee) ownership. This early method of privatization was stopped when the mass privatization program started.

In the mass privatization program from end of 1992 until mid1994, virtually all small enterprises and approximately 15.000 out of 24.000 of medium and large enterprises were transferred into private ownership.[5] The program, however, was conducted in a politically highly unstable period with changing governments, a tremendous fall in real output and high inflation. After the price and foreign trade liberalization in January, 1992, neither macroeconomic stability nor financial discipline at the enterprise level was achieved. The design of the privatization program for the medium and large firms, which form the major part of the industrial sector, was mainly influenced by a strong preference for high speed of privatization by the reform government and by the interests of enterprise insiders and the industrial lobby.

We can divide the privatization process into three stages: the decision to privatize, the choice of a privatization option and tenders, auctions and first secondary sales shaping the initial distribution of ownership after the end of the mass privatization program.

Stage 1: The privatization law either mandated or prohibited the privatization of a particular firm, or it left the decision to the privatization agency and the employees. For example, for certain sectors such as a part of the military-industrial complex, natural resources and public utilities, privatization was either postponed or needed a special government approval.[6] The

[5] For details on the privatization legislation see Frydman et al. (1993), Blasi et al. (1997) and Hare and Muravyev (2003).

[6] See Sprenger (2002) for a short summary of privatization in these sectors.

privatization plan developed by every firm to be privatized established the envisaged proportions of shares to be offered to various potential investors. After approval of the plan by the State Property Committee (GKI) or its regional offices the firms were corporatized, i.e. transformed into open joint-stock companies, at this stage still state-owned. The charter capital of enterprises was calculated as the book value of assets others than land and net of outstanding debt. That means that the prices which had to be paid by employees for shares, were very low in real terms due to high inflation.

Stage 2: The employees then had to vote with a two-thirds majority on one of the three following options for privatizations that the privatization law offered to enterprise insiders[7]:

- Option 1: 25 percent of the shares were transferred for free to workers and managers as non-voting shares. Further 10 percent were sold to employees as voting shares at a 30 per cent discount of nominal price. Senior managers could purchase an additional 5 per cent of shares.
- Option 2: Workers and managers received up to 51 per cent of the shares at a price 1.7 times the nominal value.
- Option 3 offered the sale of 20 per cent of shares at nominal price to a managing group proposing a one-year restructuring plan upon completion of the plan. A further 20 per cent could be purchased by all employees at a 30 per cent discount from the nominal price.

Stage 3: The voucher component of the privatization program envisaged that for no less than 29 per cent of shares voucher auctions had to be held. Vouchers were distributed to all citizens at a low fee and were tradable from the beginning, also for cash. But since reliable information about investment opportunities was scarce, vouchers brought very little value to the big majority of citizens. A large part of vouchers was used by employees to increase their holdings in their own firms. A smaller part was given into voucher investment funds in exchange for their shares. In our sample, investments funds obtained shares in 7.5 per cent of the enterprises, but their average share was very small at 1.3 per cent[8]. The remaining state shares in the firms, typically between 10 and 20 per cent, were sold at cash auctions or investment tenders. Later privatization steps included the loans-for-shares scheme in 1995[9] and case-by-case privatization, regulated by a new privatization law since 1997.

The ownership structures in Russian firms resulting from privatization are reported in the

[7]When no vote was achieved, option 1 was the default.

[8]The numbers for 1999 are 12.5 and 2.5 per cent.

[9]The loans-for-shares scheme was probably the most criticized part of privatization in Russia; it gave rise for some of the largest bank-led financial-industrial groups in Russia.

next section. We use our data set as one of the best available sources since there are no official statistics about ownership for the whole industrial sector.[10]

1.4 Data and Estimation Strategy

1.4.1 Sample Description

The sample contains 530 manufacturing Russian manufacturing firms. The firms to be surveyed were selected on the basis of the reported employers of employee-respondents in the Russian Longitudinal Monitoring Survey, a nationwide household survey stratified across 32 regions of the Russian Federation and by the number of employees. This sampling strategy provided a probability sample of the Russian industrial sector, which matches the official statistics reasonably well.[11]

The survey was conducted between the spring of 1999 and the fall of 2000. Both a representative of the top management and the chief accountant were interviewed. Much of the quantitative information collected by the survey, such as employment data, output, profits, capital, wages, sales, costs and investment relies on standardized accounting principles of the State Statistical Committee of Russia (Goskomstat). It is completed with information on the history of the firm, e.g. the founders, major reorganisations, changes in the top management, privatization, ownership structure, labor relations, distribution of sales and payments.

Since our interest is in the privatization process, we exclude firms that were founded from scratch after 1986, the beginning of *perestroika* in Russia. We report summary statistics for the remaining sample noting that genuinely new firms are a very small part of industrial enterprises in Russia. In our sample, we are left with 497 out of 530 firms. We keep, however, firms in the sample that were not privatized because we are interested in the determinants that drive the privatization decision, too.

The enterprise data set we use is unique in its sample size, representativeness, the number of firm characteristics included and the time period encompassed. It contains data for privatized, non-privatized and newly founded firms. The quality of survey data essentially depends on the weakest link in a chain of design of the questionnaire, sampling, fieldwork, data entry, checking and cleaning. The questionnaire underwent several stages of pilot testing, interviewers from the regions were trained and monitored by the participating researchers, data was double-entered. The author could observe the process of data collection and participated in checking for

[10]The Goskomstat Industrial Registry merely classifies firms into private, state-owned, and firms with mixed ownership.

[11]For details of the sampling and sample representativeness see Biletsky et al. (2002).

inconsistencies in the data, preparing the re-interviewing of selected firms and in data cleaning. It should be stressed that the ownership and privatization information was given high priority in the survey.

1.4.2 Summary Statistics for Ownership Variables

The variables of main interest in this paper are the date and form of privatization and the resulting distribution of ownership. To establish the ownership structure of Russian companies we consider the following groups of owners: the state, insiders and outsiders of the firm. The state share is disaggregated into federal, regional and municipal state share. Shares of insiders are distributed between managers and workers. Outsiders are disaggregated into domestic legal entities, domestic outside individuals and foreign owners. When we investigate the determinants of the ownership stakes of different groups of owners, we concentrate on private ownership, insider ownership disaggregated into managerial and worker ownership and on outsider ownership. Concentration is measured by the share of blockholders, which are defined as single outside owners with a stake of at least five per cent. We alternatively consider the ownership stake held by all blockholders, all privately controlled blockholders (here we exclude blockholders which are controlled by the state), the largest blockholder and the largest privately controlled blockholder. The distribution of ownership is observed at two points of time, July 1, 1994 and January 1, 1999. Table 1 of the appendix lists the privatization and ownership variables used in the estimations that follow.

Table 2 calculates the fraction of firms that were privatized using various privatization options. We define a firm to be privatized when a majority stake has passed to private hands. Out of all firms in the sample, 82.3 per cent were privatized at the date of the interview (1999/2000). The most frequent privatization option was option 2 which guaranteed majority insider ownership (61 per cent of the firms). The median date of privatization was July 1993 for the firms participating in the mass privatization program. The median date when lease-buyouts were accomplished was July 1992.

Table 3 displays the evolution of ownership across types of owners from 1994 to 1999. Right after the end of the mass privatization program in July 1994, the state still owned about one third of industrial assets in Russia. Nearly one half was owned by managers and workers. During the next four and a half years, the state share decreased by 9 percents. At the same time the insider ownership decreased by 5.4 percents. The decrease in insider ownership is entirely due to the decreasing shares owned by workers. In contrast, managers increased their stake by 2.4 percents on average. Outside ownership has also increased, especially holdings of outside domestic legal entities. We calculate the mean ownership stake of outsiders given that a firm has such owners,

and obtain 52 per cent in 1999 as compared to 37.3 per cent in 1994. The stake of foreigners increased from 1.4 to 3.2 per cent, i.e. stayed at a low level.

Table 4 looks at outside blockholders. The fraction of firms with blockholders has risen considerably from 26.6 to 52.5 percent. A blockholder can be a legal entity of private law, but still be controlled by the state. We calculate both the mean share of all blockholders and the mean share of privately controlled blockholders. Both have increased significantly. Table 5 shows the shares of the largest blockholders. All this evidence suggests that ownership concentration has increased between 1994 and 1999.

Figure 1 provides additional information on the distribution of ownership by privatization option. As compared to option 2, lease-buyouts result in higher ownership stakes of managers and workers and smaller stakes of outsiders and blockholders. Option 1, however, is not very different from option 2 in terms of the resulting ownership structure. State ownership is somewhat lower under option 1, insider ownership is somewhat higher, but there are only small differences in the outsider and blockholder shares.

Figure 2 displays histograms of insider and outsider shareholdings and their change between 1994 and 1999. We see that insider ownership is peaked at 0, 100 and around 50 per cent. Zero per cent insider ownership corresponds either to non-privatized firms or to full outsider ownership. Full insider ownership was often the result of lease-buyouts or option 2 privatizations with subsequent share purchases by insiders. The particular distribution of the ownership variables is important for the estimation methodology (see section 1.4.3). The change variables are peaked at zero suggesting a high persistence in ownership structures.

The definitions of explanatory variables used in the estimations are listed in Table 6. Table 7 provides summary statistics for the explanatory variables. We motivate the inclusion of these variables in section 1.5. All the explanatory variables are pre-privatization characteristics of the firm for the years 1990, 91 or 92, according to data availability.[12]

1.4.3 Data Treatment and Estimation Methods

The empirical model has the general form

$$Y_i^* = \beta_0 + \sum_{j=1}^{J} \beta_j X_{ij} + u_i = X_i'\beta + u_i$$

where Y_i^* is a latent variable in limited-dependent variable models of various types. The actual observed dependent variable is either binary, i.e. equal to one if the firm was privatized and

[12]For some exceptions due to data availability see the note below Table 6. One of the exceptions is the fraction of capital costs in total costs, which is only available for 1994 and 1998. However, the numbers for the fraction of capital costs do not differ much between the two years.

zero if not, an index of the chosen privatization option, or the ownership share of a particular group of owners in firm $i = 1, 2, ..., N$. The vector $X_i = \{X_{ij}\}$, $j = 1, 2, ..., J$ describes firm characteristics prior to privatization.

As for the estimation technique, we use a logit model for determining whether a firm is going to be privatized or not. A multinomial logit model with four alternatives is used for determining the choice of the privatization option. For the determinants of the ownership shares, we use a less common estimation method which shall be described in what follows. The special distributional characteristics of the variables of ownership shares rule out the use of ordinary least squares regressions. In each ownership category, we can have any value between 0 and 100 per cent ownership. But, realizations at the two limit points are particularly frequent. This pattern is best accounted for by a two-limit tobit model with censoring in the ownership stake. The underlying latent variable can be interpreted as the desired ownership stake by the particular group of owners. The latent variable could take values lower than zero and higher than 100 per cent, for instance agents could wish to short-sell enterprise shares.

In addition, observations with zero ownership stake are often due to the fact that these firms were not privatized by the date under consideration, July 1, 1994. If we would analyze only privatized firms, our sample would not be random any more and the results would be biased. A model structure that integrates both stages, the privatization decision and the extent of ownership by a particular type of owner within its natural limits, is a tobit model with selection.[13] This kind of model is not treated in econometric textbooks. However, a similar model with continuous variables at both stages, called a nested tobit model, was proposed by Lee (1992) and applied by Howe et al. (1994) for the analysis of contingent valuation surveys for public goods.

For our purpose, the model structure is the following:

$$D_i = \begin{cases} 1 & \text{if} \quad Z_i'\delta + \varepsilon_i > 0 \\ 0 & \text{if} \quad Z_i'\delta + \varepsilon_i \leq 0 \end{cases}$$

where D_i is a dummy equal to one if the firm was privatized by July 1, 1994 and equal to zero if not. The vector$Z_i = \{Z_{ik}\}$, $k = 1, 2, ..., K$ lists the variables which explain the privatization decision. The ownership share Y_i is defined in terms of the latent variable Y_i^*:

$$Y_i^* = X_i'\beta + u_i$$

The error terms u_i and ε_i are assumed to have zero mean and to be jointly normally distributed with covariance matrix $\begin{pmatrix} \sigma_u^2 & \rho\sigma_u \\ \rho\sigma_u & 1 \end{pmatrix}$. The dependent variable (the ownership stake) is charac-

[13]The tobit model was applied in the context of ownership regressions by Jones and Mygind (1999), but without correcting for sample selection by the privatization decision.

terized by the following equation:

$$Y_i = \begin{cases} 100 & \text{if} \quad Y_i^* \geq 100 \quad \text{and} \quad D_i = 1 \\ Y_i^* & \text{if} \quad 0 < Y_i^* < 100 \quad \text{and} \quad D_i = 1 \\ 0 & \text{if} \quad (Y_i^* \leq 0 \quad \text{and} \quad D_i = 1) \quad \text{or} \quad D_i = 0 \end{cases}$$

That is, the observed ownership stake is 100 if the latent variable (the desired ownership stake) is greater than or equal to 100 and the firm was privatized. It is equal to the latent variable if the latter is between 0 and 100 and the firm was privatized. Finally, the observed ownership stake is zero if the latent variable is either smaller than or equal to zero and the firm was privatized, or if the firm was not privatized. Let us define the following indicator functions:

$$I_i = \begin{cases} 1 & \text{if} \quad Y_i^* > 0 \\ 0 & \text{if} \quad Y_i^* \leq 0 \end{cases}$$

$$J_i = \begin{cases} 0 & \text{if} \quad Y_i^* < 100 \\ 0 & \text{if} \quad Y_i^* \geq 100 \end{cases}$$

The log-likelihood function is defined by:

$$\ln L = \sum_{i=1}^{N} \left\{ (1 - D_i) \ln \left(1 - \Phi_1 \left(Z_i{}'\delta\right)\right) + D_i \left[(1 - I_i) \ln \Phi_2 \left(Z_i{}'\delta \; , \; -\frac{X_i'\beta}{\sigma_u} \; ; \; \rho \right) \right.\right.$$
$$\left.\left. + \; I_i J_i \ln \left(\frac{1}{\sigma_u} \phi \left(\frac{Y_i - X_i'\beta}{\sigma_u} \right) \Phi_1 \left(\frac{Z_i{}'\delta + \rho \frac{Y_i - X_i'\beta}{\sigma_u}}{\sqrt{1 - \rho^2}} \right) \right) + (1 - J_i) \ln \Phi_2 \left(Z_i{}'\delta \; , \; \frac{X_i'\beta - 100}{\sigma_u} \; ; \; \rho \right) \right] \right\}$$

where $\phi(.)$ is the density funcion of the normal distribution, $\Phi_1(.)$ is the cumulative distribution function (cdf) of the univariate standard normal, and $\Phi_2(.,.;\rho)$ is the cdf of the bivariate standard normal with correlation coefficient ρ.

For estimating this model we use a Stata d2-evaluator, for which the log-likelihood function and algebraic expressions for its first and second partial derivatives are specified. Even with these inputs, the likelihood function does not converge easily to a maximum when ρ (the correlation coefficient between u_i and ε_i) is a free parameter. Therefore, we first maximize the likelihood for fixed ρ. We repeat this for a discrete grid of ρ's in the interval (-1,1), choose the estimation with the highest log likelihood[14], and use these coefficients as initial values for the unrestricted likelihood.

For all estimations, we look first at regressions that include the full set of explanatory variables. Then we reduce the number of variables included in order to deal with possible problems of multicollinearity, especially within groups of variables that capture a common concept such as quality, attractiveness to the state etc. (see section 1.5). It also allows us to use observations

[14]It turns out that the rho maximizing the likelihood functions is always at the upper bound of the interval.

for which the excluded variables are missing. Namely, by reducing the number of explanatory variables, we increase the number of observations for the regression. For a parsimonious formulation of the logit and multinomial logit models we only keep explanatory variables that are significant at the 10 per cent level except for the size, region and industry controls which are always included.

Getting a parsimonious specification for the tobit model with selection is more cumbersome since the model includes two equations and two scalars which have to be estimated. For the selection equation we use the controls and those variables that are significant either in the full model (i.e. with all variables in both equations) or in a probit regression on the binary variable for privatization by 1994.[15] For the equation of the ownership stake we proceed as before, keeping only variables that are significant at the 10 per cent level plus the controls.

Finally, for the determinants of the change in ownership stakes we apply simple OLS regressions.

1.5 Hypotheses for the Determinants of Ownership

In this section, we derive the hypotheses for the empirical analysis of determinants of ownership. For most of our estimations, we use only the information on ownership in 1994, right after the end of the mass privatization program in Russia. The goal is to find patterns how firm characteristics prior to privatization affect the initial distribution of ownership. After that we use the same variables updated for 1994 to estimate how the change of ownership stakes by groups of owners between 1994 and 1999 is influenced by these initial conditions.

The empirical model includes four groups of regressors:

1. Measures of firm quality (in order to determine whether initially better performing firms went to certain types of owners)
2. Variables that measure how attractive a particular firm is to the state vs. private owners
3. Variables that measure how attractive a particular firm is to outsiders vs. insiders of the firm (managers and workers) and
4. Controls for size, region and industry.

In the choice of variables we mainly follow and extend the framework of Earle and Estrin

[15] The significant variables in the probit estimation are the same as in the logit estimation presented in Table 9 (reduced set, columns 4 and 5).

(1997). For a summary of expected effects according to the following hypotheses see Table 8 in the appendix.

1.5.1 Firm quality

At first glance, all groups of owners should be equally interested in better performing firms. But some groups of owners, especially managers, may be able to pick better firms due to their superior information. In contrast, workers and the state may have a special interest in job security. By holding shares in worse performing firms where layoffs are more likely they could prevent such decisions in the future. Firm quality is measured as pre-privatization performance.

To measure quality we use first the logarithm of accounting pre-tax profits per worker in 1992. Since accounting profits are not very reliable data, we use also the logarithm of productivity and more indirect measures for quality, such as the share of exports in total sales in 1990, the fraction of new equipment (less than four years old) in 1990, and wages in 1992.[16] In contrast, wage arrears in 1992 should be negatively related to firm quality. Wage arrears, i.e. non-payment or late payment of wages were a widespread phenomenon in Russia since 1992, decreasing only after the financial crisis in 1998. The main reasons were the overall decline of the economy with the associated liquidity problems, and the poor monitoring of managerial behavior (see Earle and Sabirianova, 2002). Workers often accepted wage arrears since they had only little outside opportunities and benefited from non-wage compensation (e.g. social benefits, payments in kind). We measure wage arrears as multiples of the wage fund of a firm for the year 1992.

By the two arguments above, we expect a positive sign for profits, export share, new equipment and wages, and a negative sign for wage arrears in the regressions for managerial and private ownership (since it is the complement to state ownership). Opposite signs are to be expected in the regression for worker ownership.

1.5.2 Attractiveness to the state

In the privatization process, the state was represented by governments, State Property Committees and Property Funds at the federal and regional levels. We hypothesize that the state has a special interest in the control of enterprises with relation to the military and therefore wants to retain shares in these firms. We include a dummy variable for a firm being part of the military-industrial complex or, alternatively, the fraction of sales to military customers in total sales which both are expected to reduce the share of private owners.

[16] We assume that better performing firms export more, have newer equipment and pay higher wages.

Demsetz and Lehn (1985) introduced systematic regulation as a determinant of ownership concentration. This type of state interference should, in general, reduce benefits of control. We include price controls and the fraction of sales to the state budget in total sales as proxies for regulation and the special interests of the state, with expected negative sign for blockholder and other outsider shareholdings.

All variables capturing the interests of the state should be even more significant in the logit regression on the privatization decision because the state at its different levels had major decision rights here.

1.5.3 Attractiveness to outsiders vs. insiders

Following Demsetz and Lehn (1985), we argue that the need for diversification on the side of investors leads to smaller shares and hence less concentrated ownership in large firms. However, size can be also thought as a proxy for the complexity of the firm, which implies higher potential gains from control. Hence, a large firm would be more attractive to outsiders. Size is measured by the logarithm of the number of employees. The diversification effect of size would reduce blockholder shares, while the complexity effect would increase blockholder and other outsider shares.

We hypothesize that insiders are more cash-constrained than outsiders. The cost of the firm's shares should then matter especially for workers, possibly also for managers. The price of shares privatized to insiders was calculated on the basis of the book value of assets others than land net of outstanding debt in January 1992. The book value of capital to labor ratio should therefore be a good proxy for the cost of a share. Alternative measures for capital intensity and thus costliness are the fraction of new equipment and the share of capital costs in total costs. In addition, capital intensity, together with size can be a proxy for the financing needs of a firm. In Russia, debt finance was virtually not available to firms, in part due to the lack of collateral (land could not be transferred) and in part due to the deficiencies of the banking system. This leaves retained earnings and outside equity as alternative sources of finance. The extent of outside ownership could thus be predicted by the financing needs of a firm. In sum, we expect a negative sign for capital-labor ratio, new equipment and capital costs in the regressions for worker ownership, and to a lesser degree, for managerial ownership. Positive signs are to be expected for outside ownership, and outside blockholders in particular.

The complement to costs of obtaining shares is the ability of insiders to acquire shares, which is measured by the average wage. We expect a positive sign in the regression for worker ownership. Wage arrears, however, could reduce workers' ability to pay for shares. We know

from anecdotal evidence that often retained earnings were used for insider purchases of shares. Thus, profits should also serve as a proxy for the ability to pay with positive expected sign for manager and worker shares.

Sustaining employee ownership may be more difficult when the interests of insiders are not closely aligned. This argument relates to the result of Aghion and Blanchard (1998) that a resale to outsiders is less likely, and therefore insider ownership is higher on average, when workers collude. We have two proxies for the ability to collude – unionization (which may stand also for the power of workers in general) and the heterogeneity of the workforce measured by the ratio of wages of white-collar (non-production) employees to production workers. A higher wage ratio should decrease the share of insiders, while unionization is expected to have a positive effect for insiders, in particular for workers. The opposite should hold for blockholders and other outsiders.

Another result of the Aghion and Blanchard model is that higher reservation wages would make workers more inclined to sell their shares. We include the average wage in the same region and industry, as well as a measure for the concentration of local labor demand. The latter influences the outside opportunities of managers and workers to find a job in another local firm. If labor demand is very concentrated — in the extreme case, the current employer is the only one in the municipality — insiders should be more concerned with keeping their jobs and acquire a higher stake.

Most Russian firms offered social benefits, such as housing, medical services, kindergartens, catering etc., to their employees. The social assets of the enterprise should give an extra incentive for workers to buy out the enterprise in order to preserve these benefits. We measure costs of social services provided by the firm as a share of total costs or, alternatively, the number of different types of benefits. All of them are expected to have a positive impact on worker ownership and a negative on outsider ownership.

All variables capturing the interests of insiders may have an impact on the privatization decision, too. As Aghion and Blanchard (1998) argue, when the possibilities for collusion between employees are limited, they may oppose privatization altogether. At least in firms where privatization is non-mandatory, insiders could influence the decision to privatize their firm to some degree.

Our hypotheses for the choice of a privatization option are closely related to the ones for ownership shares outlined above. As described in section 1.3, the first privatization option was intended to facilitate the access of outside owners to firms, whereas option 2 and lease-buyouts would clearly lead to majority insider ownership. Since workers and managers are aware of

the possible consequences of their decision, all variables that favor outsider or constrain insider ownership should therefore make option 1 more likely, and vice versa for option 2 and lease-buyout. Given the low real prices for shares in all options we do not expect cash constraints to play a role here. If variables like capital intensity turn out to be significant then they should reflect anticipated financing needs of the firm, which would make option 1 more attractive.

1.6 Empirical Results

We estimate first the determinants of the privatization decision and the choice of a privatization option, and turn then to the estimations of levels of ownership shares in 1994 and their change between 1994 and 1999.

1.6.1 Explaining privatization and the choice of privatization option

We estimate a logit model for the binary decision on whether a firm was privatized or not for two dates: July 1, 1994, the end of the mass privatization program, and the date of the survey (1999/2000). Table 9 contains the results for both dates, in each case for the full set of explanatory variables and for a reduced set where only significant variables at a 10 per cent significance level are maintained.

For privatization by the date of the survey, industry effects are most important (apart from the size effects): firms in the energy sector (fuel, extraction of gas, coal and oil, and electricity), which corresponds to the omitted industry dummy, are less likely to be privatized. The same is true for firms belonging to the military-industrial complex. These effects reflect a special interest of the state in so-called strategic industries. Since the state influenced the privatization decision mainly through the exclusion of certain industries, the remaining effect should be mainly due to the decision of company insiders whether to privatize their firm or not. At both dates, medium and large firms are more likely to be privatized than small ones. Also, there is some evidence that better-performing firms have been already privatized by 1994, namely firms with higher productivity, higher wages and less wage arrears (although the last effect is not robust with respect to the exclusion of other variables). The effects of price controls and social benefits on privatization by 1994 are negative and statistically significant, but not economically significant.

Using only the set of privatized firms, we try to explain then, what determines the choice of a particular privatization option (see Table 10). We set the most frequently chosen option, option 2, as the base category. The other alternatives are option 1, lease-buyout and other options. The latter includes the option 3 in the mass privatization program and non-standard privatization

methods such as auctions, tenders, direct sales to outside investors, worker or manager buyouts and privatization by specific government decision.[17]

Employees of a larger firm, as measured by the logarithm of the number of employees, are more likely to choose the first privatization option than the second one.[18] With this option, managers and workers could still hold cash-flow rights via their non-voting shares, but transfer of control to outsiders is easier with this option than with other options. One explanation is that the higher financing needs of large firms made it unavoidable to choose a privatization option that allows outsiders to acquire larger equity stakes in these firms. Wage arrears have a strong negative impact on the likelihood of choosing option 1. This is partial evidence for our hypothesis that employees want to shield the firm against outside owners when the firm is not performing well, so that a possible restructuring could cost them their jobs. The negative effect of the reservation wage, however, goes against our hypothesis that workers with better outside opportunities should be less interested in acquiring shares of their company.

Firms which have chosen the lease-buyout option had less price controls than firms privatized by the second option. That reflects the smaller state control over these firms. Lease-buyouts were less frequent for large firms with more than 2000 employees[19] and for capital-intensive firms. Also, firms privatized by the lease-buyout method are more productive than firms privatized using option 2.

1.6.2 Explaining the level of ownership stakes in 1994

The choice of ownership stakes, taking into account the previous decision whether to privatize the firm or not, is estimated using a tobit model with sample selection (see section 1.4.3). Therefore, we use the data on both privatized and non-privatized firms. The results, given in Table 11, are reported for the full set and a parsimonious set of explanatory variables for each ownership category. In order to obtain a parsimonious formulation of the model we maintain the same set of variables in the selection equation[20] and eliminate variables that are not significant at the 10 per cent level in the ownership equation except for the size, region and industry controls.

In 1994, smaller firms exhibit a higher stake of private owners than larger firms. That indicates that the state still holds some share of the larger firms. Consistent with our hypothesis,

[17] For the lease-buyout option there may be a slight problem of timing since our explanatory variables for the choice of privatization option are for the years 1990-1992, but the decision on a lease-buyout might have happened before. The decision to lease the firm assets was often taken in 1989 or 1990 and the lease-buyouts mostly took place between 1991 and 1993.

[18] In spite of the opposite sign of the size dummies, the overall effect of size is positive.

[19] This size effect becomes only significant if the log of the number of employees is omitted and only the size dummies are left in the model.

[20] The choice of the variables for the second equation is described at the end of section 1.4.3

firms with a larger fraction of sales subject to price controls have a smaller private share. Somewhat puzzling, social benefits influence the private share in a twofold way: their share in overall costs reduces the private share, and the number of different benefits increases it. The positive effect of the number of benefits is also present in the estimations of insider shares, and the worker share in particular. The negative effect of the share of social benefits in total costs indicates that the state tends to retain greater stakes in firms with large social burdens and responsibilities.

Insiders (managers and workers combined) tend to have lower stakes in larger firms. That may reflect their cash constraints in acquiring large stakes in these companies. There is, however, no direct evidence that the price of shares matters to insiders since the capital cost variable is insignificant. A high number of different social benefits offered by the firm increases the insiders stake. This is especially true for workers (see below). Labor market conditions are captured by the average wage in the same region and industry and the concentration of local labor demand. We find no evidence for the hypothesis that worse outside opportunities lead to higher insider stakes. However, these variables possibly do not capture all outside opportunities to workers and managers, who often found a new employment in the emerging sectors such as retail trade and services. Higher state regulation in the form of price controls decreases the insider stake and the worker stake in particular. This could confirm the hypothesis that regulation reduces private benefits, but the effect is not present for outside owners. Insider stakes in the energy sector are significantly lower than in all other sectors.

Managerial ownership is found to be negatively influenced by the degree of unionization and the amount of wage arrears. Less wage arrears may be a sign of better performance and managers acquire larger stakes in such firms. A positive effect of the concentration of local employment suggests some sensitivity to outside opportunities, but the effect is not robust to the exclusion of insignificant variables.

The worker share is positively influenced by the degree of unionization. A higher degree of union membership could reflect a better bargaining position vis-à-vis the management which explains both the positive coefficient for the ownership stake of workers and the negative coefficient for the stake of managers. In particular, unionization may increase the ability of workers to collude in the decision to sell shares to other groups of owners, and therefore keep their ownership stake high. No evidence is found that firms in financial distress[21] have a higher ownership stake of workers that would serve as an insurance against unemployment. On the contrary, labor productivity as a positive measure of firm quality has a positive impact on the workers' share. The number of different social benefits offered by the firm increases the stake held by workers,

[21] We refer to firms with higher wage arrears. We tried also tax arrears which did not turn out to be significant, neither.

but the share of these benefits in total costs does not. So there is partial support in the data for our hypothesis that preserving the supply of social benefits provides incentives for workers to acquire shares in their firms. Neither the price of shares (as approximated by the share of capital costs in total costs or the capital-labor ratio) nor the variables standing for the ability to pay (average wage or profits) are significant. This can be explained by the fact that insiders obtained shares at very preferential terms.

The shares of outside owners and private outside blockholders are estimated to be higher when the firm exhibits a higher capital intensity measured by the share of capital costs (depreciation) in total costs. This is consistent with our hypothesis that outsiders would obtain shares in more capital-intensive firms since they are not assumed to be cash-constrained and can thus provide the necessary finance to raise the efficiency of the firm. The fraction of sales to the state in total sales and productivity are, somewhat unexpectedly, positively related to outside ownership. To estimate the determinants of ownership concentration we look at the stake of private outside blockholders[22]. The effects of capital intensity and sales to the state are the same for private blockholders as for all outside owners. In addition, the presence of private blockholders was more frequent in small and large firms than in medium size firms.

We have conducted the same analysis for voting shares, as opposed to all shares. Often non-voting shares were created in the privatization process. The resulting shares in the votes at general meetings should reflect the actual control over firms more precisely. The results were however very similar and we do not report them here.

1.6.3 Explaining the change of ownership stakes between 1994 and 1999

For the estimations of the change of ownership we apply OLS since neither sample selection nor a limited dependent variable are an issue here (see Figure 2 for the distributions of the change in insider and outsider ownership).

In the present paper, we do not want to deal with the problem of simultaneity between ownership and the performance variables. Therefore we estimate only the effects of initial conditions on the change of ownership. The idea is that initial ownership distributions may have been more influenced by the design of the privatization program than by economic factors. If initial conditions have significant effects on the change of ownership in the period under consideration, we interpret such effects as long-run forces driving ownership shares towards their "equilibrium" levels. We use the same explanatory variables as in the estimations of the

[22]Recall that the term private blockholders means that we do not count those outside block-holding entities that are owned by the state.

levels of ownership stakes, now with their values for the year 1994.[23] In addition, we include the initial shareholdings of insiders and outsiders in 1994 omitting the complementary state share. Results are given in Table 12.

In general, there are only few significant variables apart from the initial insider and outsider stakes. The stake of private owners increased more in firms of medium size and in firms which exported a higher fraction of their sales. Since our sample consists mostly of manufacturing firms, we can associate the share of exports in total sales with increased competitiveness. It turns out that further privatization between 1994 and 1999 is more likely in these firms. The negative signs of the initial insider and outsider stakes just reflect further privatizations in those firms where the stake of private owners was low initially.

The change in the stakes of all insiders, managers and workers, is negatively related to the dummy variable for large firms. That is, the stakes of insiders in general, and workers in particular, decrease more in large firms, and the stakes of managers increase less in large firms. Insiders, and workers in particular, reduce their stakes more rapidly if the initial share of insiders is high.[24] If, say, firm A has an initial insider stake by one percentage point higher than firm B, the model predicts that the stake of insiders in firm A would decrease by 0.3 percents more than in firm B in the following years. On the other hand, for the manager stake there is no relation to the initial insider stake.[25] Managers are able to increase their stake more rapidly in more competitive firms, as proxied by their share of exports in total sales. They seem to react also to regional labor market conditions, since lower reservation wages make them increase their stake even more. This is however not the case for workers.

Private blockholders and other outsiders increase their shares more where insiders[26] have a high stake initially. The effect of their own initial stake is negative for outsiders. This suggests that on average outsiders are able to acquire more shares when they have been in a minority position initially. However, there is no such effect for private blockholders. The increase in the stake of outsiders is higher in medium and large firms, while for private blockholders the same is true in medium firms only. This pattern is consistent with our hypothesis that firms with more need for financing would be more likely to be controlled by outsiders in the long run.

[23] We make the simplifying assumption is that the problem of simultaneity between ownership and performance variables is negligible before 1994.

[24] In the case of workers this is entirely due to their own initial share, not to that of managers. (We did not report the disaggregation of initial insider shares in Table 11.)

[25] There is however a negative relation between the change of the manager share and the initial share of managers; the coefficient is -0.1.

[26] Workers in particular.

1.7 Conclusion

In the descriptive statistics on ownership change between 1994 and the date of the survey, we found a considerable persistence of the initial ownership distribution. Managers often used insider ownership as a shield against outside owners and a closer monitoring of their activities. Anecdotal evidence tells us that they found various ways to prevent resales from employees to outsiders. They could even increase their direct stake slightly, contrary to the evolution of managerial ownership after IPOs in Western firms. This is consistent with the result of Edelstein et al. (2005) for the case when large shareholders have strong benefits of control. Also the general illiquidity of capital markets in Russia contributed to the persistence of insider ownership. Thus the hope of the designers of the privatization program that share trade at secondary markets would lead quickly to optimal ownership structures, has not come true.

We use a comprehensive data set of Russian manufacturing firms to estimate which factors can explain the decision to privatize, the initial ownership structure after privatization and subsequent changes of ownership stakes. We find evidence that the interests of the state play a role in the privatization process. Firms of the military-industrial complex are less likely to be privatized by 1999/2000 than non-military firms. The extent of the private share (the complement to the state share) is negatively related to price controls. Another key result is that capital intensity facilitates the acquisition of shares by outsiders and blockholders since capital-intensive firms might need finance for their restructuring most urgently. Apart from retained earnings, other forms of finance were usually not available, especially under insider ownership. In line with this reasoning we find also that insiders hold fewer shares in large firms (with supposedly higher financing needs). Also, the decrease of the stake of insiders and increase of the stake of outsiders over time were more pronounced in larger firms.

In their model on the ownership choice after insider privatization, Aghion and Blanchard (1998) assume that outside ownership and closer monitoring of the management are associated with more restructuring and layoffs. Therefore, insiders seek to insure themselves against unemployment by holding shares, especially in worse performing firms. We find that privatization option 1, which did not automatically provide insiders with a majority, was chosen less frequently if firms had accumulated more wage arrears. However, in the estimations for the ownership shares, the stakes of insiders, and workers in particular, are not sensitive to the amount of wage arrears. Our interpretation of these results is that workers chose a privatization option in order to increase their stake especially in firms in financial distress, but did not succeed in terms of their resulting ownership stake after the end of the mass privatization program. Two further predictions of the Aghion-Blanchard model on ownership choice after insider privatization were

tested empirically: First, we find support for the hypothesis that the ability of workers to collude in the decision to sell their shares to outsiders (measured by union membership) increases worker ownership. Second, the prediction that higher reservation wages should lead to less insider ownership since workers and managers would be less concerned about their jobs, found only very limited support in the data. In addition, the supply of social benefits to employees as measured by the number of different benefit types is found to increase the share of insiders and workers in particular.

The case of Russia allows drawing conclusions about privatization policy. For political reasons or because there were simply not as many wealthy investors, give-away policies have been pursued in many countries. In Russia, there was considerable political pressure for giving ownership to workers and managers before the mass privatization program was implemented. Large benefits to company insiders and the resulting insider majority ownership, however, may not be beneficial in a period when large restructuring and labor shedding are necessary.[27] If insider ownership is the only politically feasible option, collusion should be avoided. In particular, shares should be owned individually and should be tradable anonymously with share registries outside of the firm. According to our data, at the date of the survey, share registries were kept within the enterprise in 40 per cent of the firms. The Law on Joint Stock Companies stipulates for firms with more than 500 employees that share registries have to be maintained outside of the firm. Still in 17 per cent of these firms in the sample did not comply with law in this respect. Aghion and Blanchard (1998) argue that if collusion is made impossible, insiders might oppose privatization altogether. But we would argue that prolonged state ownership may make them even worse-off, and opposition against a privatization plan that gives insiders majority ownership may be politically difficult.

Policies fostering competition and entry of new businesses would certainly help increasing the reservation wage for workers. Although the evidence on the impact of outside opportunities for workers in the labor market is not conclusive, it is likely that this would make them more willing to sell their shares.

An important question for future research is the impact of various ownership structures on performance and restructuring activities of the firm. The determinants of ownership identified in this paper allow us to address the simultaneity problem between ownership and performance, e.g. by using them as instrumental variables for ownership.

[27] The evidence for Central and Eastern Europe is summarized in Djankov and Murrell (2002).

Appendix: Tables and Figures

Table 1

List of dependent variables

Dummies and Options of Privatisation	
privatised	equal to 1 if firm was privatised by date of survey (1999/2000), equal to 0 otherwise
privat94	equal to 1 if firm was privatised by July 1, 1994 equal to 0 otherwise
privopt_cond	privatisation option for privatized firms. equal to 1 for option 1, equal to 3 for lease-buyout, equal to 4 for other options Option 2 is the base group.
Ownership	
privsh94	ownership share of all private owners at July 1, 1994
inssh94	ownership share of insider owners (managers and workers)
mansh94	ownership share of manager owners
worksh94	ownership share of worker owners
outsh94	ownership share of outsider owners
allbuc94	ownership share of all blockholders ($\geq$5 per cent)
allbucpr94	ownership share of all private blockholders
largbloc94	ownership share of the largest blockholder
largblocpr94	ownership share of the largest private blockholders
dprivsh, dinssh,...	change in ownership share between July 1, 1994 and January 1, 1999 for the same categories of owners

Table 2

How and When Firms Were Privatised

Privatisation method	Number of firms	% of firms	Median date of majority privatisation
All methods	409	82.3	May 93
Mass Privatisation Program	305	74.6	July 93
of which:			
Option 1	108	26.4	Sep 93
Option 2	186	45.5	June 93
Option 3	12	2.9	Aug 93
Lease Buyout	67	16.4	July 92
Sale	6	1.5	July 94
Other Method	25	7.3	May 93
No Information On Privatisation Method	8	2.0	

Notes: The sample consists of 497 firms which existed in some form in 1986. Percentages of privatisation methods refer to the 409 privatised firms (there are 10 missing values on that question). Four firms reported multiple privatisation methods. 336 firms provided information on the date of majority privatisation. The privatisation date is defined as the time at which more than 50% of the property became owned by non-state legal entities or individuals.

Table 3

Evolution of Ownership Structure, 1994 to 1999

Type of owner	1994		1999		1994 - 99
	Mean share	Conditional mean	Mean share	Conditional mean	Mean change
State	33.9	60.2	23.8	61.7	-9.0
Federal	19.4	59.8	13.0	57.5	-5.8
Regional	5.5	65.4	4.6	67.9	-0.8
Municipal	8.8	52.2	6.2	57.2	-2.3
Private	66.1	85.7	76.2	90.8	+9.1
Insider	48.5	65.1	43.7	54.2	-5.4
Manager	9.3	13.4	12.4	16.6	+2.4
Worker	36.8	51.9	30.7	39.9	-6.5
Outsider	17.0	37.3	32.2	52.0	+14.7
Legal entity	11.0	24.8	19.5	38.3	+7.3
Individual	4.0	16.7	8.8	22.7	+4.3
Foreigner	1.4	23.7	3.2	25.4	+1.9

Notes: The sample consists of 497 firms which existed in some form in 1986 (newly founded firms are excluded). Conditional means are average shares for firms with positive shareholdings of the particular type. Regional state ownership was not asked for explicitly in the first round of the survey (371 out of 530 questionnaires), although for some firms this share could be imputed from the Goskomstat registry of Russian enterprises if they were 100 percent owned by a regional state agency in 1993 or after. Therefore, the mean of regional ownership is probably understated. The number of non-missing values varies slightly among categories (442-464 in 1994, 470-486 in 1999, and 434-463 for change), except the disaggregated insider shares (workers and managers), for which smaller numbers of observations are available (413 in 1994, 438 in 1999, and 403 for change). Therefore, the means in the disaggregated categories do not add exactly up to the means in the aggregated categories.

Table 4

Size of Outside Blockholdings

	1994	1999
% of Firms with a Block	26.6	52.5
Mean	9.9	22.6
Median	0.0	0.0
Mean Private Block	7.1	18.2
Mean Conditional on Block >0	37.3	47.6
Median Conditional on Block >0	31.8	47.0
Mean Private Conditional	35.1	45.3
Median Private Conditional	28.0	44.8
% of Firms with Blockholding >10%	22.8	44.9
> 20%	17.3	38.8
> 30%	13.8	32.1
> 40%	10.3	27.6
> 50%	7.7	21.1
> 75%	2.2	7.6

Notes: A block is defined as a share greater than or equal to five percent held by a single outside entity. Private Blockholdings means that the legal entity is not controlled by the state. The number of observations is 456 in 1994 and 474 in 1999. Eight firms with at least one blockholder in 1994 or 1999 are not included because they gave no information on the corresponding shares.

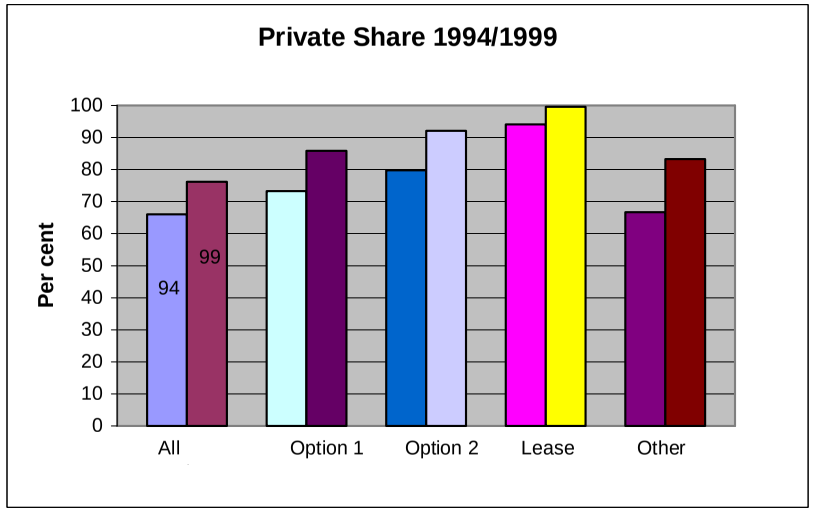
Table 5

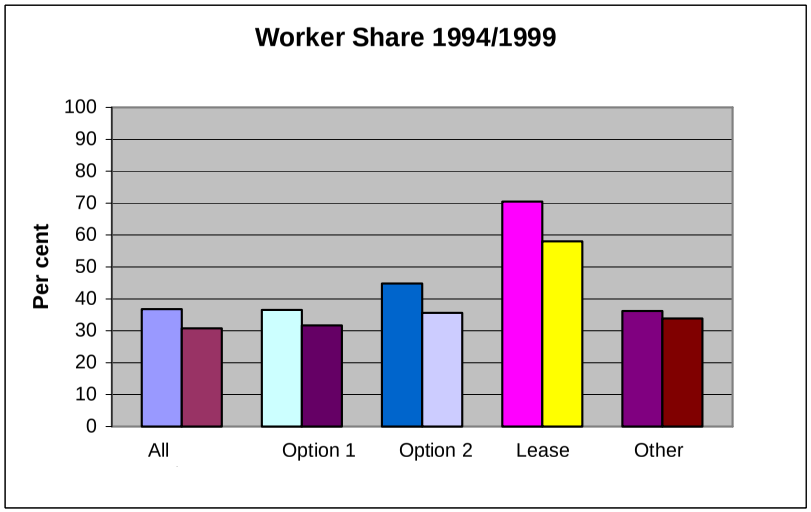
Largest Blockholders

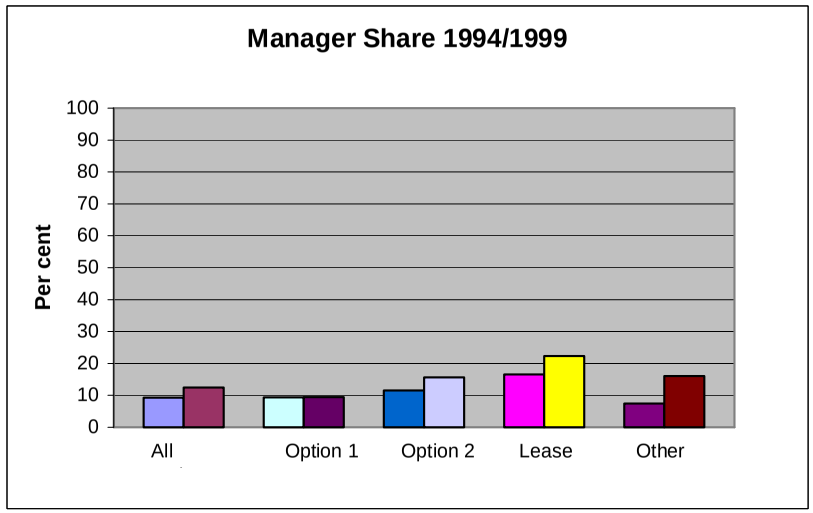
Statistic	1994		1999	
	Mean	Median	Mean	Median
Largest Blockholder	32.4	20.0	35.3	30.0
Largest Private Blockholder	28.7	19.0	34.2	29.0
Second Largest Blockholder	11.6	10.0	14.3	12.0
Third Largest Blockholder	8.0	6.5	10.1	9.9

Notes: Numbers are conditional on the presence of one, two and three blockholders, respectively. A block is defined as a share greater than or equal to five percent held by a single outside entity. The largest shareholders were identified from the available information on the shares of different blockholders, i.e., missing values for shares were treated as zeroes. The number of firms with at least one blockholder is 121 in 1994 and 225 in 1999.

Figure 1 Ownership by Privatisation Option







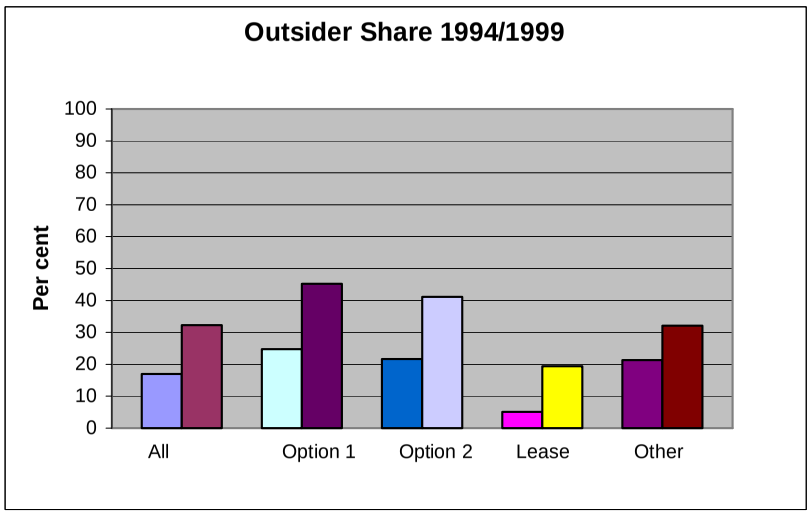


Figure 1 continued

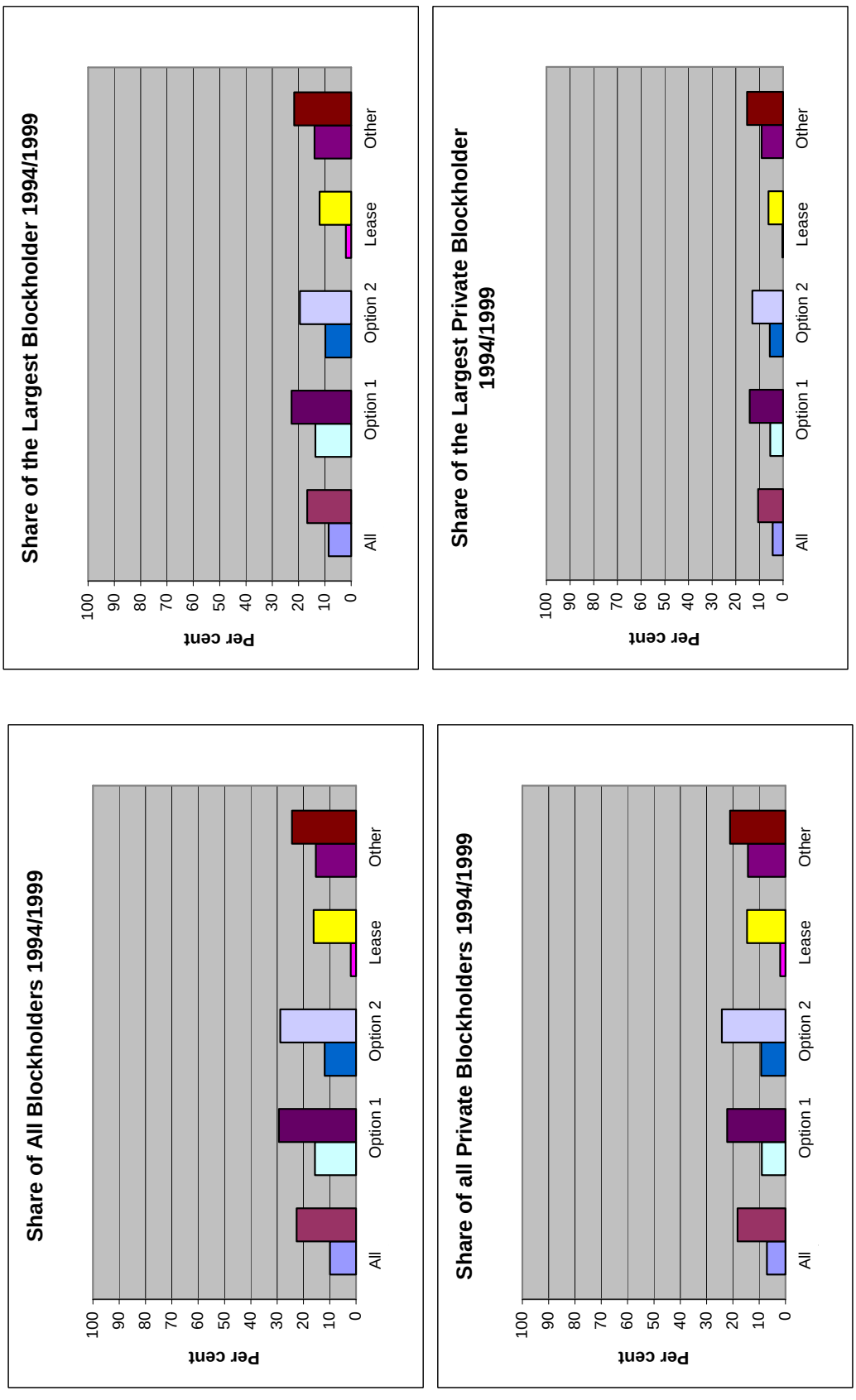


Figure 2 Frequency Distributions of Ownership Stakes in 1994 (left) and their Changes (right) from 1994 to 1999, for Outside Owners (above) and Insiders (below)

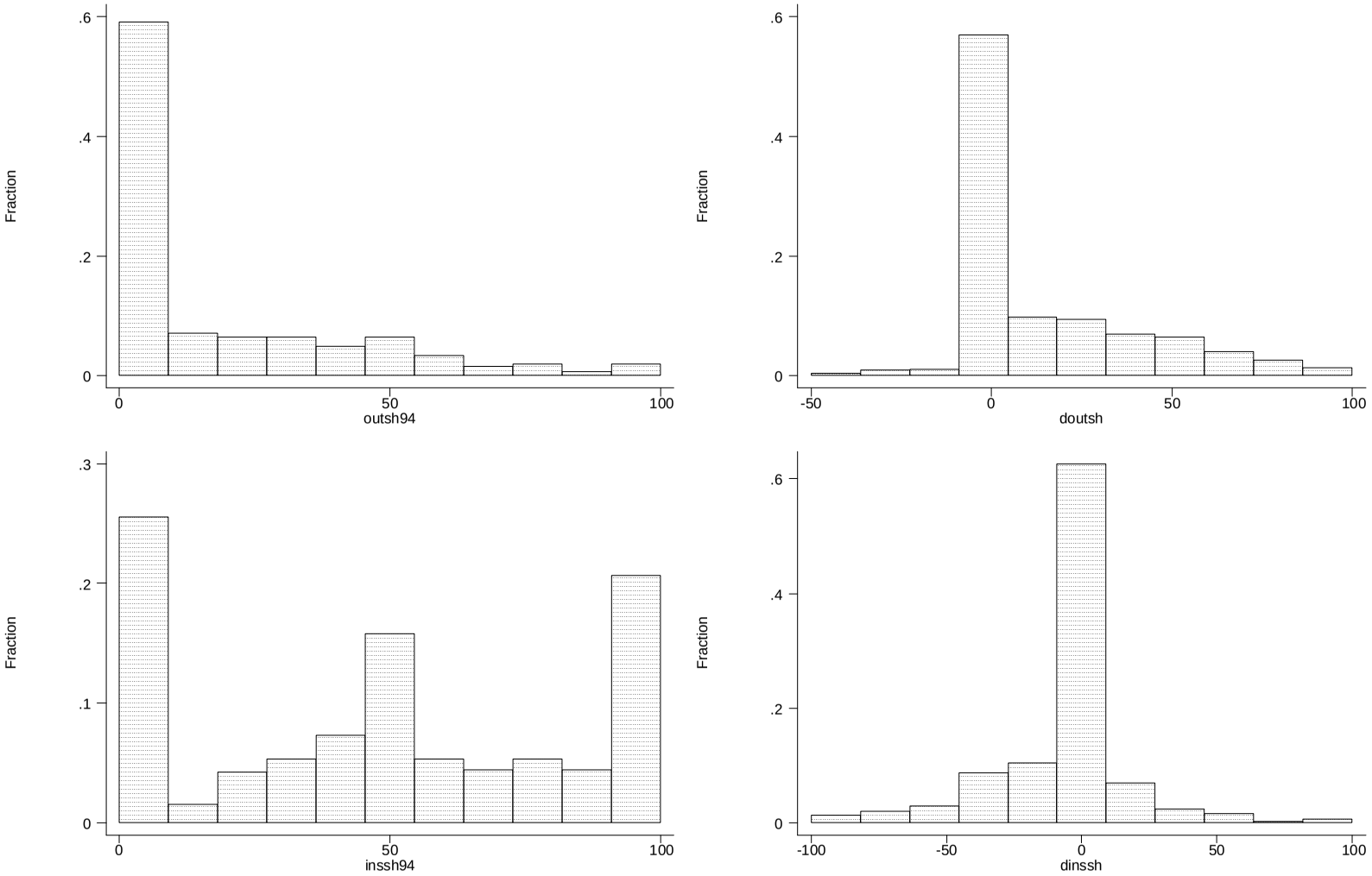


Table 6

List of explanatory variables

Variable	Explanation
Controls(*)	
reg_cap	Moscow/St. Petersburg
reg_asia	Asian part of Russia
ind_mech	ferrous and non-ferrous metallurgy and chemical industry
ind_macb	heavy and light machinery
ind_woco	forestry/construction materials
ind_foli	food/light industry
ind_othr	other industries
Size	
size_mid	500-2000 employees (based on employment 91)
size_big	> 2000 employees (based on employment 91)
lnemp91	log of employment 91
Firm Quality	
lnprod91	log of productivity = log of sales 91(**) minus log of employment 91
exp90	export share in total sales 90
newequip90	fraction of new equipment in the firm 90 (less than 4 years)
lnprofitb92	profitability: log of accounting profits before taxes 92 minus log of employment 91
wagearr92	wage arrears in monthly wage funds 92 (***)
Attractiveness to the State	
mic	military-industrial complex dummy: identified by industry code and former ministry subordination
OR milsales90	share of sales to the military 90
pricecont92	share of sales subject to price controls 92
budsales90	share of sales to the state budget 90
Attractiveness to Outsiders vs.insiders	
union92	unionization: percentage of union members among all employees, average between numbers for 90 and 94
capcosts94	share of capital costs (depreciation) in total costs 94
lnK_L92	log of the capital-labour ratio (book value of capital in thousands of roubles 92 divided by employment 91)
wagdiff92	ratio between production worker wages and wages of non-production industrial employees 92
lnavwag92	log of the average wage of industrial employees (main activity) 92
labconc92	log of the Herfindahl-Hirshman index of concentration of local labour demand 92
lnregindwage92	log of the average wage in the same region and industry 92
socben_c94	share of social benefits in total costs 94
socben_no94	number of different types of social benefits 94

All variables with a year index 90, 91 or 92 are updated for 1994 in the regression on the change of ownership (except labconc92 and lnregindwage92). Some variables with year index 94 are only available for that year.
(*) The dropped regional dummy is for the European part of Russia. The dropped industry dummy is for Coal, Gas, Fuel, Oil Extraction and Electricity. The dropped dummy for size is for small firms with less than 500 employees in 1991.
(**) Some missing values were imputed from sales in the following year (adjusted by average growth rate in sales) or from output in 1991 or the following year.
(***) There was a question on wage arrears in the first part of the questionnaire asked to the director (arrears averaged over the year), and in the second part asked usually to the chief accountant (arrears at the end of the year). Answers were not always consistent, but when both answers were different from zero, numbers were usually close. Since we weight a non-zero answer more than a zero, we essentially we use the maximum of both answers to construct wagearr92.

Table 7

Descriptive Statistics of Explanatory Variables

Variable	for 1990/92			Update 1994		
	Mean	Std. dev.	No. obs.	Mean	Std. dev.	No. obs.
reg_cap	0.13	0.34	497			
reg_asia	0.32	0.47	497			
ind_mech	0.09	0.29	497			
ind_macb	0.38	0.49	497			
ind_woco	0.12	0.33	497			
ind_foli	0.24	0.43	497			
ind_othr	0.07	0.25	497			
size_mid	0.29	0.45	497	0.30	0.46	494
size_big	0.33	0.47	497	0.27	0.44	494
lnemp91	6.73	1.67	497	6.58	1.62	494
lnprod91	4.05	1.72	438	3.17	1.27	434
exp90	2.28	7.88	331	4.75	13.21	367
newequip90	22.05	26.06	438	18.30	24.92	455
lnprofitb92	4.49	1.60	382	7.59	1.84	351
wagearr92	0.25	0.74	462	0.63	1.53	461
mic	0.13	0.34	497			
milsales90	7.01	18.12	324	5.28	16.22	360
budsales90	26.62	38.44	328	20.60	34.43	363
pricecont92	49.36	46.83	443	34.59	44.04	438
union92	91.76	16.99	466	85.88	26.34	467
capcosts94	6.35	6.59	271	6.35	6.59	271
lnK_L92	5.96	1.07	295	9.48	1.13	335
wagdiff92	1.79	3.43	400	2.49	16.15	413
lnavwag92	4.32	0.61	408	7.72	0.63	429
labconc92	-1.93	1.32	497			
lnregindwage92	4.36	0.42	496			
socben_c94	7.45	5.11	271			
socben_no94	5.22	3.37	480			

See notes at the end of Table 6.

Table 8

Expected signs for regressions on ownership levels in 1994

	Effect on the share of				
	private	managers	workers	outsiders	blockholders
Firm Quality					
Profitability 92	+	+	–		
Productivity 91	+	+	–		
Export Share in Total Sales 90	+	+	–		
Fraction of New Equipment 90	+	+	–		
Average Wage 92	+	+	–		
Wage Arrears 92	–	–	+		
Attractiveness to the State vs. Private Owners					
Price Controls 92	–			–	–
Share of Sales to the State Budget 90	–				
Military-industrial Complex	–				
Share of Sales to the Military 90	–				
Attractiveness to Outsiders vs. Insiders					
Firm Size: Employment 91		–	–	+	–/+
Various Measures for Costliness:					
Capital-labour ratio (book value of capital 92)		–	–	+	
Fraction of New Equipment 90		–	–	+	
Share of Capital Costs in Total Costs 94		–	–	+	
Ability to pay					
Average wage 92			+		
Wage Arrears 92			–		
Profitability 92		+	+		
Insider Power / Ability to Collude					
Heterogeneity of Workforce (in Terms of Wages)		–	–	+	+
Unionization			+	–	–
Outside opportunities					
Concentration of the local labour demand		+	+		
Average Wage in the Same Region and Industry		–	–		
Social assets					
as a share of total costs 94	–		+	–	
number of different benefit types 90	–		+	–	

+ positive effect
– negative effect

Table 9

Estimation Results for Logit Regression on Privatisation by July 1, 1994 and by the Date of the Survey (1999/2000)

	Privatized by July 1, 1994				Privatized by 1999/2000			
reg_cap	-0.716	*-0.45*	0.040	*0.05*	0.641	*0.35*	-0.541	*-0.96*
reg_asia	-1.249	*-1.40*	-1.125	*-2.45***	-0.302	*-0.35*	-0.619	*-1.70**
ind_mech	-0.257	*-0.16*	0.130	*0.16*	-0.275	*-0.16*	1.597	*2.05***
ind_macb	1.391	*0.79*	1.119	*1.61*	0.014	*0.01*	1.890	*3.20****
ind_woco	2.389	*1.16*	2.034	*2.06***	1.448	*0.65*	1.414	*2.15***
ind_foli	0.651	*0.40*	0.914	*1.30*	0.255	*0.15*	2.198	*3.49****
ind_othr	-0.199	*-0.10*	-0.184	*-0.21*	-0.272	*-0.13*	0.729	*1.02*
size_mid	0.667	*0.53*	1.477	*2.38***	1.224	*0.81*	1.667	*2.22***
size_big	-1.406	*-0.80*	0.849	*1.72**	-2.377	*-1.26*	-0.614	*-0.72*
lnemp91	0.568	*1.08*			1.061	*1.79**	0.534	*2.32***
lnprod91	0.431	*1.67**	0.248	*1.88**	0.209	*0.82*		
exp90	0.041	*1.00*			0.070	*0.74*		
newequip90	0.008	*0.74*			0.011	*0.96*		
lnprofitb92	0.188	*0.51*			0.136	*0.37*		
wagearr92	-0.830	*-2.26***			-0.494	*-1.10*		
mic	-0.491	*-0.46*			-0.168	*-0.15*	-1.769	*-3.37***
budsales90	0.018	*1.79*			0.015	*1.43*		
pricecont92	-0.020	*-2.34***	-0.009	*-1.84**	-0.007	*-0.79*		
union92	0.004	*0.21*			0.003	*0.14*		
capcosts94	0.046	*0.84*			0.048	*0.89*		
lnK_L92	0.181	*0.46*			0.128	*0.30*		
wagdiff92	0.019	*0.32*			-0.003	*-0.06*		
lnavwag92	-1.381	*-1.44*	0.727	*2.22***	-0.552	*-0.60*	0.731	*2.40***
labconc92	0.354	*0.88*			0.477	*1.05*		
lnregindwage92	1.264	*0.83*			-1.030	*-0.60*		
socben_c94	-0.149	*-2.09***	-0.076	*-1.93**	-0.110	*-1.43*		
socben_no94	0.093	*0.78*			-0.021	*-0.17*		
constant	-3.915	*-0.51*	-2.346	*-1.43*	1.206	*0.14*	-5.815	*-3.05*
Pseudo R^2 (%)	33.47		18.18		30.38		20.21	
No. observations	143		232		144		403	

We use the full set of explanatory variables (left column) and a reduced set with coefficients significantly different from zero except for the controls (right column).
Italic numbers are z-values.
* significant at 10% level; ** significant at 5% level; *** significant at 1% level

Table 10 Estimation Results Multinomial Logit Regressions on the Choice of Privatisation Option Given that the Firm Was Privatised
Base group = 2nd privatisation option

	1st option				Lease-buyout				Other options			
reg_cap	-0.222	*-0.12*	-0.860	*-1.04*	0.630	*0.33*	-0.170	*-0.16*	-32.858	*0.00*	2.406	*1.82**
reg_asia	3.093	*2.36***	0.392	*0.89*	-0.457	*-0.45*	0.449	*0.77*	0.802	*0.68*	0.437	*0.63*
ind_mech	-3.686	*-1.89**	-2.406	*-3.04****	3.746	*0.44*	7.345	*1.41*	1.832	*0.63*	-2.205	*-1.70**
ind_macb	-2.545	*-1.67**	-1.913	*-2.86***	3.060	*0.37*	7.103	*1.46*	3.350	*1.27*	-1.250	*-1.42*
ind_woco	-2.577	*-1.32*	-2.471	*-2.93***	2.782	*0.33*	6.731	*1.35*	-32.479	*0.00*	-36.461	*0.00*
ind_foli	-4.439	*-2.68***	-2.287	*-3.16****	2.491	*0.30*	7.096	*1.43*	2.074	*0.93*	-1.563	*-1.77**
ind_othr	-0.615	*-0.27*	-1.612	*-1.68**	1.040	*0.13*	7.716	*1.54*	-1.580	*-0.54*	-1.181	*-1.04*
size_mid	-2.540	*-1.39*	-0.952	*-1.56*	0.361	*0.29*	0.228	*0.28*	1.837	*1.01*	-0.347	*-0.41*
size_big	-0.713	*-0.28*	-0.935	*-1.01*	-0.973	*-0.47*	-1.770	*-1.27*	5.859	*1.66**	-0.797	*-0.57*
lnemp91	0.937	*1.26*	0.621	*2.40***	-0.403	*-0.59*	0.115	*0.28*	-2.816	*-2.32***	0.118	*0.32*
lnprod91	0.645	*1.95**	0.190	*1.49*	0.041	*0.13*	0.287	*1.78**	0.150	*0.35*	-0.078	*-0.43*
exp90	0.051	*1.30*			-0.065	*-0.80*			0.055	*1.29*		
newequip90	-0.030	*-1.71**			0.004	*0.26*			-0.008	*-0.41*		
lnprofitb92	-0.354	*-0.70*			0.279	*0.67*			0.755	*1.42*		
wagearr92	-2.891	*-2.58***	-0.708	*-2.03***	0.591	*1.31*	0.150	*0.59*	1.119	*1.92**	0.103	*0.40*
mic	0.562	*0.40*			-32.849	*0.00*			0.648	*0.32*		
budsales90	0.008	*0.69*			0.004	*0.40*			-0.010	*-0.69*		
pricecont92	0.007	*0.57*	0.002	*0.54*	-0.025	*-2.42***	-0.011	*-2.05***	0.009	*0.72*	0.009	*1.47*
union92	0.002	*0.06*			0.011	*0.31*			-0.024	*-0.59*		
capcosts94	-0.014	*-0.17*			0.001	*0.01*			-0.069	*-1.03*		
lnK_L92	1.032	*1.54*	0.099	*0.41*	-0.421	*-0.88*	-0.638	*-2.14***	0.480	*0.68*	-0.186	*-0.61*
wagdiff92	-2.355	*-1.39*			-0.399	*-0.53*			-0.724	*-0.79*		
lnavwag92	0.331	*0.23*			1.544	*1.20*			-0.530	*-0.35*		
labconc92	-0.111	*-0.22*	-0.163	*-0.80*	0.047	*0.11*	0.040	*0.16*	0.686	*1.34*	0.706	*2.35***
lnregindwage92	-2.341	*-1.22*	-0.972	*-2.05***	-2.012	*-1.11*	-1.460	*-1.43*	1.890	*1.09*	0.211	*0.36*
socben_c94	0.046	*0.31*			0.112	*1.00*			0.129	*0.71*		
socben_no94	-0.232	*-1.39*			0.175	*1.40*			0.410	*1.95*		

We use the full set of explanatory variables (left column) and a reduced set with coefficients significantly different from zero (except for the controls) for at least one of the options, (right column). A constant is not included since some standard errors could not be estimated and the model performance would be worse in term of pseudo R^2.
Firms that reported multiple privatisation options are excluded.
Italic numbers are z-values.
* significant at 10% level; ** significant at 5% level; *** significant at 1% level
The pseudo R^2 is 49.45 per cent for the full set of variables and 28.85 per cent for the most parsimonious set. The number of observations is 122 and 229 respectively.

Table 11 Estimation Results for OWNERSHIP LEVELS in 1994 (Tobit Regressions with Correction for Selection Bias)

	Private Share				Insider Share			
Ownership equation								
size_mid	11.393	*0.50*	-19.127	*-1.85**	18.519	*1.52*	15.812	*1.76**
size_big	30.169	*0.95*	-25.360	*-2.41***	11.280	*0.56*	10.986	*0.80*
reg_cap	-2.343	*-0.09*	-1.122	*-0.09*	-6.774	*-0.38*	-5.925	*-0.66*
reg_asia	-22.481	*-1.07*	-13.216	*-1.51*	-13.357	*-1.40*	-6.178	*-1.09*
ind_mech	15.970	*0.53*	-1.133	*-0.07*	21.041	*1.04*	1.208	*0.11*
ind_macb	18.749	*0.48*	16.579	*1.14*	38.274	*1.65**	15.608	*1.61*
ind_woco	24.070	*0.63*	26.042	*1.45*	58.475	*2.33***	32.535	*2.64****
ind_foli	19.869	*0.59*	18.490	*1.30*	31.783	*1.46*	18.529	*1.85**
ind_othr	-19.485	*-0.49*	-10.414	*-0.53*	32.890	*1.22*	5.852	*0.43*
lnemp91	-16.487	*-1.67**			-5.431	*-0.90*	-6.937	*-1.80**
lnprod91	0.691	*0.19*			1.752	*0.71*		
exp90	-0.359	*-0.78*			-0.357	*-1.02*		
newequip90	0.058	*0.33*			0.183	*1.45*		
lnprofitb92	-2.220	*-0.40*			2.793	*0.74*		
wagearr92	-4.308	*-0.64*			-1.730	*-0.38*		
mic	-18.100	*-0.90*			1.973	*0.14*		
budsales90	0.159	*0.79*			-0.077	*-0.80*		
pricecont92	-0.243	*-1.08*	-0.263	*-2.76****	-0.187	*-2.06***	-0.212	*-3.45****
union92	-0.286	*-0.70*			-0.061	*-0.22*		
capcosts94	1.417	*1.24*			0.164	*0.37*		
lnK_L92	-1.165	*-0.17*			-8.265	*-1.80**		
wagdiff92	1.594	*0.23*			-0.572	*-0.68*		
lnavwag92	-2.392	*-0.16*			17.065	*1.53*		
labconc92	2.259	*0.35*			1.571	*0.40*		
lnregindwage92	21.563	*0.75*			4.054	*0.24*		
socben_c94	-0.949	*-0.75*	-1.908	*-1.95**	-0.493	*-0.57*		
socben_no94	4.454	*1.83**	4.306	*2.93***	2.313	*1.81**	1.980	*2.24***
constant	129.452	*0.85*	102.234	*5.67*	6.080	*0.06*	87.732	*3.56*
Privatisation (selection) equation								
size_mid	1.157	*1.31*	0.712	*0.79*	0.740	*0.76*	0.858	*0.96*
size_big	0.422	*0.48*	0.470	*0.49*	0.311	*0.28*	0.450	*0.46*
reg_cap	0.252	*0.24*	0.162	*0.14*	0.472	*0.39*	0.193	*0.17*
reg_asia	-0.662	*-1.16*	-0.497	*-0.78*	-1.119	*-1.54*	-0.821	*-1.27*
ind_mech	0.038	*0.04*	0.087	*0.08*	-0.031	*-0.03*	0.043	*0.04*
ind_macb	0.650	*0.68*	0.449	*0.45*	0.770	*0.63*	0.342	*0.31*
ind_woco	1.119	*1.10*	0.904	*0.80*	1.206	*1.01*	0.885	*0.79*
ind_foli	0.551	*0.73*	0.653	*0.76*	0.404	*0.43*	0.572	*0.65*
ind_othr	-0.572	*-0.65*	0.039	*0.04*	-0.671	*-0.57*	-0.431	*-0.40*
lnprod91	0.081	*0.58*	0.064	*0.50*	0.072	*0.43*	0.077	*0.50*
wagearr92	-0.206	*-0.60*	-0.019	*-0.05*	-0.139	*-0.33*	-0.069	*-0.18*
pricecont92	-0.008	*-1.23*	-0.004	*-0.57*	-0.008	*-1.04*	-0.006	*-0.90*
union92	-0.005	*-0.17*	-0.004	*-0.16*	-0.025	*-0.82*	-0.025	*-0.93*
lnavwag92	0.653	*1.65*	0.633	*1.50*	0.710	*1.49*	0.385	*0.89*
labconc92	0.234	*0.79*	0.036	*0.12*	0.369	*1.08*	0.156	*0.50*
socben_c94	-0.040	*-0.91*	-0.051	*-1.16*	-0.034	*-0.65*	-0.021	*-0.44*
constant	-1.464	*-0.54*	-1.566	*-0.57*	0.660	*0.22*	1.747	*0.65*
sigma_u	37.795	*2.16*	43.467	*6.23*	31.037	*7.30*	32.659	*11.37*
rho	1.000	*0.00*	1.000	*2.67E06*	1.000	*5.42E07*	1.000	*0.00*
p-value LR test	0.8965		0.0510		0.0472		0.0000	
no. obs.	150		219		149		217	

Table 11 continued

	Manager Share				Worker Share			
Ownership equation								
size_mid	15.601	*2.56***	3.961	*1.20*	12.114	*1.17*	4.947	*0.86*
size_big	15.362	*1.49*	-2.543	*-0.74*	11.615	*0.66*	-2.355	*-0.39*
reg_cap	5.977	*0.68*	-3.571	*-0.77*	-9.971	*-0.67*	-6.870	*-0.89*
reg_asia	7.488	*1.68*	1.582	*0.58*	-18.535	*-2.45***	-9.807	*-2.08***
ind_mech	9.319	*0.76*	2.362	*0.40*	44.878	*2.12***	8.157	*0.80*
ind_macb	7.397	*0.52*	4.475	*0.92*	62.696	*2.52***	18.534	*2.08***
ind_woco	19.781	*1.39*	15.723	*2.72****	56.515	*2.26***	18.631	*1.83**
ind_foli	12.361	*0.97*	10.784	*2.17***	46.017	*2.06***	13.893	*1.58*
ind_othr	2.848	*0.18*	-0.649	*-0.08*	50.744	*1.86**	-2.180	*-0.16*
lnemp91	-5.913	*-1.77**			-4.514	*-0.83*		
lnprod91	-0.138	*-0.11*			3.992	*1.90**	2.735	*2.08***
exp90	0.125	*0.71*			-0.360	*-1.25*		
newequip90	0.076	*1.27*			0.008	*0.08*		
lnprofitb92	0.480	*0.27*			0.887	*0.29*		
wagearr92	-4.812	*-1.78**	-4.109	*-2.02***	4.294	*0.95*		
mic	3.517	*0.46*			3.375	*0.27*		
budsales90	-0.012	*-0.26*			-0.089	*-1.10*		
pricecont92	0.023	*0.57*			-0.208	*-2.93****	-0.174	*-3.52****
union92	-0.249	*-2.09***	-0.234	*-2.95****	0.173	*0.85*	0.317	*2.38***
capcosts94	0.191	*0.87*			-0.070	*-0.19*		
lnK_L92	-0.859	*-0.39*			-4.452	*-1.17*		
wagdiff92	-2.610	*-0.66*			-1.198	*-0.18*		
lnavwag92	2.947	*0.54*			15.629	*1.68*		
labconc92	3.793	*1.90**			-1.356	*-0.40*		
lnregindwage92	-3.289	*-0.38*			11.006	*0.76*		
socben_c94	-0.219	*-0.51*			-0.162	*-0.22*		
socben_no94	0.071	*0.11*			1.404	*1.31*	1.475	*2.01***
constant	62.338	*1.19*	24.437	*2.76*	-95.218	*-1.10*	-6.352	*-0.36*
Privatisation (selection) equation								
size_mid	0.981	*0.96*	0.564	*0.60*	0.769	*0.79*	0.863	*0.97*
size_big	0.683	*0.59*	0.347	*0.35*	-0.141	*-0.12*	0.203	*0.20*
reg_cap	0.384	*0.30*	0.252	*0.21*	0.009	*0.01*	0.298	*0.26*
reg_asia	-0.911	*-1.20*	-0.409	*-0.63*	-0.810	*-1.11*	-0.385	*-0.59*
ind_mech	0.314	*0.25*	-0.048	*-0.04*	0.689	*0.56*	0.560	*0.51*
ind_macb	0.988	*0.75*	0.337	*0.32*	1.322	*1.06*	0.827	*0.73*
ind_woco	1.878	*1.39*	0.956	*0.86*	0.947	*0.77*	0.815	*0.71*
ind_foli	1.318	*1.30*	0.637	*0.72*	0.587	*0.62*	0.686	*0.77*
ind_othr	-0.307	*-0.23*	-0.282	*-0.30*	-0.480	*-0.40*	-0.308	*-0.28*
lnprod91	0.100	*0.54*	0.039	*0.30*	0.074	*0.44*	0.094	*0.60*
wagearr92	-0.294	*-0.71*	-0.295	*-0.73*	-0.177	*-0.42*	-0.093	*-0.24*
pricecont92	-0.011	*-1.33*	-0.005	*-0.65*	-0.007	*-0.86*	-0.003	*-0.42*
union92	-0.020	*-0.65*	-0.016	*-0.58*	-0.010	*-0.32*	-0.021	*-0.75*
lnavwag92	0.676	*1.28*	0.213	*0.50*	0.584	*1.25*	0.308	*0.72*
labconc92	0.319	*0.89*	0.158	*0.51*	0.248	*0.73*	0.054	*0.17*
socben_c94	-0.024	*-0.43*	-0.027	*-0.65*	-0.045	*-0.85*	-0.029	*-0.59*
constant	-0.671	*-0.22*	1.351	*0.49*	-0.755	*-0.25*	0.883	*0.33*
sigma_u	14.647	*11.39*	16.016	*15.51*	24.928	*9.19*	26.700	*13.39*
rho	1.000	*2.54E08*	1.000	*34482.8*	1.000	*14044.9*	1.000	*0.54*
p-value LR test	0.0029		0.0000		0.0931		0.0002	
No. obs.	138		202		138		202	

Table 11 continued

	Outsider Share				Share of private outside blockholders			
Ownership equation								
size_mid	-10.285	*-0.77*	-5.853	*-0.71*	-43.123	*-1.83**	-26.036	*-2.18***
size_big	2.151	*0.09*	6.783	*0.81*	-19.305	*-0.47*	3.212	*0.30*
reg_cap	15.197	*0.79*	5.635	*0.52*	10.653	*0.36*	7.762	*0.51*
reg_asia	-5.733	*-0.56*	-3.497	*-0.51*	-4.254	*-0.23*	3.457	*0.33*
ind_mech	-3.717	*-0.17*	2.428	*0.18*	44.064	*1.17*	28.140	*1.47*
ind_macb	-16.130	*-0.66*	-10.546	*-0.86*	17.874	*0.41*	8.895	*0.53*
ind_woco	-22.587	*-0.85*	-16.719	*-1.19*	13.186	*0.29*	-4.130	*-0.20*
ind_foli	-9.371	*-0.40*	-5.159	*-0.43*	24.148	*0.62*	19.970	*1.19*
ind_othr	-26.837	*-0.74*	-18.005	*-0.92*	*(dropped)*		*(dropped)*	
lnemp91	1.561	*0.21*			4.024	*0.33*		
lnprod91	1.111	*0.42*	3.276	*1.71**	2.699	*0.68*		
exp90	-0.115	*-0.31*			0.260	*0.54*		
newequip90	-0.069	*-0.45*			-0.131	*-0.41*		
lnprofitb92	-1.974	*-0.47*			-10.282	*-1.56*		
wagearr92	-2.320	*-0.37*			1.426	*0.16*		
mic	-2.226	*-0.14*			0.850	*0.04*		
budsales90	0.201	*1.89**	0.148	*1.74**	0.194	*1.33*	0.222	*1.93**
pricecont92	0.016	*0.17*			0.029	*0.22*		
union92	-0.196	*-0.67*			-0.134	*-0.24*		
capcosts94	0.611	*1.28*	0.771	*1.81**	0.579	*0.77*	0.891	*1.79**
lnK_L92	1.879	*0.34*			5.393	*0.57*		
wagdiff92	0.557	*0.56*			-3.167	*-0.53*		
lnavwag92	-1.120	*-0.09*			-19.243	*-1.06*		
labconc92	1.105	*0.26*			1.275	*0.20*		
lnregindwage92	0.022	*0.00*			32.453	*1.13*		
socben_c94	-0.441	*-0.49*			-1.891	*-0.93*		
socben_no94	-0.762	*-0.53*			1.963	*0.98*		
constant	27.023	*0.26*	-10.731	*-0.57*	-78.448	*-0.45*	-30.333	*-1.62*
Privatisation (selection) equation								
size_mid	0.376	*0.58*	0.341	*0.47*	1.291	*2.33*	0.906	*1.88*
size_big	0.006	*0.01*	0.307	*0.46*	0.392	*0.88*	0.048	*0.11*
reg_cap	-0.191	*-0.17*	-0.048	*-0.04*	-0.037	*-0.04*	0.219	*0.26*
reg_asia	-0.182	*-0.37*	-0.187	*-0.38*	-0.700	*-1.70*	-0.287	*-0.78*
ind_mech	0.338	*0.39*	0.112	*0.12*	-0.450	*-0.57*	-0.316	*-0.48*
ind_macb	0.494	*0.56*	0.392	*0.50*	0.374	*0.61*	0.410	*0.71*
ind_woco	0.571	*0.59*	0.534	*0.57*	1.072	*1.29*	0.868	*1.19*
ind_foli	0.391	*0.51*	0.392	*0.50*	0.010	*0.02*	0.069	*0.12*
ind_othr	-0.091	*-0.11*	0.065	*0.08*	-0.488	*-0.68*	-0.120	*-0.19*
lnprod91	0.022	*0.17*	0.036	*0.27*	0.062	*0.59*	0.044	*0.47*
wagearr92	-0.052	*-0.22*	-0.048	*-0.17*	-0.118	*-0.58*	-0.040	*-0.21*
pricecont92	-0.001	*-0.11*	-0.001	*-0.23*	-0.010	*-2.25*	-0.004	*-0.99*
union92	0.008	*0.34*	-0.002	*-0.17*	0.006	*0.51*	-0.003	*-0.27*
lnavwag92	0.289	*0.78*	0.363	*0.90*	0.670	*1.89*	0.465	*1.44*
labconc92	0.101	*0.43*	0.078	*0.33*	0.068	*0.32*	0.064	*0.37*
socben_c94	-0.019	*-0.46*	-0.009	*-0.22*	-0.012	*-0.39*	-0.026	*-0.92*
constant	-1.907	*-0.77*	-1.446	*-0.77*	-2.950	*-1.53*	-1.365	*-0.82*
sigma_u	30.892	*6.91*	33.380	*10.62*	27.301	*5.98*	31.852	*6.67*
rho	1.000	*4.93E06*	1.000	*1.78E09*	1.000	*4673.55*	1.000	*14858.8*
p-value LR test	0.9725		0.3029		0.8789		0.1648	
no. obs.	149		192		133		168	

Italic numbers are z-values. The standard errors of rho are not properly estimated, but that does not affect those of other coefficients.

Table 12 Estimation Results for OLS Regressions on the CHANGE of Ownership Shares from 1994 to 1999

	Private Share				Insider Share				Manager Share			
size_mid94	3.407	*0.56*	10.220	*3.91****	6.468	*0.96*	-1.655	*-0.66*	-6.121	*-1.44*	-1.137	*-0.57*
size_big94	1.083	*0.11*	3.194	*1.07*	-0.243	*-0.02*	-9.081	*-3.27****	-11.884	*-1.80**	-6.085	*-2.70****
reg_cap	1.433	*0.18*	-3.788	*-1.04*	-11.009	*-1.25*	-2.722	*-0.83*	7.172	*1.26*	1.831	*0.63*
reg_asia	-0.520	*-0.13*	0.043	*0.02*	1.592	*0.35*	-1.640	*-0.72*	3.290	*1.12*	1.932	*1.01*
ind_mech	8.662	*0.97*	7.373	*1.44*	-4.620	*-0.47*	1.388	*0.29*	5.081	*0.79*	2.990	*0.72*
ind_macb	0.509	*0.05*	2.677	*0.72*	-4.833	*-0.47*	9.057	*2.41***	-2.876	*-0.41*	-2.275	*-0.54*
ind_woco	2.006	*0.21*	3.773	*0.83*	-2.723	*-0.26*	11.349	*2.47***	-1.244	*-0.18*	-2.823	*-0.70*
ind_foli	3.408	*0.40*	3.927	*0.98*	5.853	*0.62*	14.274	*3.49****	-1.375	*-0.23*	2.513	*0.67*
ind_othr	4.735	*0.46*	2.873	*0.55*	-16.598	*-1.46*	-0.069	*-0.01*	-7.965	*-0.95*	-5.543	*-1.13*
lnemp94	2.123	*0.77*			-2.194	*-0.71*			1.310	*0.66*		
lnprod94	2.894	*1.21*			0.983	*0.37*			1.570	*0.91*		
exp94	0.154	*1.03*	0.146	*1.68**	0.171	*1.04*			0.199	*1.99**	0.130	*2.07***
newequip94	0.006	*0.11*			-0.053	*-0.79*			-0.080	*-1.91**		
lnprofitb94	-1.522	*-1.26*			-0.458	*-0.35*			0.366	*0.44*		
wagearr94	-0.043	*-0.04*			-1.538	*-1.16*			0.235	*0.28*		
mic	-8.432	*-1.34*			-2.005	*-0.29*			-2.169	*-0.50*		
budsales94	0.048	*0.92*			-0.013	*-0.22*			0.040	*1.10*		
pricecont94	-0.011	*-0.24*			0.007	*0.13*			0.006	*0.18*		
union94	-0.016	*-0.21*			-0.095	*-1.17*			0.026	*0.53*		
capcosts94	-0.033	*-0.11*			-0.099	*-0.29*			-0.003	*-0.01*		
lnK_L94	1.830	*0.87*			1.180	*0.51*			1.069	*0.75*	1.605	*2.08***
wagdiff94	-0.059	*-0.04*			1.297	*0.78*			-0.502	*-0.19*		
lnavwag94	-4.618	*-0.87*			1.563	*0.27*			-0.129	*-0.04*		
labconc92	0.391	*0.21*			-1.735	*-0.85*			1.850	*1.40*		
lnregindwage92	-6.782	*-0.86*			-20.468	*-2.34***			-10.958	*-2.05***	-6.269	*-1.84**
socben_c94	0.095	*0.25*			0.351	*0.82*			0.111	*0.41*		
socben_no94	-0.476	*-0.87*			0.941	*1.56*			0.848	*2.23***	0.524	*2.02***
inssh94	-0.199	*-3.85****	-0.204	*-6.55****	-0.245	*-4.31****	-0.311	*-10.34****	-0.051	*-1.44*	-0.024	*-1.04*
outsh94	-0.243	*-3.16****	-0.214	*-4.94****	-0.218	*-2.56***	-0.128	*-3.02***	-0.068	*-1.31*	-0.029	*-0.89*
constant	57.435	*1.31*	15.444	*3.86*	90.022	*1.84*	7.357	*1.84*	28.531	*0.88*	14.736	*0.83*
adj. R^2(%)	6.04		16.44		32.51		20.99		25.03		11.12	
no. observations	152		348		151		443		139		256	

Italic numbers are t-ratios.
* significant at 10% level; ** significant at 5% level; *** significant at 1% level.

Table 12 continued

	Worker Share				Outsider Share				Share of private outside blockholders			
size_mid94	12.836	*2.00***	-2.508	*-1.02*	-0.834	*-0.11*	8.524	*3.11****	-0.698	*-0.10*	5.606	*2.23***
size_big94	12.839	*1.28*	-5.126	*-1.89**	4.987	*0.44*	10.681	*3.53****	0.003	*0.00*	3.035	*1.10*
reg_cap	-15.009	*-1.74**	-4.196	*-1.27*	12.721	*1.32*	-0.056	*-0.02*	17.598	*2.03***	1.090	*0.32*
reg_asia	-2.877	*-0.64*	-3.135	*-1.43*	-2.222	*-0.44*	0.444	*0.18*	1.403	*0.31*	0.890	*0.39*
ind_mech	-6.589	*-0.67*	-2.340	*-0.51*	14.849	*1.38*	7.263	*1.42*	17.139	*1.82**	12.688	*2.67***
ind_macb	2.930	*0.28*	6.123	*1.65*	6.717	*0.59*	-4.407	*-1.08*	0.534	*0.05*	-0.566	*-0.16*
ind_woco	2.642	*0.26*	11.556	*2.58*	6.310	*0.55*	-4.029	*-0.81*	6.849	*0.69*	3.934	*0.89*
ind_foli	10.329	*1.13*	11.297	*2.81*	-1.474	*-0.14*	-8.791	*-1.98**	-7.272	*-0.80*	-5.515	*-1.38*
ind_othr	1.379	*0.11*	1.292	*0.24*	21.486	*1.73*	2.877	*0.50*	15.895	*1.42*	5.299	*1.01*
lnemp94	-2.883	*-0.95*			2.711	*0.82*			0.472	*0.16*		
lnprod94	-0.881	*-0.34*			2.764	*0.96*			6.406	*2.53***		
exp94	-0.002	*-0.02*			0.010	*0.05*			0.114	*0.66*		
newequip94	0.012	*0.20*			0.064	*0.87*			0.038	*0.60*		
lnprofitb94	-0.330	*-0.26*			-1.054	*-0.73*			-1.734	*-1.36*		
wagearr94	-1.941	*-1.54*			1.293	*0.90*			0.449	*0.35*		
mic	2.052	*0.31*			-4.945	*-0.65*			-12.299	*-1.72**		
budsales94	-0.016	*-0.29*			0.040	*0.63*			0.049	*0.90*		
pricecont94	0.034	*0.72*			-0.021	*-0.38*			-0.056	*-1.13*		
union94	-0.127	*-1.71**			0.079	*0.89*			0.007	*0.10*		
capcosts94	-0.069	*-0.20*			0.020	*0.05*			0.284	*0.86*		
lnK_L94	-0.375	*-0.17*			1.010	*0.40*			0.198	*0.09*		
wagdiff94	5.103	*1.26*			-1.546	*-0.85*			-0.835	*-0.53*		
lnavwag94	2.633	*0.48*			-7.079	*-1.10*			-14.031	*-2.45***		
labconc92	-2.276	*-1.14*			2.264	*1.02*			1.720	*0.89*		
lnregindwage92	-10.761	*-1.33*			12.166	*1.28*			11.758	*1.42*		
socben_c94	0.026	*0.06*			-0.221	*-0.47*			-0.142	*-0.35*		
socben_no94	0.165	*0.29*			-1.491	*-2.26***			-0.664	*-1.13*		
inssh94	-0.183	*-3.40****	-0.288	*-9.89****	0.054	*0.86*	0.109	*3.30****	-0.013	*-0.24*	0.065	*2.25***
outsh94	-0.139	*-1.76**	-0.094	*-2.31***	-0.015	*-0.16*	-0.073	*-1.57**	0.047	*0.53*	0.044	*1.03*
constant	50.163	*1.02*	5.696	*1.47*	-17.024	*-0.32*	8.069	*1.85*	57.086	*1.17*	1.952	*0.50*
adj. R^2(%)	17.16		21.46		3.53		8.46		11.95		5.81	
no. observations	139		399		152		444		133		381	

Chapter 2

The Effects of Shareholder Disagreement under Majority Voting

2.1 Introduction

Conflicts of interests in firms may arise not only between shareholders and managers, as it is studied in most of the corporate finance literature, but also among shareholders. Proxy fights or the purchase of shares in order to gain control over a firm are evidence for different strategies of different groups of shareholders. This observation seems not to be consistent with the assumption of profit maximization as the objective of the firm — an objective on which all shareholders would agree. In this paper, we mean by control the right to decide on the level of investment of the firm. We choose a setting where differences in wealth, initial stake or preferences among shareholders matter for the investment decision and show *how* they matter. The goal is to analyze investment decisions and share trade when the owners of a firm are not unanimous.

The widespread use of profit maximization in economic models goes back to the Fisher separation theorem. According to the theorem, shareholders unanimously agree on a production plan that maximizes (expected) discounted profits, independently of their preferences and independently of the financial policy of the firm. It was formulated later for a setting with uncertainty by Modigliani and Miller (1958). However, for the theorem to hold, some important conditions have to be satisfied, such as:

1. Financial markets are complete, i.e. the rank of the payoff matrix of all assets in the economy is equal to the number of possible states of the world.[1]

2. There are no externalities between shareholders and the firm, i.e. the firm output only enters shareholders' utility functions via the dividends, not directly.

[1] This condition can be weakened by partial spanning conditions, see below.

3. There is perfect competition in the economy.

If either of the three conditions is not fulfilled, shareholders will generally not be unanimous on the firm objective. For example, under incomplete markets and conditions of uncertainty, the investment decision of a firm may alter the risk sharing possibilities in the economy, and shareholders may disagree on how to value the associated contingent payoffs. In any case, decisions have to be made using some social choice mechanism. Here we adopt a simple form of majority voting, the most frequently used mechanism to resolve disagreement among shareholders in practice.

Another motivation for the present paper comes from the observed ownership dynamics of privatized companies in Central and Eastern Europe. Control over firms was often acquired in order to extract private benefits of control, thereby expropriating minority shareholders — especially in countries with deficient corporate governance provisions or weak enforcement of the law. On the one hand, managers, who effectively controlled most firms, could increase their stake in the years after privatization. This is in contrast to shrinking managerial ownership after IPOs in Western firms.[2] On the other hand, workers who had received large ownership stakes in the privatization in several countries, but presumably did not enjoy significant private benefits, sold shares to other owners in the following years. Our model and its extensions can account for both observations.

In this paper we study the decision-making in a partnership firm with two owners with no uncertainty. Financial markets are incomplete in the sense that there are no assets in the economy with exogenously given payoffs. The only available asset to transfer wealth across time are shares of the firm. Their returns depend on the investment decision of the owners. When the owners differ in wealth, their initial stake or their disposition to substitute consumption across time, they value the returns differently, and thus prefer different amounts of investment. We assume that the decision is made by majority voting, i.e. by the majority owner. Our goal is to study how investment policy, firm value, and share trade are affected by heterogeneity among shareholders. The focus is on the conflict between minority and majority owners. Thus, we abstract from agency problems between shareholders and managers.

Outline of the model. The timing of the basic model is as follows: At time $t = 0$, initial shareholders decide on how much to invest given their initial endowments. After that, they are free to trade their shares with each other. At time $t = 1$, the production of the firm is realized and distributed according to the after-trade shares. There is no uncertainty. The financial markets are assumed to be incomplete, which in our case means that borrowing and lending are

[2]See Chapter 1 for data from a large sample of Russian manufacturing firms, and Mikkelson et al. (1997) for Western firms.

impossible. The investment decision is made by the owner whose initial stake is greater than 50 per cent.[3] The majority owner can be thought also as a (homogeneous) control group, and the minority owner as many (identical) small shareholders. Using this setup, we obtain results for the level of investment, the value of the firm, and the after-trade shareholdings. The findings are contrasted with the complete markets solution. In that case, borrowing from and lending to exogenous investors are allowed.

The main comparative statics results of the basic model are summarized as follows. The firm invests more if the controlling shareholder is relatively wealthier, *ceteris paribus*. Relative wealth is the fraction in the endowment of the consumption good that an owner receives initially. The intuition behind this result is as follows: since firm shares are the only asset in the economy, the more investment is needed if higher consumption possibilities have to be spread out over the two dates. Also, investment is higher if the controlling owner holds a smaller initial stake in the firm, *ceteris paribus*. A higher stake obliges her to finance a higher share of the investment, thus she chooses a lower level to achieve a similar consumption profile. The value of the firm is decreasing in the amount of investment since with a high level of investment one needs less shares in order to smooth out consumption over the two dates. As a consequence, the firm value is also decreasing in the relative wealth of the controlling owner and increasing in her initial stake. The final ownership stake of an owner is increasing in her relative wealth, and decreasing in her initial stake. Furthermore, an owner always acquires additional shares if her relative wealth is higher than her initial stake. In the basic model we only impose the constraint that consumption of any owner cannot be negative. It may become binding when the controlling owner is relatively rich and prefers high levels of investment which the minority owner cannot afford. In this case, all the mentioned comparative statics results are reversed.

Differences in the preferences on the intertemporal substitution of consumption between the two owners also affect the level of investment. If returns of the productive technology are relatively low or the initial endowment in the single good is high, a single owner of the firm would invest more the higher his desire for consumption smoothing is. This does however not necessarily happen in the partnership firm. Fixing the preferences of the controlling owner and increasing the desire for consumption smoothing of the non-controlling owner may decrease the level of investment: Since the non-controlling owner cannot influence the investment decision he demands more shares instead and thus drives the price up. The controlling owner exploits this mechanism setting the level of investment even lower in order to sell shares at a higher price. This is an example how the decision on investment and share trade are inter-related.

The majority owner has to take into account in her investment decision its effects on the

[3] In the case of 50 per cent ownership by both owners a seniority rule applies.

demand for shares by the non-controlling owner and the share price. But the chosen level of investment may still be unfavorable for the minority shareholder, especially if wealth or initial stakes are distributed extremely unequal. As an extension of the model, we introduce a participation constraint of the minority shareholder, i.e. he can credibly threaten to leave the firm. Alternatively, one can interpret it as a better protection of the rights of minority shareholders. Then, his/her interest has to be taken into account in the investment decision when the constraint binds. For example, if the controlling owner is very rich, the participation constraint lowers investment. It also prevents her to acquire the entire firm. In all cases where the participation constraint binds, it lowers ownership concentration as compared to the basic model. This is consistent with the empirical finding of La Porta et al. (1998) that investor protection and ownership concentration are substitutes.

In another extension of the basic model we assume that one of the shareholders has private benefits of control, i.e. she can extract a higher payoff from the firm at time $t = 1$ than what would correspond to her ownership stake. This externality between the firm and its shareholders invalidates the Fisher separation theorem for this case. Even with complete financial markets, the two shareholders do not agree on the level of investment. A higher fraction of private benefits increases investment under complete markets. In the incomplete markets model, this is only the case if the controlling owner's initial stake is higher than her relative wealth. In contrast to the basic model, there is share trade even if relative wealth and initial stake are equal. In this case, the controlling owner reduces her stake in order to smooth consumption in the presence of an extra payoff (the private benefit) at time $t = 1$.

When we further extend the model with private benefits to two periods, share trade at time $t = 0$ may change the identity of the majority owner. To our knowledge, multi-period models with a majority decision on investment and share trade in every period have not been analyzed in the literature so far. Concerning the power to decide on investment and the allocation of private benefits, we distinguish the following cases: A ("Non-transferable control") — the right to make the investment decision and private benefits always accrue to the initial majority owner no matter what the ownership distribution is, B ("Partial control") — the right to decide on investment at $t = 1$ goes to the majority owner after the first round of share trade, but private benefits stay with the original majority owner, C ("Full control via majority") — both control and private benefits are transferred to the new majority owner. We compare the results with a two-period version of the basic model without private benefits (case D). In cases B and C we observe a kind of anti-takeover behavior of the controlling owner. At values of relative wealth close to the point where the control transfer occurs, she reduces investment in order to keep her ownership stake at exactly 50 per cent. A misalignment of private benefits and control over investment as in case B is bad for investment and leads typically to lower utility of both owners

than in cases A and C. As for the ownership dynamics, the initial controlling owner acquires shares in both trading rounds if her relative wealth is not considerably smaller than her initial stake.

The assumptions of our model mimic the environment of firms in the transition countries of Eastern Europe after privatization: they had almost no access to external finance, shares were typically not traded on public stock markets with outsiders, and managers were able to extract large private benefits of control. The results of the model in terms of changes in the ownership structure can explain the observations on the dynamics of ownership in these firms mentioned at the beginning. Workers often received large ownership stakes during privatization, but can be assumed to be the least wealthy shareholders. It is therefore not surprising that they sold part of their ownership stakes as predicted by the model. Managers, however, accumulated shares in their firms together with some affiliated parties during the years following privatization. This is consistent with the finding from the two-period model with private benefits.

Related literature. This paper is related to various strands of literature. First, it relates to the literature on firm objectives under incomplete markets.[4] The production decision in a stock market economy is usually analyzed in one-period, one good models with uncertainty. One group of contributions, including seminal papers such as Diamond (1967), Ekern and Wilson (1974) and Radner (1974), formulate restrictions on the production plan of a firm, which restore the unique equilibrium of complete markets where all shareholders agree to maximize expected discounted profits. These restrictions are referred to as partial spanning conditions[5], and mean essentially that a firm cannot create an asset with a vector of contingent payoffs that is independent of existing assets in the economy. Grossman and Stiglitz (1980) show that spanning is not enough to ensure unanimity if consumers receive information on the future production of the firm after the investment decision and can trade shares on that information. With an additional competitivity assumption[6] not only unanimity is restored, but the common objective of shareholders is net value maximization — the same as under complete markets. Carceles-Poveda and Coen-Pirani (2005a) have shown conditions that imply partial spanning for the neoclassical growth model with capital and labor inputs: If the production function exhibits either constant returns to scale or is of the Cobb-Douglas type[7], and if there is a continuum of identical firms, then unconstrained shareholders are unanimous about the investment decision. Carceles-Poveda and Coen-Pirani (2005b) show in turn the conditions for equivalence between general equilibria with

[4] For extensive surveys of this literature see Drèze (1987) and Magill and Quinzii (1996, Chapter 5).

[5] Drèze (1987) shows that Diamond's assumption of multiplicative uncertainty is a special case of partial spanning.

[6] This assumption says that shareholders perceive *ex-ante* that their production decision for a particular firm does not affect the share price of other firms.

[7] St-Pierre (2005) derives a more general separability condition for the production function that yields the unanimity result.

value-maximizing firms[8] and equilibria in the setup with households renting capital to firms, which is used in the macroeconomic literature on incomplete markets (e.g. Aiyagari (1994)).

In another group of contributions, disagreement among shareholders is taken for granted, and the authors search for objective functions based on some collective decision-making mechanism. Our paper belongs to this group. It seems reasonable to look at the firm's problem when shareholders are *not* unanimous, since partial spanning conditions are quite restrictive and are not satisfied under different and equally plausible theoretical assumptions, such as: production functions with decreasing returns of other types than Cobb-Douglas, heterogeneous firms, idiosyncratic shocks to firm productivity, a finite set of firms, binding short-sale constraints or externalities. Needless to say that diverging interests of shareholders are also observed frequently in practice. Drèze (1974) and Grossman and Hart (1979) introduce side payments, such that shareholders favoring a new production plan may compensate the others for incurred losses. This leads to a criterion to find the optimal investment that is based on contingent future profits discounted by a weighted average of shareholders' stochastic discount factor (present value vector). Both papers differ in giving the decision making power to initial (Grossman-Hart) or after-trade shareholders (Drèze), and the weights are given accordingly by the initial or final stakes. If initial shareholders make the investment decision in a one-period model, they have to take into account the effect of the investment decision on the share price. Therefore, this setup extends more easily to several periods. The timing in our basic model and equilibrium definitions follow mainly Grossman and Hart (1979). However, instead of the possibility of side-payments between shareholders we assume that decisions are made by majority voting.

Several authors have included voting among shareholders in their models of stock market economies. Drèze (1985) assigns decision making power to a control group, which consists of a subset of shareholders or other stakeholders. Production decisions must be approved unanimously by a control group and a by majority of shareholders. Existence of an equilibrium of production and exchange can be shown (Drèze, 1989). A general proof of existence of equilibria in economies where firms' decisions are made by a collective choice of shareholders is given in Kelsey and Milne (1996). Possible decision rules include veto power of a control group and generalized median voter rules. DeMarzo (1993) characterizes equilibria resulting from majority voting of shareholders and shows that these imply that production is optimal for the largest shareholder. In our model we intend to be more specific about the effects of different interests among shareholders on investment, share prices and the change in the stakes of each owner.

A second strand of literature, which is related to our paper, deals with ownership structure under the presence of a large shareholder (see Admati et al. (1994) for a static, and DeMarzo

[8] That requires unanimity among shareholders in the control group.

and Urošević (2006) for a dynamic setup). These papers model a tradeoff between the desire for diversification and shared benefits of control of a large shareholder. Payoffs are influenced by the monitoring effort of the large shareholder. Edelstein et al. (2005) add private benefits of control to this setup. Instead of assuming individual effort with an instantaneous payoff, we explicitly model production, which takes time (one period), and requires a collective decision on the amount of investment (the main interest of this paper).

Third, our paper is related to the literature on corporate governance, as summarized in Bolton et al. (2003) and Shleifer and Vishny (1997). We investigate the effects of different corporate governance rules, such as the protection of minority shareholders (section 2.3.1) and different rules for the allocation of private benefits of control (section 2.3.3). Massa and Simonov (2005) study the relation between shareholder composition and the value of the firm. They find that the degree of shareholder homogeneity in beliefs on the true firm value affects firm value positively. In our model, differences of interest among shareholders do not stem from asymmetric information, but rather from differences in endowments or preferences. Homogeneity, i.e. identical endowment or preferences, does in general not maximize investment or the firm value in our model.

Lastly, we contribute to the literature on financing imperfections and firm investment, as summarized in Hubbard (1998). Our paper suggests that in the presence of financial constraints, not only information costs and internal funds of the firm, but also the wealth, initial stake, and preferences of the firm owners determine the investment decision.

Organization of the paper. The paper is organized as follows: Section 2.2 presents the basic model. Subsection 2.2.1 states the model assumption and subsection 2.2.2 introduces the notions of an exchange equilibrium and an production-exchange equilibrium. Subsection 2.2.3 analyzes the model for the case when owners differ in their initial wealth and ownership stakes. The main proposition states how initial endowments affect the investment decision, the firm value and after-trade ownership stakes. We contrast the results with a model of complete markets (developed in Appendix B), where the owners can borrow from and lend to exogenous investors. Subsection 2.2.3 analyzes the model for the case when owners differ in their preferences on intertemporal substitution of consumption. Section 2.3 extends the model in several dimensions. In subsection 2.3.1 we introduce a participation constraint and determine numerically optimal investment, firm value, and ownership stakes, with and without the additional constraint. We consider both differences among shareholders in their initial endowments and in their preferences on intertemporal substitution. Subsection 2.3.2 introduces private benefits of control and analyzes the model in one period, both for complete and incomplete markets. In neither setup the Fisher separation theorem holds, but the effects of private benefits on the

investment decisions are different. Subsection 2.3.3 presents the model with private benefits in two periods, with repeated production and trading. Section 2.4 concludes. Appendix A contains all longer proofs of propositions and details of calculations. Appendix B develops a complete markets version of the basic model and confirms that the Fisher separation theorem holds in this setup. Appendix C analyzes the basic model with a more general utility function.

2.2 The basic model

2.2.1 Model formulation

We analyze the problem of different shareholder interests in a deterministic model. There are two dates, 0 and 1. The technology is defined by a a Cobb-Douglas production function, which related a single input y_0 to output y_1:

$$-y_0 = k \ ; \ y_1 = Ak^\alpha \tag{2.1}$$

where $\alpha \in (0,1)$, and $A > 0$ is a constant indicating the level of technology. k represents the initial capital investment.

There is one firm in the economy with two owners, indexed by $i = 1, 2$. Each owner i is endowed initially with a share in the firm $\bar{\theta}^i \in (0,1)$. The total number of shares is normalized to one, i.e. $\bar{\theta}^1 + \bar{\theta}^2 = 1$. The only asset that can be used to transfer wealth between the two dates are the shares of the firm. Every owner also has an initial endowment in the (sole) consumption good ω^i. Let ω denote the aggregate endowment, and let owner 1 receive the fraction $\beta \in [0,1]$ of this endowment. That is, the initial wealth of the two owners is given by $\omega^1 = \beta\omega$ and $\omega^2 = (1-\beta)\omega$. We call β the relative wealth of owner 1, and $1-\beta$ the relative wealth of owner 2. The timing of actions is depicted in the following figure.

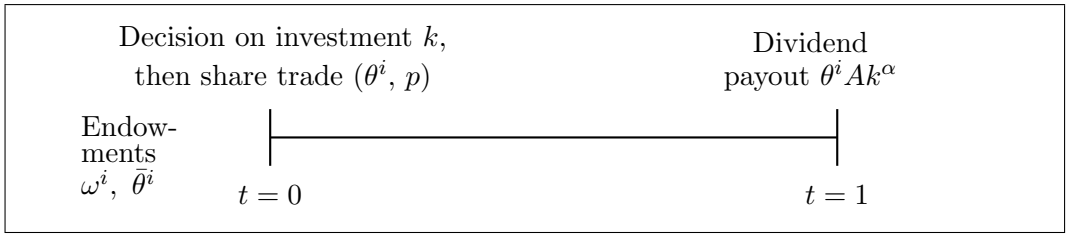


Figure 2.1: *Time line of the basic model*

The initial investment k is financed proportional to the initial ownership stakes $\bar{\theta}^i$, $i = 1, 2$. After that, the owners may trade their shares at market value p. The post-trade ownership stakes are denoted by θ^i. The budget constraint for time $t = 0$ reads

$$c_0^i = \omega^i + \left(\bar{\theta}^i - \theta^i\right) p - \bar{\theta}^i k \tag{2.2}$$

In words, owners allocate their endowments and the net proceeds from share trade to consumption and investment. Afterwards, at time $t = 1$, the owners consume the dividends of the firm according to their stakes after trade, so the budget constraint for date 1 reads

$$c_1^i = \theta^i A k^\alpha \tag{2.3}$$

We follow Grossman and Hart (1979) in placing the decision on a production plan in the hands of the initial shareholders. In a one-period model, initial owners take into account the effect of the production decision on the share price, while post-trade (final) shareholders would not. This setting can be more easily extended to more than multiple periods — final shareholders would then be the initial shareholders in the next period, and would have to be treated like initial shareholders in a one-period model, i.e. the effect of their investment decision on the value of the firm has to be taken into account.

This model is an incomplete market model in the following sense: there is one state of the world at date 1, but there is no asset with exogenously given payoff.

The utility function is assumed to be logarithmic.[9] The expected utility function for owner i is time-additive and reads

$$U^i = \ln c_0^i + \delta \ln c_1^i \tag{2.4}$$

where δ is the (objective) discount factor.

2.2.2 The notion of equilibrium

In this section, we provide the tools for the analysis of the model outlined above. Substituting the constraints (2.2) and (2.3) into the expected utility function (2.4) leads to the following objective function

$$U^i = \ln \left[\omega^i + \left(\bar{\theta}^i - \theta^i\right) p - \bar{\theta}^i k\right] + \delta \ln \left[\theta^i A k^\alpha\right] , \quad i = 1, 2 \tag{2.5}$$

We solve the model backward in time, starting with the decision on the optimal ownership stakes. Therefore, we define first the notion of an exchange equilibrium.

Definition 1 (Exchange equilibrium). For a given investment plan k, given initial endowments of the consumption good $(\omega^i), i = 1, 2$ and initial shareholdings $(\bar{\theta}^i), i = 1, 2$, an exchange equilibrium is the pair of vectors of consumption and ownership stakes in the firm $(c^i, \theta^i), i = 1, 2$ and a firm market value p, such that (i) owners $i = 1, 2$ maximize (2.5) with respect to θ^i, and (ii) the market for shares clears, i.e. $\theta^1 + \theta^2 = 1$.

[9] Appendix C presents the basic model with the constant relative risk aversion utility function which includes log utility as a special case.

The definition implies that owners are price-takers. One way to motivate it, is to think of the two owners as many owners of two types.[10] From (i) and (ii), we get the optimal stakes of the two owners as well as the firm value as functions of the level of investment k. By substituting these functions into (2.5) we obtain the indirect utility functions $V^i(k)$, $i = 1, 2$.

The next step is to go from the exchange equilibrium with a fixed production plan to a production equilibrium. In our model, as we will show in section 2.2.3, there is no unanimity among shareholders about the optimal level of investment. For this reason, we have to specify the decision making within the firm.

We do not follow a normative approach, rather we assume that majority voting is the rule. In our model, this means that one of the partners decides, and without loss of generality we assume that $\bar{\theta}^1 \geq 0.5$. For the limiting case of $\bar{\theta}^1 = \bar{\theta}^2 = 0.5$ we assume that the "senior" owner 1 decides. Then the optimal investment decision is the result of the following maximization problem

$$\max_k V^1(k) \quad \text{s.t.} \quad c_t^i \geq 0\,, \quad i = 1, 2\,, \quad t = 0, 1 \qquad (2.6)$$
$$\text{and budget constraints (2.2) and (2.3)}$$

Owner 1 decides on the production plan subject to non-negativity constraints for consumption of each owner at time $t = 0$ and the budget constraints. Note that these constraints imply that investment k lies between zero and the total endowment ω.[11] We are now able to define a production-exchange equilibrium.

Definition 2 (Production-exchange equilibrium). For given initial endowments of the consumption good $(\omega^i)\,, i = 1, 2$ and initial shareholdings $(\bar{\theta}^i)\,, i = 1, 2$, a production-exchange equilibrium is a pair of vectors of consumption and and ownership stakes in the firm $(c^i, \theta^i)\,, i = 1, 2$, a firm market value p and a level of initial investment k, such that the conditions (i) and (ii) of the exchange equilibrium are satisfied, and (iii) the majority owner chooses a level of initial investment k that solves (2.6).

2.2.3 Analysis for owners with different initial endowments

In this section, we allow for differences between owners in the endowments only, and investigate their impact on investment, firm value and after-trade ownership stakes. Solving for the **exchange equilibrium** provides us expressions for the firm value (price of a 100 per cent stake

[10] The reader may want to check with equation (2.9) that if initial endowments and stakes are split equally among with n owners of the same type, also the after-trade ownership stake of each individual is the n-th part of the after-trade ownership stake. Thus, there is no problem of aggregation.

[11] To see this, note that from (2.2), $c_0^1 + c_0^2 = \omega - k \geq 0$. Even if $c_0^2 = 0$, owner 1 chooses a level of investment such that $c_0^1 > 0$ since zero consumption would give the lowest possible level of utility. It follows that $\omega - k > 0$.

in the firm) and the optimal ownership stake of each owner as functions of investment:[12]

$$p(k) = \delta(\omega - k) \tag{2.7}$$

$$\theta^i(k) = \frac{\omega^i + \bar{\theta}^i(p(k) - k)}{\omega + p(k) - k} \tag{2.8}$$

$$= \frac{\omega^i + \bar{\theta}^i\left(\delta\omega - (1+\delta)k\right)}{(1+\delta)(\omega - k)} \tag{2.9}$$

Note that the price is a negative function of investment. A high level of investment means that one needs less shares in order to smooth out consumption over the two dates. Hence, with an increasing amount of investment, demand for shares and their price go down. As discussed in Appendix C for the class of CRRA preferences, this is true only if the elasticity of intertemporal substitution is not too high. For owners which are nearly risk-neutral (i.e. whose elasticity is very large), investment affects the firm value positively.

The following proposition gives a simple condition when owners sell or buy additional shares in the trading stage.

Proposition 1. An owner acquires (sells) shares whenever her relative wealth is higher (smaller) than her initial ownership stake. In the case of owner 1 this condition is $\beta > \bar{\theta}^1$ ($\beta < \bar{\theta}^1$). For $\beta = \bar{\theta}^1$, no share trade takes place.

Proof. We use (2.9) to write the change in the asset position of owner i

$$\theta^i(k) - \bar{\theta}^i = \frac{\omega^i - \bar{\theta}^i\omega}{(1+\delta)(\omega - k)}$$

For owner 1, this is

$$\theta^1(k) - \bar{\theta}^1 = \frac{(\beta - \bar{\theta}^1)\omega}{(1+\delta)(\omega - k)} \tag{2.10}$$

This expression is positive (i.e. owner 1 acquires shares) whenever $\beta > \bar{\theta}^1$.[13] The other cases follow similarly. ■

In order to solve for the **production-exchange equilibrium** we have to find the optimal level of initial investment. As stated in problem (2.6) we maximize the indirect utility function of the controlling owner, owner 1 (since by assumption $\bar{\theta}^1 \geq 0.5$):

$$V^1(k) = \ln\left[\beta\omega + \left(\bar{\theta}^1 - \theta^1(k)\right)p(k) - \bar{\theta}^1 k\right] + \delta \ln\left[\theta^1(k) A k^\alpha\right] \tag{2.11}$$

We characterize first the interior solution where the non-negativity constraints for consumption do not bind. Intermediate steps of the calculations are given in Appendix A.2. The first-order

[12] More details of the calculations are given in Appendix A.1.

[13] Note that the denominator is always positive since $k < \omega$.

condition yields a quadratic equation characterizing the unconstrained optimal investment with the solution

$$k^{int} = \left(-\frac{P}{2} - \sqrt{\frac{P^2}{4} - Q} \right) \omega \tag{2.12}$$

where

$$P = \frac{(1-\alpha)\beta}{(1+\delta)(\delta^{-1}+\alpha)\bar{\theta}^1} - \frac{1+2\delta}{1+\delta} \tag{2.13}$$

$$Q = \frac{\alpha(\beta+\delta\bar{\theta}^1)}{(1+\delta)(\delta^{-1}+\alpha)\bar{\theta}^1} \tag{2.14}$$

At corner solutions, the level of investment k is determined such that consumption at date $t = 1$ of the non-controlling owner 2 is equalized to zero.[14] We obtain

$$k^{constr} = \frac{1-\beta+\delta\left(1-\bar{\theta}^1\right)}{\left(1-\bar{\theta}^1\right)(1+\delta)}\,\omega \tag{2.15}$$

The constraint of non-negative consumption is binding whenever the level of investment k, optimally chosen by owner 1, is higher than or equal to the level that leads to zero consumption of owner 2 at time $t = 1$. That is, the condition for the constraint to bind is

$$-\frac{P}{2} - \sqrt{\frac{P^2}{4} - Q} \geq \frac{1-\beta+\delta\left(1-\bar{\theta}^1\right)}{\left(1-\bar{\theta}^1\right)(1+\delta)} \tag{2.16}$$

Equations (2.12) to (2.16) fully characterize the production-exchange equilibrium of the basic model of incomplete markets.

Appendix B shows the results of a model with complete markets. There, we make the same assumptions as we do here, except that owners are allowed to borrow from or lend to exogenous investors at some given interest rate. Since the Fisher Separation theorem holds in that setting, investment does not depend on any individual characteristics of the owners. It only depends on the technological parameters and the interest rate. In contrast, in the model of incomplete markets analyzed here, the desired level of investment of owner 1 depends on her relative wealth β and the initial stake $\bar{\theta}^1$. A similar condition holds for owner 2, and since endowments may be different across owners, both optimality conditions will in general not coincide. Therefore, shareholders do not agree on how much to invest. Note also that the firm value is an increasing function of investment if markets are complete, but a decreasing function in our model. Lastly, ownership stakes are determined in our model, but indeterminate under complete markets.

Example 1 (Proportional endowments). Consider the special case where relative wealth and initial ownership stake coincide, i.e. $\beta = \bar{\theta}^1$. We know from Proposition 1 that in this case

[14] It turns out that if the constraint of non-zero consumption at time $t = 0$ binds, so does the constraint of non-zero consumption at time $t = 1$. Thus, only the latter one has to be taken into consideration. Also we will show below that the constraints for owner 1 do never bind. See Appendix A.2.

there is no share trade in equilibrium, i.e. $\bar{\theta}^1 = \theta^1$. The indirect utility function for owner i then simplifies to

$$\begin{aligned} V^i(k) &= \ln\left[\bar{\theta}^i(\omega - k)\right] + \delta \ln\left[\bar{\theta}^i A k^\alpha\right] \\ &= \ln(\omega - k) + \delta\alpha \ln k + \delta \ln A + (1+\delta)\ln\bar{\theta}^i \end{aligned}$$

The last term is just a constant, so the optimal level of investment k does not depend on the individual variables β and $\bar{\theta}^1$ in this special case. Thus, shareholders will be unanimous. The optimal level of investment is given by $k = \frac{\alpha\delta}{1+\alpha\delta}$. ■

How do differences in the endowments of cash and shares between the two owners influence the optimal level of investment k, the firm value p and the stake of each owner in the firm after trade? In the following proposition we state some comparative statics results and use them to further characterize the solution.

Proposition 2. At interior solutions to the production-exchange equilibrium,
(i) the optimal level of investment k is an increasing function of the relative wealth of the controlling shareholder, β, and a decreasing function of her initial ownership stake, $\bar{\theta}^1$,
(ii) the value of the firm p is decreasing in β, and increasing in $\bar{\theta}^1$, and
(iii) the after-trade ownership stake of owner 1, θ^1, is increasing in β, and decreasing in the initial ownership stake $\bar{\theta}^1$.

(iv) At corner solutions, all comparative statics results in (i) and (ii) are reversed. The after-trade ownership stake of owner 1 is constant and equal to one.
(v) The non-negativity constraint for consumption of owner 2 at time $t = 1$ can be binding only if $\beta > \bar{\theta}^1$. Given this, it is more likely to be binding the higher is β, and the lower is $\bar{\theta}^1$.
(vi) The non-negativity constraints for consumption of the controlling owner 1 are never binding.

Proof. See Appendix A.3. ■

Part (i) says simply that as owner 1 becomes relatively richer, she can afford to save and invest more for tomorrow's consumption. As for the effect of the initial ownership stake, there are two effects at work. First, a higher $\bar{\theta}^1$ means that owner 1 has to put a higher fraction of investment. In order not to drive down consumption today, she chooses a smaller k. Second, when $\bar{\theta}^1$ is higher, owner 1 can sell shares to owner 2 and use the revenues for consumption and investment. This effect leads to a higher k. It turns out that in equilibrium the first effect dominates.

A similar result is obtained in the model of a monopolistic firm in general equilibrium by Yalcin and Renström (2003). If the relative labor endowment of a shareholder is equal to his

initial stake, he wants the firm to act as a competitive firm. If the relative labor endowment of a shareholders is higher (lower) than his initial stake he prefers a higher (lower) level of production than the competitive level.

Part (ii): Recall that in our model, the value of the firm is a decreasing function of investment. As owner 1 becomes relatively richer (β increases), she invests more while owner 2 would prefer less. Thus, shares are worth less to owner 2, and the price goes down.[15] As shown in Appendix C, the price may be increasing in the level investment and thus with β only if owners' readiness to substitute consumption across time is very high.[16] In this case owners take advantage of a very productive technology and tolerate to consume few amounts initially.

Part (iii): The parameters β and $\bar{\theta}^1$ affect the after-trade ownership stake of owner 1 both directly and indirectly via their effect on the optimal level of investment, see equation (2.10). As for relative wealth β, a higher value has a direct positive effect on the after-trade ownership stake. Since it also affects investment positively, which in turn affects the final ownership stake, the indirect effect depends on the sign of $\beta - \bar{\theta}^1$. It is positive if $\beta > \bar{\theta}^1$ and negative if $\beta < \bar{\theta}^1$. For this last case, however, it turns out that the direct effect is dominant in equilibrium, such that β affects the final stake of owner 1 positively for all possible values of β.

Part (iv): If the non-negativity constraint for consumption of owner 2 at date $t = 1$ binds, it forces the controlling owner to lower investment, and more so the higher is her relative wealth or the lower is her initial stake. This implies for the price of shares that with increasing relative wealth of owner 1, shares become more attractive again to owner 2, and the price increases. The corner solution always implies that the controlling owner acquires the entire firm in the trading round.

Part (v): We can have corner solutions only if owner 1's relative wealth is higher than her initial stake. The larger this difference, the higher is the desired level of investment of owner 1 until it reaches a level where the poorer owner 2 cannot afford it since his consumption would go to zero.

Part (vi): Owner 1 will never choose investment levels that drive her own consumption to zero at any date, and it turns out that this is neither the case at corner solutions. Effectively, the only constraint that has to be taken into account is the non-negativity constraint of date $t = 1$ consumption of owner 2.

Numerical solutions that take the non-negativity of consumption and further constraints into account are presented in section 2.3.1.

[15] Recall that share trade takes place after the investment decision.

[16] Within the class of CRRA utility functions, the parameter of relative risk aversion has to be near zero, and in any case lower than 1 (corresponding to log utility).

2.2.4 Analysis for owners with different preferences on intertemporal substitution

In addition to their wealth, the owners can differ in their willingness to substitute consumption between the two dates. Different preferences on intertemporal substitution generate, in general, disagreement among owners about the preferred level of investment.[17] In this section, the preferences of the controlling owner 1 are described as before by log utility, but owner 2's preferences are given by a CRRA utility function with coefficient of relative risk aversion $\gamma \geq 0$. For values of γ smaller than 1, owner 2 is more willing to substitute consumption at one date by consumption at the other date, and for values of γ larger than 1, he would have a stronger interest of smoothing consumption across time as compared to owner 1.[18] Appendix A.4 lists the demand functions for shares of the two owners and an implicit expression for the value of the firm $p(k)$. The value of the firm and the optimal level of investment k are found numerically.

How do investment, and consequently firm value and ownership stakes, depend on differences in preferences, in particular on the value of γ in the utility function of owner 2? The answer depends on how the preferred level of investment of owner 2 changes with γ. For a relatively unproductive technology (low A) and a high level of the endowment ω, the preferred investment is an increasing function of γ: an owner with no interest in consumption smoothing will invest low amounts since returns are low, but an owner with a higher γ would invest higher fractions of the endowment in order to smooth consumption across time. In contrast, preferred investment will be decreasing if returns are high and the endowment is relatively small. An exact condition is given at the end of Appendix C.

To see how differences in preferences affect the outcomes in the partnership firm, we conduct a numerical analysis. We assume that the two owners are equally endowed with shares and the consumption good, i.e. $\bar{\theta}^1 = \beta = 0.5$, in order to isolate the effects of different endowments from differences in preferences. We look both at the case where the preferred investment of owner 2 is increasing in γ (we let $A = 1$) and where it is decreasing ($A = 2$). The rest of the parameter values are set at $\omega = 1$, $\alpha = 0.5$ and $\delta = 0.99$. The following graphs display the endogenous variables of the model, investment k, firm value p and share purchase of owner 1, $\theta^1 - \bar{\theta}^1$, as functions of different values of γ in the utility function of owner 2. The first row of graphs refers to the case where $A = 1$ and the second to $A = 2$.

Consider first the case of relatively low returns where owner 2 (if he were the sole owner of the firm) would increase investment the higher the value of γ is in his utility function – depicted in the first row of graphs. If $\gamma > 1$, owner 2 has a stronger preference for consumption smoothing

[17] This can be seen from the optimality condition for investment when both owners have CRRA utility functions, see appendix C.

[18] The elasticity of intertemporal substitution is given by $1/\gamma$.

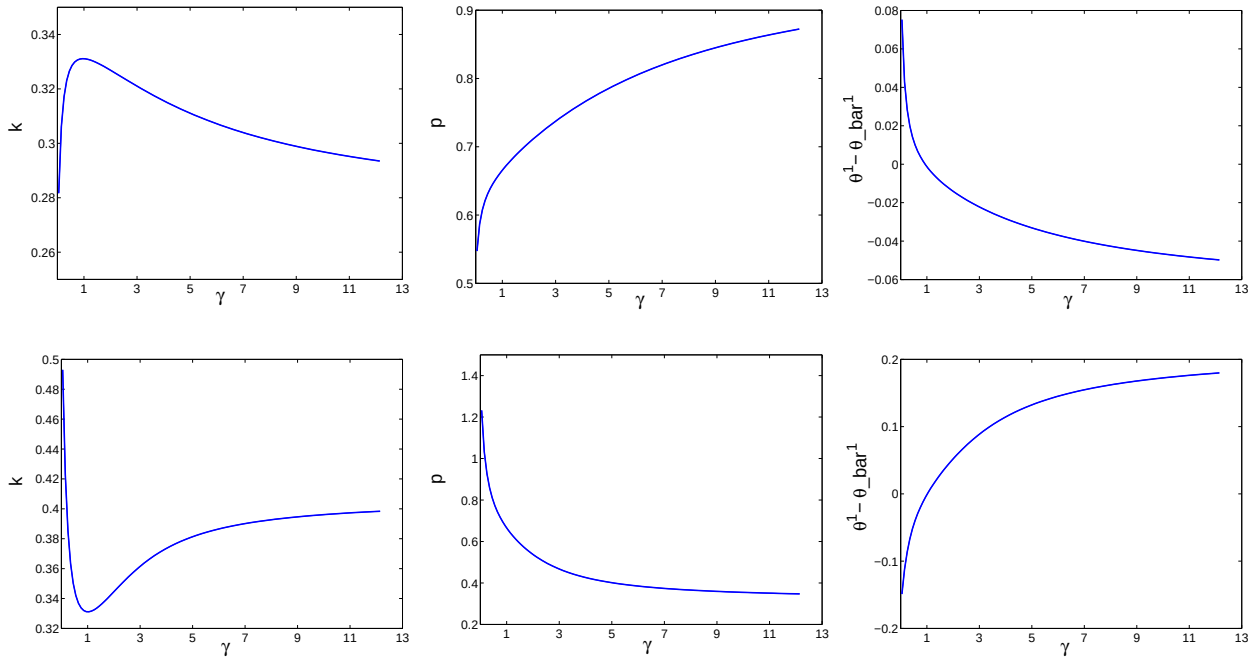


Figure 2.2: *Optimal investment k, firm value p and the purchase of shares by owner 1 ($\theta^1 - \bar{\theta}^1$), as functions of the value of γ in the utility function of owner 2. First row of graphs: $A = 1$, second row: $A = 2$.*

than owner 1, and he would like to invest more than the latter. But since he cannot influence the decision directly, he instead demands more shares, and drives the price up. The controlling owner exploits this mechanism and sets k even lower (as γ increases) in order to sell shares at a higher price. Here we have an example how the decision on investment and share trade are inter-related. In the case where $\gamma < 1$, i.e. owner 2 is more willing to substitute consumption across time than owner 1. The controlling owner 1 decides to invest low amounts (since the technology offers relatively low returns) and acquires shares in order to smooth consumption. The level of investment is however above the preferred level of owner 2 to make the latter sell at a lower price. As a result, the level of investment is highest when shareholders have the same preferences ($\gamma = 1$) and are therefore unanimous.

Exactly the opposite occurs when the technology offers relatively high returns (see the second row of graphs). With increasing desire for consumption smoothing (increasing γ), owner 2 would like to invest less, but owner 1 invests more if $\gamma > 1$ and as γ increases. The result is that owner 2 has to sell shares at a low price if he wants a more or less equalized consumption profile over time. Investment reaches a minimum when shareholders are unanimous.

Example 2 (Infinite elasticity of substitution). It is interesting to calculate the limiting case where owner 2 is completely indifferent between consuming today or tomorrow ($\gamma = 0$). In this case, there is only one price at which owner 2 has a finite demand for shares: $p = \delta A k^{\alpha}$. At this price he is indifferent between any amount of shares. The after-trade ownership stake of

owner 1 as a function of k is given by

$$\theta^1(k) = \frac{\beta\omega + \bar{\theta}^1(\delta A k^\alpha - k)}{(1+\delta)Ak^\alpha}$$

where we substituted the price above into the demand function for shares (equation 43) in appendix A.4. This yields an indirect utility function for owner 1 of the following form

$$V^1(k) = (1+\delta)\ln\left[\beta\omega + \bar{\theta}^1(\delta A k^\alpha - k)\right] - \ln[1+\delta]$$

which leads to the investment rule $k = (\delta A\alpha)^{\frac{1}{1-\alpha}}$. This, however, is the same result as if both owners had $\gamma = 0$ (see Appendix C for a discussion). So whenever one owner is completely indifferent between consuming today or tomorrow, there is unanimity about the preferred level of investment. Furthermore, the other owner can smooth consumption perfectly since the owner with infinite elasticity is indifferent between any amount of shares held (as long as consumption is positive). ■

2.3 Extensions

In this section, we extend the basic model in several ways. First, we give an outside option to the minority shareholder, which improves his bargaining position. So far, differences of interest between shareholders and changes in the ownership distribution were derived without referring to asymmetric information or moral hazard problems. In a second extension, we assume that one of the owners is able to extract a constant share of profits as private benefits of control. This model is also extended to two periods (three dates).

2.3.1 Participation constraint

Giving the controlling shareholder all decision rights ignores the bargaining power of minority shareholders. In this extension, we assume that the minority shareholder can vote with his feet, which means that he can make a credible threat to leave the firm. In particular, we assume that both owners are needed to operate the firm technology.[19] The outside option is a single proprietor firm with a somewhat inferior technology. It is given by

$$-y_0 = m \;\; ; \;\; y_1 = m$$

and yields some reservation utility to each owner U^i_{Res}, specified below. In this section we assume $A = 1$, and normalize the aggregate endowment $\omega = 1$ such that $k < 1$. With these assumptions, the output of this technology is strictly inferior to the output of the partnership

[19] We have to exclude the possibility that it is in the interest of the controlling owner to operate the firm alone. For instance, suppose that some human capital inputs of both owners are necessary for the partnership firm. Alternatively, we could assume a minimum level of investment, which is needed to operate the firm.

technology for the same level of investment. It may still be preferred by the minority shareholder if the investment decision of the controlling shareholders implies an unfavorable consumption profile over time. The production-exchange equilibrium with participation constraint is defined as before, but in addition the participation constraints of both owners are taken into account, such that owner 1's investment problem reads now:

$$\begin{aligned} \max_k V^1(k) \quad \text{s.t.} \quad V^i(k) &\geq U^i_{Res}\,, \quad i=1,2 \\ c^i_t &\geq 0\,, \quad i=1,2\,, \quad t=0,1 \\ &\text{plus budget constraints (2.2) and (2.3)} \end{aligned} \tag{2.17}$$

Differences in initial endowments

The goal in this section is to see how investment, share price and the after-trade ownership stake of each shareholder are affected by differences in owners' endowments of the consumption good and initial stakes, and how the outcome is influenced by the presence of the participation constraint.

Using the expected utility function (2.4) and the budget constraints $c^i_0 = \omega^i - m^i$ and $c^i_1 = m^i$, we can specify the optimal amount of investment in the outside technology of each owner, $m = \frac{\delta}{1+\delta}\,\omega^i$. This implies a reservation utility $U^i_{Res} = \ln\left(\frac{1}{1+\delta}\,\omega^i\right) + \delta \ln\left(\frac{\delta}{1+\delta}\,\omega^i\right)$. We conduct a numerical analysis of the model with the following parameters: $\omega = 1$, $A = 1$, $\delta = 0.99$ and $\alpha = 0.5$. In the left graph of each of the following three figures, we let the the relative wealth of owner 1, β, vary between 0 and 1 while the initial ownership stake $\bar{\theta}^1$ is fixed at 0.5. In the right graph of each figure, we let $\bar{\theta}^1$ vary between 0.5 and 1 while β is fixed at 0.5. The solid lines correspond to the model with participation constraint, in particular to problem (2.17). The dotted lines represent the solution to the basic model with non-negativity constraints for consumption only, i.e. the solution to problem (2.6).

Figure 2.3 shows the optimal level of investment in each case. At very low values of β, owner 1 would like to invest very small amounts. In this case, however, the richer owner 2 would prefer the outside option. Thus, the participation constraint of owner 2 imposes some minimum value of investment. At high values of β, some maximum value of k is imposed - not only by the participation constraint of owner 2, but later on also from the non-negativity constraint for consumption at $t = 1$ of owner 2 (he could not afford as high a level of investment as owner 1 would prefer). As for the effect of the initial share distribution, we mentioned in the discussion of Proposition 2 the two effects that are at work here. We see that the level of investment k is decreasing with owner 1's initial stake since she has to put a higher fraction of investment — this is the first and dominant effect. On the other hand, a higher stake gives extra revenue in the share trade that can be used for consumption and investment. We observe that individual

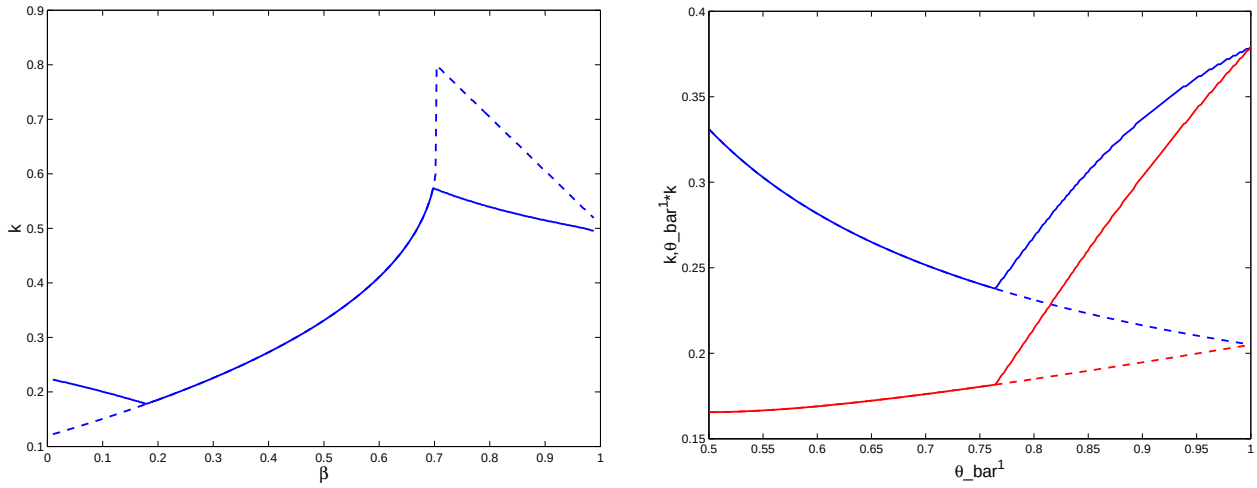


Figure 2.3: *Left graph: Optimal investment k as a function of owner 1's share of the endowment in the consumption good β ($\bar{\theta}^1$ is fixed to 0.5). Right graph: Optimal total investment k (upper line) and individual investment expenditure of owner 1 $\bar{\theta}^1 k$ (lower line) as a function of owner 1's initial stake $\bar{\theta}^1$ (β is fixed to 0.5). The dotted lines are the solution problem without participation constraint.*

investment expenditure of owner 1, $\bar{\theta}^1 k$, is increasing in the initial stake for most of its values. For high values of $\bar{\theta}^1$, the participation constraint of owner 2 is binding, and total investment has to go up in order to transfer a sufficient amount of wealth from date 0 to 1 for owner 2.

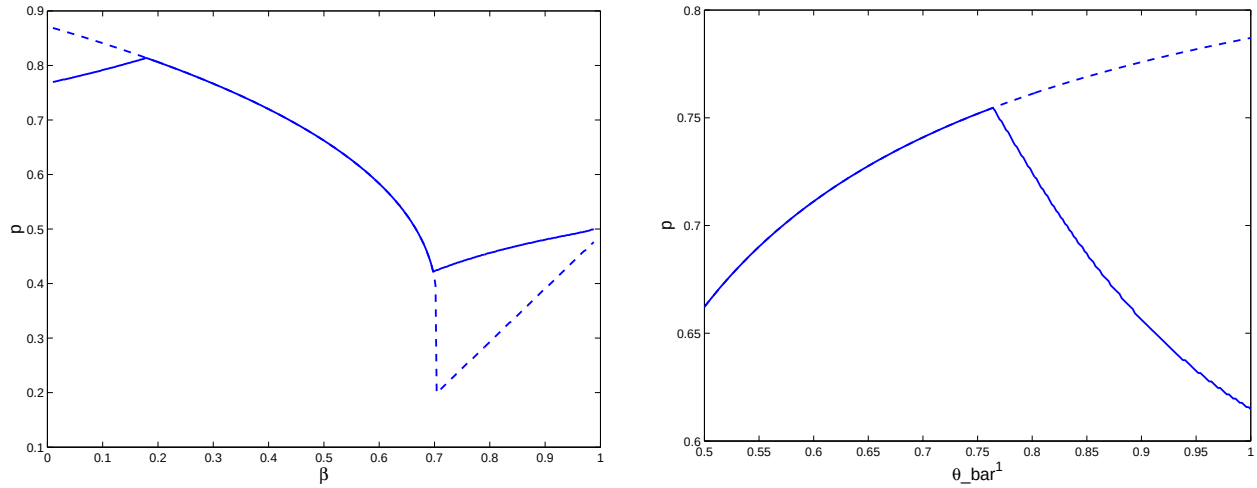


Figure 2.4: *Equilibrium firm value p as a function of owner 1's share of the endowment in the consumption good β (left graph) and as a function of owner 1's initial stake $\bar{\theta}^1$ (right graph).*

Figure 2.4 plots the firm value (the price of all shares). As stated in Proposition 2, the firm value is decreasing in the relative wealth position of the controlling owner. This relation is reversed at extreme values of β since the investment decision is bound by the participation constraint of owner 2. At high initial stakes of owner 1, investment is increased due to the participation constraint, and the share price falls.

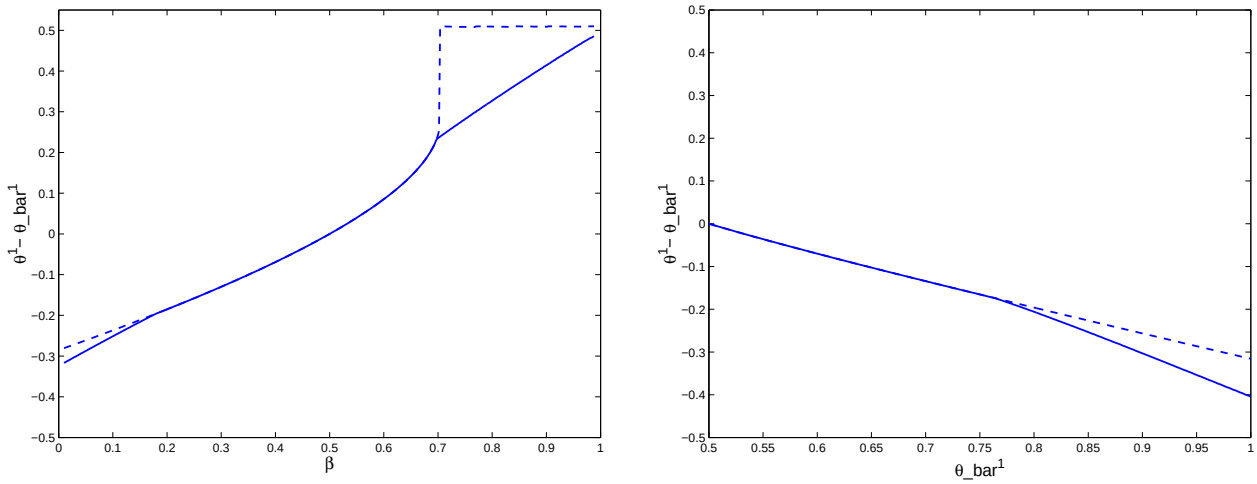


Figure 2.5: *Equilibrium purchase of shares by owner 1 ($\theta^1 - \bar{\theta}^1$) as a function of owner 1's share of the endowment in the consumption good β (left graph) and as a function of owner 1's initial stake $\bar{\theta}^1$ (right graph).*

Finally, Figure 2.5 shows the net purchase of shares by owner 1. It illustrates the result in Proposition 1: the final stake of owner 1 should increase whenever her relative wealth β is higher than her initial stake in the company $\bar{\theta}^1$ (note that the latter is fixed to 0.5 in the left graph of the figure). The participation constraint prevents owner 1 from acquiring the entire firm in the trading round if she is relatively rich. Also, it slows down the sale of shares by owner 1 if she holds high stake initially, but her relative wealth position is lower. That means that the participation constraint lowers the concentration of ownership as compared to the basic model whenever it binds. This is consistent with the empirical finding of La Porta et al. (1998) that investor protection and ownership concentration are negatively correlated, even after controlling for GNP per capita, GNP as a proxy for average firm size, and Gini coefficient of income. The authors' interpretation is that both mechanisms are substitutes in serving the purpose of controlling self-interested managers. In our model, however, it is the different endowments and preferences of shareholders that may lead to an increase of ownership concentration.

Differences in preferences on intertemporal substitution and in endowments

As we have seen in section 2.2.4, different utility functions of the two owners, in general, create disagreement on the preferred level of investment. In the numerical solution with equal endowments presented there, the differences of interest do not become so large as to make the participation constraint binding. Here we look at the interaction of different endowments in the consumption good and different preferences on intertemporal substitution. Appendix A.4 contains details of the calculations and the reservation utilities of both owners. The following two sets of graphs in Figure 2.6 present the case where $\beta = 0.65$ (first row) and $\beta = 0.35$ (second

row). The initial stakes of both owners are 0.5.

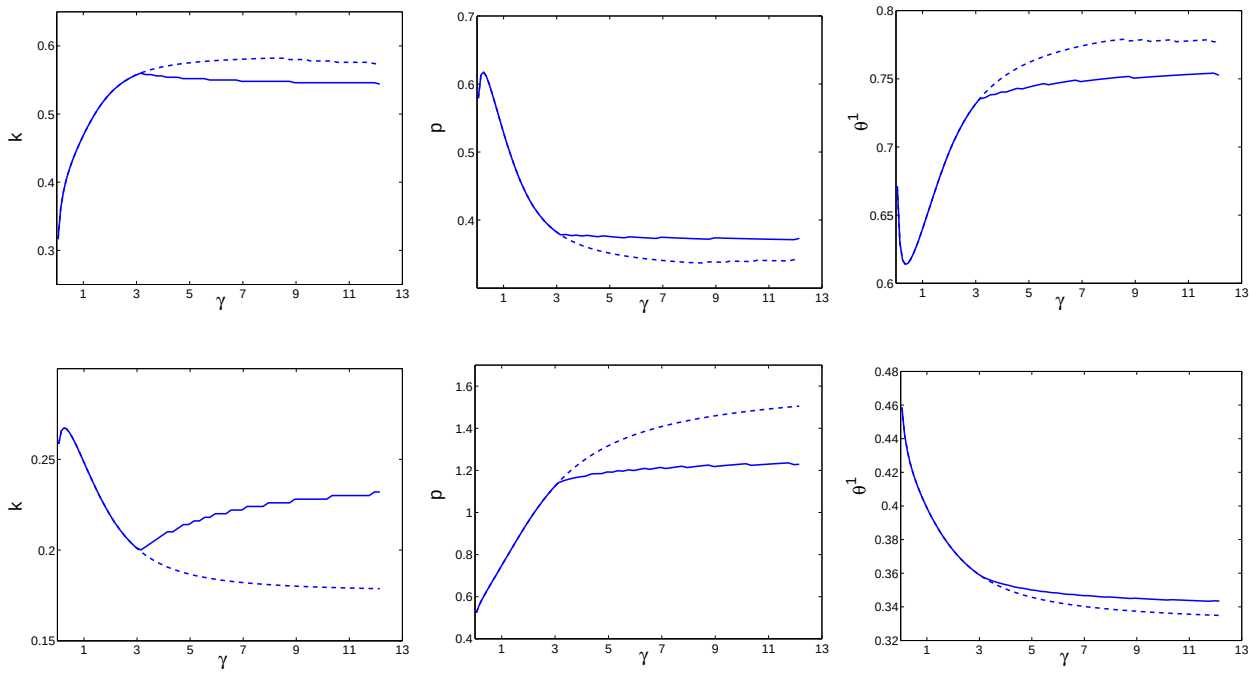


Figure 2.6: *Optimal investment k, firm value p and the ownership stake of owner 1, θ^1 as functions of the value of γ in the utility function of owner 2. First row of graphs: $\beta = 0.65$, second row: $\beta = 0.35$. In each case, $\bar{\theta}^1 = 0.5$. The dotted lines are the solution to the problem without participation constraint.*

We see that with an unequal distribution of initial wealth, differences in preferences on intertemporal substitution have a larger effect on investment than under equal distribution (section 2.2.4). If the controlling owner is wealthier than the non-controlling owner, investment is increasing in γ until the point where the participation constraint sets in. From the viewpoint of owner 2, investment is too high and would lead to an uneven distribution of consumption over the two dates. Therefore, owner 2 seeks to sell shares, which in turn increases the price. The controlling owner exploits this mechanism by setting k even higher (the more the higher γ) – up to a point where this makes her own consumption profile too uneven or, in the presence of a participation constraint, where this constraints becomes binding. At this point, owner 2 is indifferent between investing in the partnership firm and his outside option.

If the controlling owner is less wealthier than the non-controlling owner, investment is again largest when both owners have the same preferences ($\gamma = 1$) and decreases for higher γ until the participation constraint imposes some minimum investment. Owner 2 would prefer higher levels of investment whenever $\gamma > 1$, but since he cannot influence the decision directly, he seeks to acquire shares, which in turn increases their price. Note that the presence of the participation constraint lowers the ex-post ownership concentration in both cases since it lowers the amount of shares that is acquired by the wealthier agent when γ is high.

2.3.2 Private benefits of control, one period

In this section, we investigate the effects of private benefits of control on investment, firm value and after-trade ownership distribution in one-period models. While subsection 2.3.2 extends our basic one-period model to the presence of private benefits, we analyze a complete markets version of this model in subsection 2.3.2 to show that private benefits alone are enough to create disagreement on the investment policy among shareholders. The following section 2.3.3 extends the incomplete markets model with private benefits to two periods.

In this section, we assume that a fraction $\lambda \in [0,1]$ of the output (=profits) can be expropriated by the initial majority owner (owner 1), so that only the fraction $1-\lambda$ is distributed according to the after-trade ownership stakes. Private benefits are also considered in the dynamic model of ownership by Edelstein et al. (2005).[20] In their model, a large shareholder who enjoys higher private benefits of control holds a greater stake in the long run. In our model of incomplete markets, however, the initial controlling owner may hold a larger or smaller share at the final date of the model depending on her relative wealth and initial stake. In contrast to the monotonic nature of adjustment in Edelstein et al. (2005), the adjustment in the two-periods model does not have to be monotonic.

Complete markets

In this section, we make a digression to a setup with complete markets. Markets are completed by the possibility of unconstrained borrowing and lending from exogenous investors at the interest rate r. The version without private benefits just confirms the Fisher separation theorem, and is therefore confined to Appendix B. Here we show that the existence of private benefits is sufficient for the Fisher separation theorem to break down, even if markets are complete. We derive how investment depends on the magnitude of private benefits and the initial ownership stake of the controlling owner. As we do in Appendix B, we use a general utility function and a neoclassical production function $F(k)$ to demonstrate the results. Every owner can invest in firm shares and bonds. Individual bond-holdings are denoted by b^i. The budget constraints for the two owners and the two dates read

$$\begin{aligned} c_0^i &= \omega^i + \left(\bar{\theta}^i - \theta^i\right) p - \bar{\theta}^i k - b^i\,, \quad i = 1,2 \\ c_1^1 &= \left((1-\lambda)\theta^1 + \lambda\right) F(k) + (1+r) b^1 \\ c_1^2 &= (1-\lambda)\theta^2 F(k) + (1+r) b^2 \end{aligned}$$

[20] In the cited paper, private benefits of an additional share are allowed to vary in a continuous way with the ownership stake while we restrict them to be constant, except at the stake of 50% where they switch from zero to λ.

Similar to the results in Appendix B, a no-arbitrage condition for bonds and shares[21] yields the firm value $p = \frac{(1-\lambda)F(k)}{1+r}$. Note that the value of the firm is reduced by the proportion λ as compared to the result without private benefits in Appendix B. Individual asset holdings are not uniquely determined since the non-arbitrage price makes both assets, firm shares and bonds, equivalent.

By maximizing utility with respect to k we obtain the rules for the preferred investment levels for the two owners:

$$F'(k^{(1)}) = \frac{\bar{\theta}^1(1+r)}{\bar{\theta}^1(1-\lambda)+\lambda} \tag{2.18}$$

$$F'(k^{(2)}) = \frac{1+r}{1-\lambda} \tag{2.19}$$

We see that in this case shareholders do not agree on the amount of investment. Furthermore, the preferred level of investment of the controlling shareholder does not maximize the net value of the firm $(p-k)$. Private benefits create an externality between the firm and its shareholders[22], and therefore the Fisher separation theorem is not valid any more. In the following proposition, we provide comparative statics results for the level of investment.

Proposition 3. Suppose that the controlling owner receives private benefits of control and that markets are complete. Then
(i) the preferred level of investment of the controlling owner, $k^{(1)}$, and therefore the level of investment under majority voting, is increasing in the proportion of private benefits of output λ, while the preferred level of investment of the non-controlling owner, $k^{(2)}$, is decreasing in λ;
(ii) the preferred level of investment of the controlling owner, $k^{(1)}$, depends negatively on her initial ownership stake $\bar{\theta}^1$, while the preferred level of investment of the non-controlling owner does not depend on his initial ownership stake.

Proof. See Appendix A.5. ■

Higher private benefits give higher dividends to the controlling owner for the same amount of investment. This leads her to invest more since only returns are important in the investment decision, and the optimal consumption profile can be achieved by bond trading. The opposite is true for the non-controlling owner. As a consequence, the preferred level of investment of the owner with private benefits, $k^{(1)}$, is larger than the investment in the case without private benefits, and the preferred level of investment of the non-controlling owner, $k^{(2)}$, is smaller.[23] As for part (ii), an additional share decreases the level investment since it lowers the return:

[21] We use the first-order conditions with respect to θ^i and b^i.
[22] See Kelsey and Milne (2006) for a general model of the firm with externalities.
[23] The investment rule for the complete markets model without private benefits of control is given in equation (63).

it increases the dividends to be paid to this owner relatively less than the amount of initial investment since the fraction λ of output received as private benefits stays constant. No such effect is present for the non-controlling owner.

Incomplete markets

After this digression to the complete markets model, we come back to our basic model of incomplete markets with log utility and Cobb-Douglas production function, and augment it by private benefits of control. We analyze the effect of private benefits on investment and share trade. The budget constraints are now as follows:

$$\begin{aligned} c_0^i &= \omega^i + \left(\bar{\theta}^i - \theta^i\right) p - \bar{\theta}^i k\,, \quad i = 1, 2 \\ c_1^1 &= \left((1-\lambda)\theta^1 + \lambda\right) A k^\alpha \\ c_1^2 &= (1-\lambda)\theta^2 A k^\alpha \end{aligned}$$

The equilibrium definitions are the same as in the basic model (see Section 2.2.2). The steps needed to obtain the following exchange equilibrium are similar to the ones for the basic model outlined in Appendix A.1. The market-clearing price of the firm and ownership stakes, all as functions of the level of investment, are given by the following expressions

$$\begin{aligned} p(k) &= \delta(1-\lambda)(\omega - k) \\ \theta^1(k) &= \frac{\beta\omega + \left(\delta\bar{\theta}^1(1-\lambda) - \lambda\right)(\omega - k) - \bar{\theta}^1 k}{(1+\delta)(1-\lambda)(\omega - k)} \\ \theta^2(k) &= \frac{(1-\beta)\omega + \delta\bar{\theta}^2(1-\lambda)(\omega - k) - \bar{\theta}^2 k}{(1+\delta)(1-\lambda)(\omega - k)} \end{aligned} \tag{2.20}$$

In the following proposition we give some sufficient conditions when the owners will sell or acquire shares in the trading stage.

Proposition 4. The controlling owner sells shares if her relative wealth is smaller than or equal to her initial ownership stake ($\beta \leq \bar{\theta}^1$). A sufficient condition for the controlling owner to acquire shares is $\beta > \bar{\theta}^1(1-\lambda) + \lambda$. Necessary conditions for the direction of share trade are given in Appendix A.6.

Proof. See Appendix A.6. ■

In contrast to the basic model, now there is share trade in the case of proportional endowments ($\beta = \bar{\theta}^1$). The controlling owner sells some of her shares since this allows her to consume a part of the private benefits already at time $t = 0$. Since the model ends at time $t = 1$, there is no need to maintain the majority in order to have access to private benefits in the future.

One could add arbitrarily many trading periods between the time of investment and the time where the dividends are paid out. In the case of proportional endowments, owner 1 would then gradually reduce her stake over all trading periods.

Next, we characterize the production-exchange equilibrium. Interior solutions are given by the following expression. As in the basic model, the first-order condition for k of owner 1 takes the form of a quadratic equation.

$$k = \left(-\frac{P_\lambda}{2} - \sqrt{\frac{P_\lambda^2}{4} - Q_\lambda} \right) \omega \tag{2.21}$$

where

$$P_\lambda = \frac{(1-\alpha)\delta\beta - \delta(1+2\alpha\delta)\left[(1-\lambda)\bar{\theta}^1 - \lambda\right] + \left[1+\delta(1+\alpha)\right]\bar{\theta}^1}{(1+\alpha\delta)\left[(1+\delta)\bar{\theta}^1 + \delta\lambda(1-\bar{\theta}^1)\right]} \tag{2.22}$$

$$Q_\lambda = \frac{\alpha\delta\left[\beta + \delta\left((1-\lambda)\bar{\theta}^1 + \lambda\right)\right]}{(1+\alpha\delta)\left[(1+\delta)\bar{\theta}^1 + \delta\lambda(1-\bar{\theta}^1)\right]} \tag{2.23}$$

The following proposition addresses the question how the presence and magnitude of private benefits of control affects the level of investment at interior solutions.

Proposition 5. If the controlling shareholder is able to extract private benefits of control, a higher fraction of private benefits λ increases (decreases) the amount of investment if her initial stake exceeds (falls below) her relative wealth, i.e. if $\bar{\theta}^1 > \beta$ ($\bar{\theta}^1 < \beta$). In the case of proportional endowments, $\bar{\theta}^1 = \beta$, private benefits do not affect the level of investment.

Proof. See Appendix A.7. ■

Consider the case where $\bar{\theta}^1 > \beta$. Here, a higher fraction of private benefits λ leads to more investment. On the one hand, this enables the controlling agent to extract more private benefits since she gets a larger part of the output. On the other hand, a higher λ lowers the share price.[24] Consumption smoothing is achieved by selling more shares in response to a higher λ.[25] So a reduced share price is bad for owner 1 but the first effect, more private benefits, dominates, and the level of investment increases. The other cases may be explained similarly by the interplay of these effects.

2.3.3 Private benefits of control, two periods

Most of the existing models of the firm with incomplete markets and collective decision-making on production cited in the introduction are one-period models. One exception is the generalized

[24] Note that $\frac{\partial p(k)}{\partial \lambda} = -\delta\left(\omega - k + (1-\lambda)\frac{\partial k}{\partial \lambda}\right)$. This is unambiguously negative if $\bar{\theta}^1 > \beta$.

[25] The effect on the final stake of owner 1 of an increase in λ is negative for $\bar{\theta}^1 \geq \beta$, but may become positive for large β. See Appendix A.8 for details.

model in Grossman and Hart (1979) with many time periods but only one production decision at date 1 that is binding for all future periods. We will analyze our model with private benefits for two periods (three dates) with a decision on investment at the beginning of each period. The investment decision in the second period depends on the (endogenously determined) ownership stakes after the first round of trade. One of the difficulties with multi-period models is that this investment function may be discontinuous — for example at 0.5 if a majority rule is assumed. As Grossman and Hart (1979) note, there may also arise a conflict between present and future shareholders if production plans can be reversed later. We circumvent this problem by assuming that capital fully depreciates in one period.

When we extend our basic model without private benefits to two periods and assume exogenous endowments only at the initial date, there is no further need to trade after the first period. Both the payoffs and the new investment would be split among the owners according to the ownership stakes after the first round of trade. This amounts to the case of proportional endowments, and we have shown in the basic one-period model that there is no share trade in this case. In contrast, with private benefits of control, there are incentives to trade if relative wealth and ownership stake coincide. So it is interesting to analyze this model for two periods since we are likely to see share trade in both periods. The following figure depicts the timing of the two-period model.

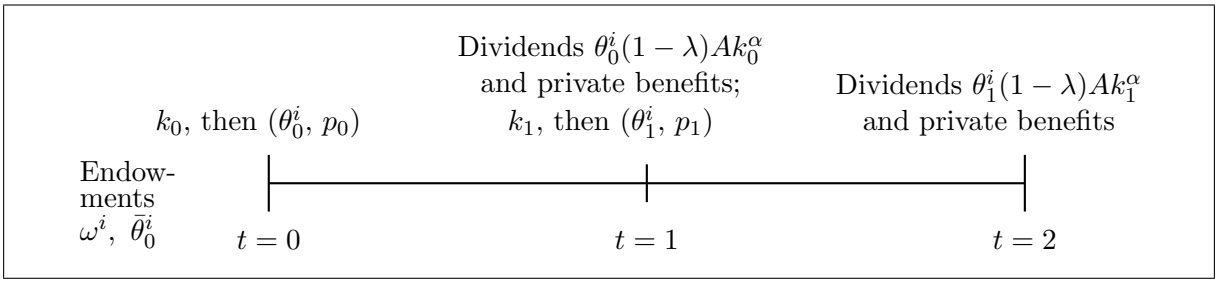


Figure 2.7: *Time line of the two-period model with private benefits*

Owners receive an exogenous endowment in the first period only. As before, we assume without loss of generality that owner 1 holds a majority initially. Therefore, she has decision power on the level of investment k_0, and receives the private benefits after the first period. Both owners receive dividends at dates $t = 1$ and $t = 2$. The budget constraints are the following:

$$
\begin{aligned}
c_0^i &= \omega^i + \left(\bar{\theta}_0^i - \theta_0^i\right) p_0 - \bar{\theta}_0^i k_0 \,,\ i = 1, 2 \\
c_1^1 &= \left((1-\lambda)\theta_0^1 + \lambda\right) A k_0^\alpha + \left(\theta_0^1 - \theta_1^1\right) p_1 - \theta_0^1 k_1 \\
c_1^2 &= (1-\lambda)\,\theta_0^2 A k_0^\alpha + \left(\theta_0^2 - \theta_1^2\right) p_1 - \theta_0^2 k_1 \\
c_2^1 &= \left((1-\lambda)\theta_1^1 + \tilde{\lambda}^1\right) A k_1^\alpha \qquad (2.24) \\
c_2^2 &= \left((1-\lambda)\theta_1^2 + \tilde{\lambda}^2\right) A k_1^\alpha \qquad (2.25)
\end{aligned}
$$

The distribution of private benefits at $t = 2$ and the power to make a decision on the level of investment k_1 are endogenously determined in the model. We need to make assumptions on the rules according to which private benefits at $t = 2$ are distributed, i.e. we need to specify $\tilde{\lambda}^i$, $i = 1, 2$ in equations (2.24) and (2.25). We distinguish the following four cases:

- Case A ("Non-transferable control"): The control over the investment decision and private benefits always accrue to the initial majority owner no matter what the ownership distribution after the first round of trade is. Thus, the extra payment to owner 1, $\tilde{\lambda}^1$, is assumed to be equal to λ, and $\tilde{\lambda}^2 = 0$. Owner 1 can be thought as a founder family with informational advantages or authority to keep private benefits and control even after selling out a majority stake.

- Case B ("Partial control"): The decision power on k_1 goes to the majority owner after the first round of share trade, but private benefits stay always with owner 1 (the original majority owner). Again, we have $\tilde{\lambda}^1 = \lambda$ and $\tilde{\lambda}^2 = 0$.

- Case C ("Full control via majority"): Both decision power on k_1 and private benefits in the second period are transferred to the new majority owner. That is, holding a majority assures full control over the firm. Thus, we have

$$
\begin{aligned}
\tilde{\lambda}^1 &= \mathbf{I}\left(\theta_0^1 \geq 0.5\right) \lambda \qquad (2.26) \\
\tilde{\lambda}^2 &= \left(1 - \mathbf{I}\left(\theta_0^1 \geq 0.5\right)\right) \lambda \qquad (2.27)
\end{aligned}
$$

  where $\mathbf{I}(.)$ is the indicator function.

- Case D ("No private benefits"): There are no private benefits, i.e. $\tilde{\lambda}^1 = \tilde{\lambda}^2 = \lambda = 0$. This case is a simple extension of the one-period basic model, and we include it for comparison.

This distinction of four different cases allows us to infer how the existence of private benefits, the possibility to become the controlling owner and the possibility to extract private benefits by

the majority owner change the decisions on investment and share trading of the owners, as well as the share price.

The expected utility function is

$$U^i = \ln c_0^i + \delta \ln c_1^i + \delta^2 \ln c_2^i$$

The equilibrium definitions of the basic model apply at each of the two periods. We restrict our attention to interior solutions where non-negativity constraints for consumption do not bind. The solutions are calculated backwards in time, taking previously determined variables as given. In other words, we derive time-consistent solutions, hence assuming that owners cannot commit to particular trading or investment strategies. The decision on investment depends on whether owner 1 or 2 hold a majority after the first round of trade. That means that the owners have to anticipate the identity of the new majority owner already in their demand for shares at $t = 0$. All details of the solution are given in Appendix A.9.

We now report the numerical findings for the four cases. We fix the initial stake of each owner at 50 per cent, and show the results for investment, share trade and firm value in both periods for different values of β, the relative (initial) wealth of owner 1. The proportion of output extracted as private benefits λ is 0.1. The other parameter values used for the calculations are $A = 1$, $\omega = 1$, $\delta = 0.99$ and $\alpha = 0.35$.[26] Figure 2.8 shows the results for investment at dates $t = 0$ (left) and $t = 1$ (right).

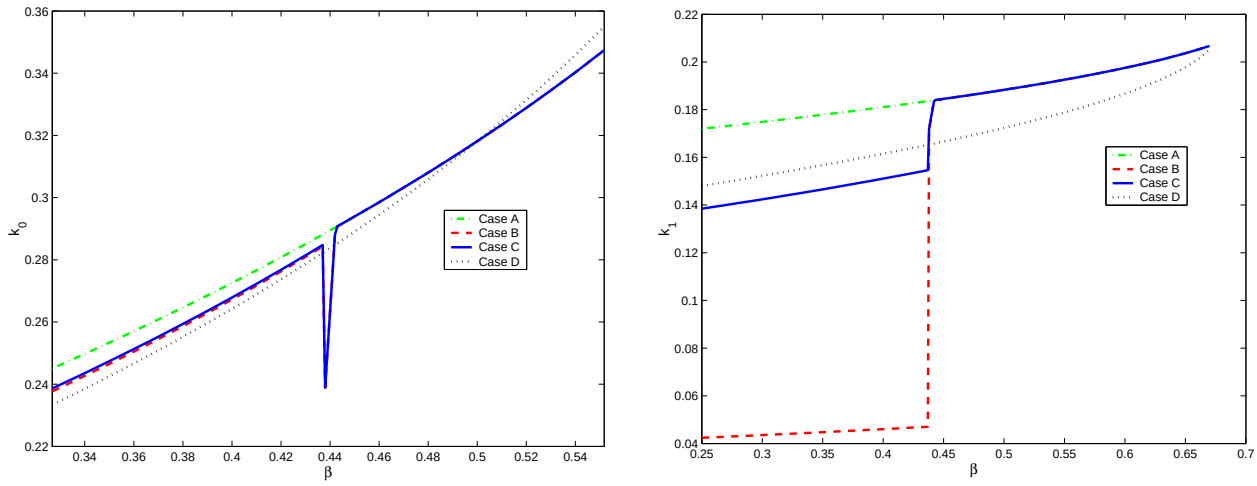


Figure 2.8: *Left graph: Optimal level investment k_0 as a function of owner 1's share of the initial endowment in the consumption good β. The initial ownership stake $\bar{\theta}_0^1$ is fixed to 0.5. Right graph: Similarly, the optimal level of investment k_1.*

Just as in the basic model, investment k_0 is overall increasing in the relative wealth of the

[26] With $\alpha = 0.5$, as we fixed it in the previous sections, the results are qualitatively the same. However, the changes in investment around the point where control is transferred from owner 1 to owner 2 are less pronounced.

(initial) controlling owner.[27] This also carries over to k_1 since a higher k_0 implies more output, part of which can be invested at time $t = 1$. All cases that involve private benefits (A, B and C) are identical if the initial majority owner keeps the majority after the first round of trade.[28] That happens in our example for values of β of approximately 0.45 and higher. For lower values of β, investment depends on our assumptions on the allocation of control and private benefits when owner 2 acquires a majority stake in the firm. Furthermore, the numerical solution for k_0 (left chart) confirms the finding of Proposition 5 for the one-period model: The presence of private benefits increases investment if $\beta < \bar{\theta}_0^1$ ($= 0.5$ in our example), and decreases it for the opposite case.[29]

In cases B and C, where owner 1 may loose the control over the firm, we observe some strategic behavior of owner 1 for values of β close to the point where the control transfer takes place (at 0.44 approximately). In order to keep the control over the investment decision at $t = 1$, she "manipulates", i.e. drastically reduces, the level of investment at $t = 0$. Consider also the left chart of Figure 2.9, which depicts the ownership stake of owner 1 after the first round of trading, θ_0^1. One can see that owner 1's ownership stake θ_0^1 jumps to exactly 50 per cent at the point when investment jumps downwards.

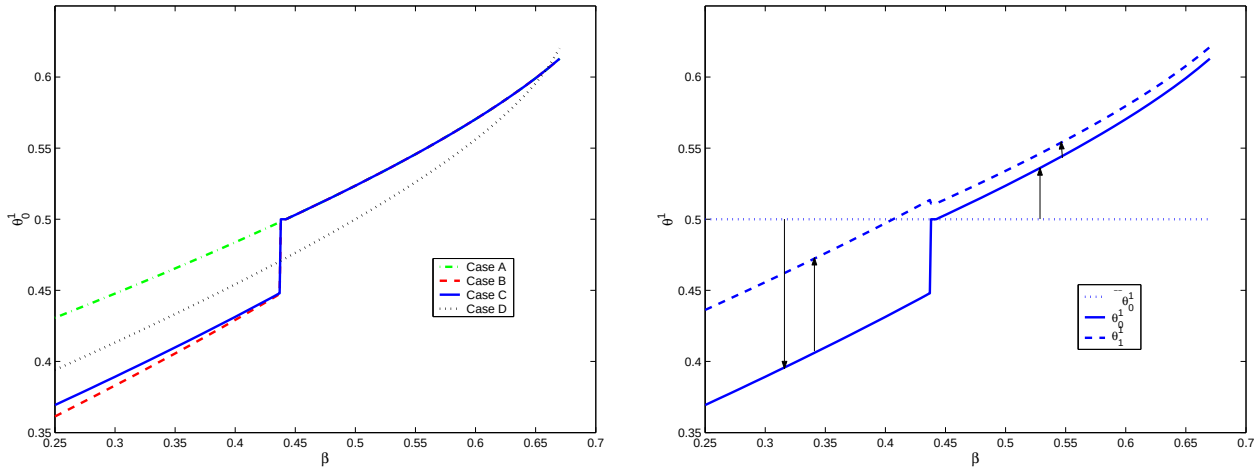


Figure 2.9: *Left graph: Ownership stake θ_0^1 as a function of owner 1's share of the initial endowment in the consumption good β. The initial ownership stake $\bar{\theta}_0^1$ is fixed to 0.5. Right graph: Evolution of the ownership stake of owner 1 for case C.*

Note that at the point where control is transferred to owner 2 in cases B and C, also investment k_1 changes sharply (right chart of Figure 2.8). The reason is that both owners maximize different objective functions when they decide on investment. In contrast, in case A, owner 1 continues to control the firm no matter what the ownership distribution is, and in case D owners

[27] An exception is the downward spike in cases B and C around $\beta = 0.44$ that we shall discuss shortly.
[28] Recall that the owners can perfectly anticipate whether the identity of the majority owners changes or not.
[29] Again, the only exception is the downward spike in cases B and C.

are unanimous about the level of investment k_1 (see the analytical solution in Appendix A.9). If owner 2 acquires a majority stake, the level of investment k_1 is higher in cases C and A than in case B, since in the former private benefits and control over investment are concentrated in one hand. Recall that in case B control is transferred to owner 2, while private benefits still accrue to owner 1. This misalignment of control and private benefits is obviously bad for investment. Furthermore, k_1 is higher in case A than in C since the decision over investment is made by the owner with a smaller share.[30]

Turning to the ownership dynamics, we have the following analytical result:

Proposition 6. In cases A, B and C where private benefits are non-zero, the initial majority owner increases her stake in the second round of trade.

Proof. See Appendix A.9. ■

This effect is a pure wealth effect. The controlling owner disposes of a relative wealth that is by the fraction of private benefits λ higher than her ownership stake at time $t = 1$. Therefore she always acquires shares.

In the right graph of Figure 2.9, we pick case C and show the evolution of the ownership stake of initial controlling owner from the initial stake $\bar{\theta}_0^1$, over the stake after the first round of trade θ_0^1 to the final stake after the second round of trade θ_1^1, as indicated by the arrows.

The important result we observe is an accumulation of shares in the hands of the initial controlling owner 1 over both periods, even for levels of relative wealth equal to the initial stake or slightly lower (down to $\beta = 0.45$ in our example).[31] This result is different from the one-period model with private benefits (section 2.3.2), where the ownership stake of the owner with private benefits decreases in the case of proportional endowments ($\beta = \bar{\theta}_0^1$). This result of an increase in the ownership stake in the hands of the owner with private benefits of control can be related to the observed increase in managerial ownership in post-privatization enterprises in Central and Eastern Europe.[32] If we believe the amounting anecdotal evidence that managers and their affiliates were able to extract private benefits of control, then our two-period model correctly predicts the increase in managerial ownership. To obtain this result it is not necessary to assume that managers are the wealthier shareholders right after privatization — the private benefits alone allow them to accumulate shares over time.

Figure 2.10 shows the results for the firm value p at date $t = 0$ (left) and date $t = 1$ (right). At the continuous parts of the curve, p_0 is decreasing in β. As in the one-period model, investment

[30] This owner needs a higher investment to generate the same dividend for herself. See Proposition 2 for a discussion of this comparative statics result in the basic model.

[31] For higher values of λ this threshold would be even lower.

[32] See for example Chapter 1 of this Thesis for data on Russian firms.

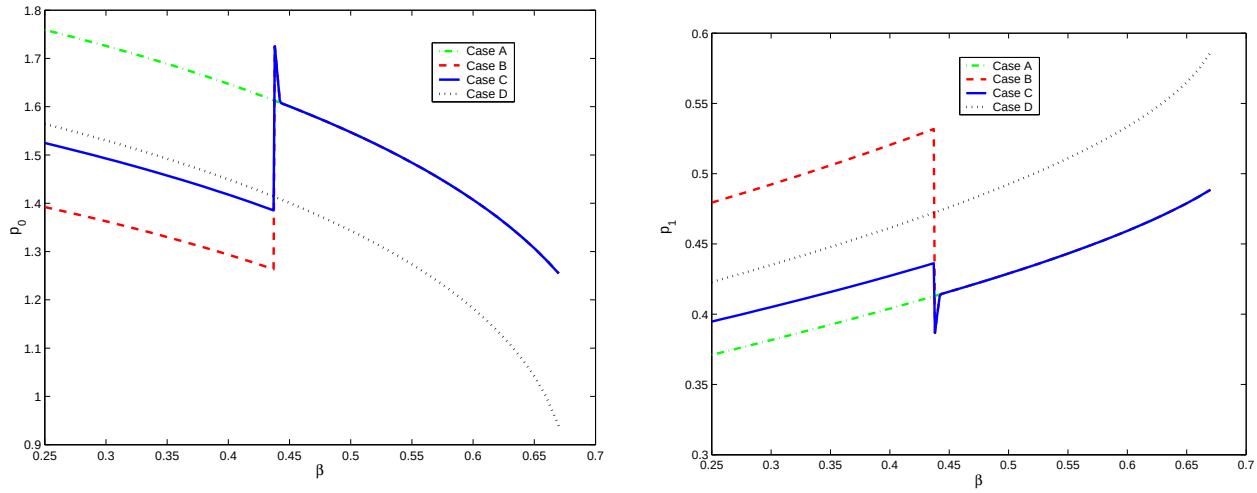


Figure 2.10: *Left graph: Firm value p_0 as a function of owner 1's share of the initial endowment in the consumption good β. The initial ownership stake $\bar{\theta}_0^1$ is fixed to 0.5. Right graph: similarly, the firm value p_1.*

is increasing in β, and the share price is a decreasing function of investment. (With a higher investment, an owner needs less shares to smooth consumption.) The price in the second trading round p_1 is increasing since a higher β implies more investment k_0 and thus higher output at time $t = 1$, so owners dispose of more resources to acquire shares. Near to the point where control is transferred (cases B and C), the price "jumps" upwards at $t = 0$ and downwards at $t = 1$. We now see why owner 1 strategically lowers investment k_0 when she wants to keep control over the firm. Lower investment k_0 increases the share price and makes it therefore more difficult for owner 2 to acquire shares. The price p_1 jumps downward since the reduced investment k_0 makes that there are less resources at $t = 1$ to acquire shares.

From a normative point of view, which of the corporate governance arrangements in the presence of private benefits — case A, B or C — would be preferred by the owners? Our numerical simulations indicate that both cases A and C (non-transferable control and full control via majority ownership) are Pareto-superior to cases B (partial control). The low investment levels when there is a misalignment of control over investment and private benefits make this the least preferred option. It depends however on the initial stake and the distribution of relative wealth whether control should better stay in the hands of a powerful family (case A) or should be transferred to the majority owner (case C) according to the Pareto criterion.[33]

[33]When both solutions are different — for lower values of β where the majority goes to owner 2 — owner 1 is always better off in case A, but owner 2 may be better off in case C or in case A.

2.4 Conclusion

In this paper, we have analyzed a general equilibrium model with one firm, two owners and an incomplete markets structure (i.e. lending and borrowing are impossible). Under these assumptions, there is no unanimity between shareholders about the amount of investment. We assume that the investment decision is made by the majority owner. We have studied the effects of different wealth, initial stakes and disposition to substitute consumption between periods among shareholders on three outcomes: the amount of investment, the firm value and after-trade ownership stakes. When we extend the basic model by introducing private benefits of control, interesting dynamics of ownership arise. In particular, increasing stakes of controlling shareholders, as observed in Eastern European countries after privatization, can be rationalized in this model.

In future research, the model can be extended in several dimensions. In a model with aggregate and idiosyncratic uncertainty, we could study how shocks to productivity or individual endowments (or labor supply) affect investment, firm value and share trade. A model with more than two (and more than two types of) owners, coalition building among shareholders becomes important. Furthermore, pricing mechanisms other than the competitive Walrasian mechanism in this paper can be introduced. It is likely that a large shareholder who faces a continuum of small shareholders can influence the share price. Finally, more than one firm in the model would imply that owners have to determine their demand for shares in each firm by optimal portfolio considerations. It would then be interesting to derive and to test hypotheses about the relation between the composition of the shareholder base of a firm on the one hand and investment, firm value and share trade on the other hand. We believe that the model of this paper and possible extensions contribute to highlight the importance of ownership arrangements for real economic outcomes.

Appendix

A Proofs and details of calculations

A.1 Exchange equilibrium in the basic model

We prove expressions (2.7) -(2.9). The first-order condition of (2.5) with respect to θ^i is

$$\frac{-p}{\omega^i + \left(\bar{\theta}^i - \theta^i\right) p - \bar{\theta}^i k} + \frac{\delta}{\theta^i} = 0$$

Note that the second-order condition for a maximum is satisfied. Solving for θ^i yields the ownership stake as a function of the price of the firm p and investment k:

$$\theta^i(k,p) = \frac{\delta\left(\omega^i + \bar{\theta}^i(p-k)\right)}{(1+\delta)p} \tag{28}$$

The market clearing condition $\theta^1 + \theta^2 = 1$ yields equation (2.7) for the price, and substituting into (28) we get (2.9) and the equivalent expression (2.8).

A.2 Production-exchange equilibrium in the basic model

The first-order condition of the indirect utility function (2.11) reads

$$\frac{\partial V^1}{\partial k} = -\frac{\delta(\bar{\theta}^1 - \theta^1) + \bar{\theta}^1}{\beta\omega + \left(\bar{\theta}^1 - \theta^1\right)p - \bar{\theta}^1 k} + \frac{\delta\alpha}{k} = 0 \tag{29}$$

Note that we skipped all derivatives of the ownership stake θ^i with respect to k since they cancel out due to the first-order condition for the optimal stake (envelope theorem). Multiplying by k and c_0^1 and rearranging terms leads to the quadratic equation

$$0 = k^2 + P\omega k + Q\omega^2 \tag{30}$$

where P and Q are given in equations (2.13) and (2.14). To see which of the two solutions is the maximum, note first that the derivative of the right hand side of (30) with respect to k has the same sign as the derivative of (29), which is the second derivative of the indirect utility function (2.11). For a maximum we need that this derivative is negative, i.e. $2k + P\omega < 0$ or $k < -\frac{P}{2}\omega$. Consequently, (2.12) is the optimal interior solution.

Next, we find the corner solution for k when some non-negativity constraint for consumption is binding. Suppose that the constraint $c_0^2 \geq 0$ is binding. Using the budget constraint (2.2) for $i = 2$ and then expressions (2.7) and (2.10), we get

$$\begin{aligned} c_0^i &= (1-\beta)\omega + \left(\theta^1 - \bar{\theta}^1\right)p - \left(1 - \bar{\theta}^1\right)k \\ &= \tfrac{1}{1+\delta}\left[(1+\delta-\beta)\omega - \left(1+\delta-\bar{\theta}^1\right)k\right] \end{aligned}$$

Equalizing to zero gives the level of investment

$$k = \frac{1+\delta-\beta}{1+\delta-\bar{\theta}^1}$$

Using (2.10), this yields an after-trade ownership stake of owner 1

$$\begin{aligned} \theta^1(k) &= \bar{\theta}^1 + \frac{(\beta - \bar{\theta}^1)\omega}{(1+\delta)\left(\omega - \frac{1+\delta-\beta}{1+\delta-\bar{\theta}^1}\right)} \\ &= \bar{\theta}^1 + \frac{(\beta - \bar{\theta}^1)\omega\left(1+\delta-\bar{\theta}^1\right)}{(1+\delta)(\beta-\bar{\theta}^1)\omega} \\ &= 1 + \frac{\delta}{1+\delta}\bar{\theta}^1 \end{aligned}$$

This would imply a negative stake of owner 2. The constraint $c_1^2 = \theta^2 A k^\alpha \geq 0$ however requires that $\theta^2 \geq 0$ (or $\theta^1 \leq 1$) since A, k and α are all positive numbers. Now, setting $\theta^1(k) = 1$ and using (2.10), we get the corner solution for the level of investment given in equation (2.15).

A.3 Proof of Proposition 2

Part (i): In order to see how k, given in equation (2.12) changes with β and $\bar{\theta}^1$, we calculate first the derivatives of P and Q:

$$\frac{\partial P}{\partial \beta} = \frac{1-\alpha}{(1+\delta)(\delta^{-1}+\alpha)\bar{\theta}^1} > 0 \tag{31}$$

$$\frac{\partial Q}{\partial \beta} = \frac{\alpha}{(1+\delta)(\delta^{-1}+\alpha)\bar{\theta}^1} > 0 \tag{32}$$

$$\frac{\partial P}{\partial \bar{\theta}^1} = -\frac{(1-\alpha)\beta}{(1+\delta)(\delta^{-1}+\alpha)(\bar{\theta}^1)^2} < 0 \tag{33}$$

$$\frac{\partial Q}{\partial \bar{\theta}^1} = -\frac{\alpha\beta}{(1+\delta)(\delta^{-1}+\alpha)(\bar{\theta}^1)^2} < 0 \tag{34}$$

Next, we prove that P is a negative number. From (2.13),

$$P = \frac{(1-\alpha)\beta - (1+2\delta)(\delta^{-1}+\alpha)\bar{\theta}^1}{(1+\delta)(\delta^{-1}+\alpha)\bar{\theta}^1} < 0$$

Note that the denominator is positive, and the numerator is negative since by assumption $\bar{\theta}^1 \geq 0.5$, $\alpha \in (0,1)$ and $\beta \in [0,1]$. Now we calculate from equation (2.12) the derivative of k with respect to β:

$$\frac{\partial k}{\partial \beta} = \left[-\frac{1}{2} \underbrace{\frac{\partial P}{\partial \beta}}_{>0} - \frac{1}{2} \left(\frac{P^2}{4} - Q \right)^{-\frac{1}{2}} \left(\frac{1}{2} \underbrace{P \frac{\partial P}{\partial \beta}}_{<0} - \underbrace{\frac{\partial Q}{\partial \beta}}_{>0} \right) \right] \omega \tag{35}$$

In order to prove that $\frac{\partial k}{\partial \beta} > 0$, one can see from (35) that it suffices to show that $\frac{1}{2}\left(\frac{P^2}{4} - Q\right)^{-\frac{1}{2}} P < -1$. Multiplying by $-2\sqrt{\frac{P^2}{4} - Q}$ yields

$$\begin{aligned} 2\sqrt{\frac{P^2}{4} - Q} &< -P \\ 4\left(\frac{P^2}{4} - Q\right) &< P^2 \\ Q &> 0 \end{aligned}$$

Taking squares without changing the inequality sign is possible since we have positive numbers on both sides. It can be verified easily that Q, given in equation (2.14), is indeed a positive number.

With respect to the initial ownership stake, we have the following derivative:

$$\frac{\partial k}{\partial \bar{\theta}^1} = \left[-\frac{1}{2} \underbrace{\frac{\partial P}{\partial \bar{\theta}^1}}_{<0} - \frac{1}{2} \left(\frac{P^2}{4} - Q \right)^{-\frac{1}{2}} \left(\frac{1}{2} \underbrace{P \frac{\partial P}{\partial \bar{\theta}^1}}_{>0} - \underbrace{\frac{\partial Q}{\partial \bar{\theta}^1}}_{<0} \right) \right] \omega \tag{36}$$

By the same argument as before, the second term has more weight than the first term, such that the whole expression becomes negative.

Part (ii): Since p is a function of k, part (ii) follows directly from part (i) and equation (2.7):

$$\begin{aligned} \frac{\partial p(k)}{\partial \beta} &= \frac{\partial p(k)}{\partial k} \frac{\partial k}{\partial \beta} = -\delta \frac{\partial k}{\partial \beta} < 0 \\ \frac{\partial p(k)}{\partial \bar{\theta}^1} &= \frac{\partial p(k)}{\partial k} \frac{\partial k}{\partial \bar{\theta}^1} = -\delta \frac{\partial k}{\partial \bar{\theta}^1} > 0 \end{aligned}$$

As noted in the text, this the derivative of the price with respect to k is negative only for a low or intermediate elasticity of intertemporal substitution. The result holds at least for log utility and CRRA utility with $\gamma > 1$ (see Appendix C).

Part (iii): The derivative of the final ownership stake of owner 1 (equation (2.10)) with respect to the relative wealth β reads:

$$\frac{\partial \theta^1(k)}{\partial \beta} = \frac{\omega - k + (\beta - \bar{\theta}^1) \frac{\partial k}{\partial \beta}}{(1+\delta)(\omega - k)^2} \omega \tag{37}$$

Clearly, the expression is positive for $\beta \geq \bar{\theta}^1$. In order to show that expression (37) is positive also when $\beta < \bar{\theta}^1$, we show first that it is positive for $\beta = 0$. Afterwards we show that it is monotonous for β between 0 and $\bar{\theta}^1$.

For $\beta = 0$, we show that $\text{sign}\left(\frac{\partial \theta^1(k)}{\partial \beta} \right) = \text{sign}\left(\omega - k - \bar{\theta}^1 \frac{\partial k}{\partial \beta} \right)$ is positive. We have

$$\begin{aligned} k &= \left[\frac{1+2\delta}{2(1+\delta)} - \frac{\sqrt{(1+2\delta)^2(\delta^{-1}+\alpha) - 4\alpha\delta(1+\delta)}}{2(1+\delta)\sqrt{\delta^{-1}+\alpha}} \right] \omega \\ &= \frac{(1+2\delta)\sqrt{\delta^{-1}+\alpha} - \sqrt{\delta^{-1}+\alpha+4(1+\delta)}}{2(1+\delta)\sqrt{\delta^{-1}+\alpha}} \omega \\ \omega - k &= \frac{\sqrt{\delta^{-1}+\alpha} + \sqrt{\delta^{-1}+\alpha+4(1+\delta)}}{2(1+\delta)\sqrt{\delta^{-1}+\alpha}} \omega \end{aligned} \tag{38}$$

$$\tag{39}$$

On the other hand, using (35) we get

$$\begin{aligned}
-\bar{\theta}^1\frac{\partial k}{\partial \beta} &= \frac{1}{2}\left[\frac{1-\alpha}{(1+\delta)(\delta^{-1}+\alpha)} - \frac{2(1+\delta)\sqrt{\delta^{-1}+\alpha}}{\sqrt{\delta^{-1}+\alpha+4(1+\delta)}}\ ...\right.\\
&\quad \left. ...\left(\frac{1+2\delta}{2(1+\delta)}\frac{1-\alpha}{(1+\delta)(\delta^{-1}+\alpha)} + \frac{\alpha}{(1+\delta)(\delta^{-1}+\alpha)}\right)\right]\omega\\
&= \frac{\omega}{2(1+\delta)\sqrt{(\delta^{-1}+\alpha)}}\left(\frac{1-\alpha}{\sqrt{(\delta^{-1}+\alpha)}} - \frac{1+2\delta+\alpha}{\sqrt{(\delta^{-1}+\alpha)+4(1+\delta)}}\right) \qquad (40)
\end{aligned}$$

Summing up expressions (38) and (40), we get

$$\begin{aligned}
\omega - k - \bar{\theta}^1\frac{\partial k}{\partial \beta}|_{\beta=0} &= \frac{\omega}{2(1+\delta)\sqrt{(\delta^{-1}+\alpha)}}\left[\sqrt{\delta^{-1}+\alpha} + \sqrt{\delta^{-1}+\alpha+4(1+\delta)}...\right.\\
&\quad \left. ... + \frac{1-\alpha}{\sqrt{(\delta^{-1}+\alpha)}} - \frac{1+2\delta+\alpha}{\sqrt{(\delta^{-1}+\alpha)+4(1+\delta)}}\right]
\end{aligned}$$

$$\begin{aligned}
&= \frac{\omega}{2(1+\delta)\sqrt{(\delta^{-1}+\alpha)}\sqrt{(\delta^{-1}+\alpha)+4(1+\delta)}}\left[\sqrt{(\delta^{-1}+\alpha)}\sqrt{(\delta^{-1}+\alpha)+4(1+\delta)}...\right.\\
&\quad \left. ... + \frac{\sqrt{((1-\alpha)\delta^{-1}+\alpha)+4(1+\delta)}}{\sqrt{(\delta^{-1}+\alpha)}} + \underbrace{\delta^{-1}+\alpha+4(1+\delta)-(1+2\delta+\alpha)}_{=\delta^{-1}+3+2\delta}\right] > 0
\end{aligned}$$

For the second part of the argument, we write first the derivative of the function $\frac{\partial\theta^1(k)}{\partial\beta}$ with respect to β, i.e. the second derivative:

$$\frac{\partial^2\theta^1(k)}{\partial\beta^2} = \frac{2(1+\delta)(\omega-k)\frac{\partial k}{\partial\beta}\left[\omega - k + \left(\beta-\bar{\theta}^1\right)\frac{\partial k}{\partial\beta}\right]}{(1+\delta)^2(\omega-k)^4}\,\omega$$

Note that it has the same sign as the first derivative itself. At $\beta = 0$ the function $\frac{\partial\theta^1(k)}{\partial\beta}$ is positive and increasing. If it would change direction, then at the turning point, say $\tilde{\beta}$, the second derivative would have to become zero. But then it must be also that $\frac{\partial\theta^1(k)}{\partial\beta}(\tilde{\beta}) = 0$. But this is a contradiction since $\frac{\partial\theta^1(k)}{\partial\beta}(\tilde{\beta}) > \frac{\partial\theta^1(k)}{\partial\beta}(0) > 0$. Therefore, $\frac{\partial\theta^1(k)}{\partial\beta}$ is positive and increasing for all $\beta \in [0,1]$.

As for the effect of the initial ownership stake $\bar{\theta}^1$ on the final stake, we calculate the derivative

$$\frac{\partial\theta^1(k)}{\partial\bar{\theta}^1} = \frac{(\beta-\bar{\theta}^1)\frac{\partial k}{\partial\bar{\theta}^1} - (\omega-k)}{(1+\delta)(\omega-k)^2}\,\omega \qquad (41)$$

Clearly, the expression is negative for $\bar{\theta}^1 \leq \beta$. In order to show that it is also negative the case of $\bar{\theta}^1 > \beta$, we look at the second derivative of $\theta^1(k)$ with respect to the initial stake $\bar{\theta}^1$.

$$\frac{\partial^2\theta^1(k)}{\partial\left(\bar{\theta}^1\right)^2} = \frac{\left(\beta-\bar{\theta}^1\right)\frac{\partial^2 k}{\partial\left(\bar{\theta}^1\right)^2}(\omega-k) + 2\left[\left(\beta-\bar{\theta}^1\right)\frac{\partial k}{\partial\bar{\theta}^1} - (\omega-k)\right]}{(1+\delta)(\omega-k)^3}\,\omega \qquad (42)$$

Next, we show that $\frac{\partial^2 k}{\partial\left(\bar{\theta}^1\right)^2}$ is positive. From (36) we calculate

$$\begin{aligned}\frac{\partial^2 k}{\partial\left(\bar{\theta}^1\right)^2} &= -\frac{1}{2}\Bigg[\frac{\partial^2 P}{\partial\left(\bar{\theta}^1\right)^2} - \frac{1}{2}\left(\frac{P^2}{4}-Q\right)^{-\frac{3}{2}}\left(\frac{1}{2}P\frac{\partial P}{\partial\bar{\theta}^1} - \frac{\partial Q}{\partial\bar{\theta}^1}\right)^2 + \left(\frac{P^2}{4}-Q\right)^{-\frac{1}{2}}... \\ &\quad ...\left(\frac{1}{2}\left(\frac{\partial P}{\partial\bar{\theta}^1}\right)^2 + \frac{1}{2}P\frac{\partial^2 P}{\partial\left(\bar{\theta}^1\right)^2} - \frac{\partial^2 Q}{\partial\left(\bar{\theta}^1\right)^2}\right)\Bigg]\omega\end{aligned}$$

where $\frac{\partial P}{\partial\bar{\theta}^1}$ and $\frac{\partial Q}{\partial\bar{\theta}^1}$ are given in (33) and (34), and

$$\begin{aligned}\frac{\partial^2 P}{\partial\left(\bar{\theta}^1\right)^2} &= \frac{2(1-\alpha)\beta}{(1+\delta)(\delta^{-1}+\alpha)(\bar{\theta}^1)^3} > 0 \\ \frac{\partial^2 Q}{\partial\left(\bar{\theta}^1\right)^2} &= \frac{2\alpha\beta}{(1+\delta)(\delta^{-1}+\alpha)(\bar{\theta}^1)^3} > 0\end{aligned}$$

Positive terms are outweighed by negative terms:

$$\frac{\partial^2 P}{\partial\left(\bar{\theta}^1\right)^2} + \underbrace{\frac{1}{2}\left(\frac{P^2}{4}-Q\right)^{-\frac{1}{2}}}_{<-1}P\frac{\partial^2 P}{\partial\left(\bar{\theta}^1\right)^2} < 0$$

and

$$\begin{aligned}-\frac{1}{2}\left(\frac{P^2}{4}-Q\right)^{-\frac{3}{2}}\left(\frac{1}{2}P\frac{\partial P}{\partial\bar{\theta}^1} - \frac{\partial Q}{\partial\bar{\theta}^1}\right)^2 + \frac{1}{2}\left(\frac{P^2}{4}-Q\right)^{-\frac{1}{2}}\left(\frac{\partial P}{\partial\bar{\theta}^1}\right)^2 &< 0 \\ -\underbrace{\left(\frac{P^2}{4}-Q\right)^{-1}\left[\frac{1}{4}P^2\right.}_{>1}\left(\frac{\partial P}{\partial\bar{\theta}^1}\right)^2 - \underbrace{P\frac{\partial P}{\partial\bar{\theta}^1}\frac{\partial Q}{\partial\bar{\theta}^1}}_{<0} + \left.\left(\frac{\partial Q}{\partial\bar{\theta}^1}\right)^2\right] + \left(\frac{\partial P}{\partial\bar{\theta}^1}\right)^2 &< 0\end{aligned}$$

where we have multiplied the first line by $2\sqrt{\frac{P^2}{4}-Q}$ to obtain the second line, without affecting the sign of the expression. Therefore, we have that $\frac{\partial^2 k}{\partial\left(\bar{\theta}^1\right)^2} > 0$. This means for the numerator of $\frac{\partial^2\theta^1(k)}{\partial\left(\bar{\theta}^1\right)^2}$ given in equation (42) in the case where $\bar{\theta}^1 > \beta$ and the first derivative is negative, i.e. $(\beta-\bar{\theta}^1)\frac{\partial k}{\partial\bar{\theta}^1} - (\omega-k) < 0$:

$$\underbrace{\left(\beta-\bar{\theta}^1\right)}_{<0}\underbrace{\frac{\partial^2 k}{\partial\left(\bar{\theta}^1\right)^2}}_{>0}\underbrace{\left(\omega-k\right)}_{>0} + 2\underbrace{\left[\left(\beta-\bar{\theta}^1\right)\frac{\partial k}{\partial\bar{\theta}^1} - (\omega-k)\right]}_{<0} < 0$$

That is, whenever the first derivative is negative and $\bar{\theta}^1 > \beta$, the second derivative is negative, too. Note that the first and second derivative are negative at $\bar{\theta}^1 = \beta$. In other words, the function $\frac{\partial\theta^1(k)}{\partial\bar{\theta}^1}$ is decreasing in $\bar{\theta}^1$. Consequently, it will be negative and decreasing for higher initial stakes $\bar{\theta}^1$, too.

Part (iv): From expression (2.15) for the level of investment when the non-negativity constraint binds we derive the derivatives

$$\begin{aligned}\frac{\partial k}{\partial \beta} &= -\frac{1}{\left(1-\bar{\theta}^1\right)(1+\delta)} < 0 \\ \frac{\partial k}{\partial \bar{\theta}^1} &= \frac{1-\beta}{\left(1-\bar{\theta}^1\right)^2(1+\delta)} \geq 0\end{aligned}$$

These are the opposite signs of the ones found for the interior solution in part (i). From part (ii) it is clear then that also the price reacts to changes in β or $\bar{\theta}^1$ in the opposite way, i.e. $\frac{\partial p(k)}{\partial \beta} > 0$ and $\frac{\partial p(k)}{\partial \bar{\theta}^1} \leq 0$. As we argued in Appendix A.2, the constraint that has to be taken into consideration is $c_1^2 \geq 0$, and, when binding, it implies that $\theta^2 = 0$ and $\theta^1 = 1$.

Part (v): On the one hand, no constraint can be binding if $\beta = \bar{\theta}^1$. As shown in Example 1, under this condition both owners are unanimous, and would therefore not choose a level of investment that leads to zero or negative consumption. On the other hand, the constraint is binding whenever $k^{int} \geq k^{constr}$ (see equations (2.12)-(2.16)). Holding $\bar{\theta}^1$ fixed, if we increase β, we have the following effects: According to part (i), k^{int} increases, and according to part (iv), k^{constr} decreases. Thus, the inequality becomes more likely to hold. In contrast, it is less likely to hold when β decreases. Since the likelihood is zero at $\beta = \bar{\theta}^1$, it can only hold if $\beta > \bar{\theta}^1$. The argument for $\bar{\theta}^1$ runs similarly.

Part (vi): At interior solutions, the non-negativity constraint for the controlling owner never binds since she will not optimally choose zero or negative consumption. If the constraint for owner 2 binds at $t = 1$, i.e. $c_1^2 = 0$, then we can use equation (2.15), $\theta^1 = 1$, and the budget constraint (2.2) to write

$$\begin{aligned}c_0^1 &= \beta\omega + \left(\bar{\theta}^1 - \theta^1\right)p - \bar{\theta}^1 k \\ &= \beta\omega + \frac{\left(\bar{\theta}^1 - 1\right)\delta\left(\beta - \bar{\theta}^1\right)\omega}{\left(1-\bar{\theta}^1\right)(1+\delta)} - \frac{\bar{\theta}^1\left(1-\beta+\delta\left(1-\bar{\theta}^1\right)\right)\omega}{\left(1-\bar{\theta}^1\right)(1+\delta)} \\ &= \frac{\left(\beta - \bar{\theta}^1\right)\omega}{\left(1-\bar{\theta}^1\right)(1+\delta)}\end{aligned}$$

As shown in part (v), the constraint for owner 2 can only bind if $\beta > \bar{\theta_1}$. But in this case, the foregoing expression is positive, i.e. the constraint for owner 1 at $t = 0$ does not bind. Neither the constraint at $t = 1$ binds: consumption is $c_1^1 = \theta^1 A k^\alpha > 0$ since $\theta^1 = 1$ at corner solutions.

A.4 Different preferences on intertemporal substitution

The optimal demand for shares of owner 1, with log utility, is (see also Appendix A.1)

$$\theta^1(k,p) = \frac{\delta\left(\beta\omega + \bar{\theta}^1(p-k)\right)}{(1+\delta)p} \tag{43}$$

and for owner 2, with CRRA utility (see also Appendix C),

$$\theta^2(k,p) = \frac{(1-\beta)\omega + \bar{\theta}^2(p-k)}{\delta^{-\frac{1}{\gamma}}\left(Ak^{\alpha}\right)^{-\frac{1-\gamma}{\gamma}} p^{\frac{1}{\gamma}} + p}$$

Market clearing ($\theta^1 + \theta^2 = 1$) yields an implicit function for the firm value $p(k)$:

$$\begin{aligned} 0 &= -\bar{\theta}^1 p - \left(1 + \delta^{-\frac{1-\gamma}{\gamma}}(1-\bar{\theta}^1)\right)\left(Ak^{\alpha}\right)^{-\frac{1-\gamma}{\gamma}} p^{\frac{1}{\gamma}} \\ &+ \delta^{-\frac{1-\gamma}{\gamma}}\left(Ak^{\alpha}\right)^{-\frac{1-\gamma}{\gamma}}\left(\beta\omega - \bar{\theta}^1 k\right) p^{\frac{1-\gamma}{\gamma}} + (1+\delta-\beta)\omega - \left(1+\delta-\bar{\theta}^1\right)k \end{aligned}$$

This expression is used to find $p(k)$ numerically, which is then used to calculate the ownership shares (43) and to solve for the optimal level of investment, problem (2.17).

For the case with participation constraint (section 2.3.1), the reservation utilities for both owners are given by

$$\begin{aligned} U^1_{Res} &= \ln\left(\frac{\beta}{1+\delta}\,\omega\right) + \delta \ln\left(\frac{\delta\beta}{1+\delta}\,\omega\right) \\ U^2_{Res} &= \frac{1}{1-\gamma}\left[\left(\frac{\delta^{-\frac{1}{\gamma}}(1-\beta)}{1+\delta^{-\frac{1}{\gamma}}}\omega\right)^{1-\gamma} + \delta\left(\frac{(1-\beta)}{1+\delta^{-\frac{1}{\gamma}}}\omega\right)^{1-\gamma}\right] \end{aligned}$$

A.5 Proof of Proposition 3

(i) As for the controlling owner, the derivative of (2.18) with respect to λ is

$$\frac{\partial F'(k^{(1)})}{\partial \lambda} = -\frac{(1+r)\bar{\theta}^1(1-\bar{\theta}^1)}{\left(\bar{\theta}^1(1-\lambda)+\lambda\right)^2} < 0$$

Since F' is a decreasing function, $k^{(1)}$ is increasing in λ. As for the non-controlling owner, the derivative of (2.19) with respect to λ is positive, therefore $k^{(2)}$ is decreasing in λ.

(ii) The derivative of (2.18) with respect to $\bar{\theta}^1$ is

$$\frac{\partial F'(k^{(1)})}{\partial \bar{\theta}^1} = \frac{(1+r)\lambda}{\left(\bar{\theta}^1(1-\lambda)+\lambda\right)^2} > 0$$

Therefore, $k^{(1)}$ is decreasing in $\bar{\theta}^1$. It is immediate from (2.19) that $k^{(2)}$ does not depend on the initial ownership stake.

A.6 Proof of Proposition 4 and exact conditions for final shareholdings with private benefits

We use (2.20) to write the change in the asset position of owner 1

$$\begin{aligned} \theta^1(k) - \bar{\theta}^1 &= \frac{\left(\beta - \bar{\theta}^1\right)\omega - \lambda\left(1-\bar{\theta}^1\right)(\omega - k)}{(1+\delta)(1-\lambda)(\omega-k)} \\ &= \frac{\left[\beta - \left(\bar{\theta}^1(1-\lambda)+\lambda\right)\right] + \lambda\left(1-\bar{\theta}^1\right)k}{(1+\delta)(1-\lambda)(\omega-k)} \end{aligned} \tag{44}$$

This gives immediately the two conditions given in the proposition. For the special case of proportional endowments $\bar{\theta}^1 = \beta$, this simplifies to

$$\theta^1(k) - \bar{\theta}^1 = -\frac{\lambda(1-\bar{\theta}^1)}{(1+\delta)(1-\lambda)} < 0$$

and the change in the shareholdings of both agents becomes independent of investment.

Next we derive exact necessary conditions for the direction of change of the shareholdings of owner 1 (not given in Proposition 4). From (44) we see that $\theta^1(k) - \bar{\theta}^1 \gtreqless 0$ if and only if

$$k \gtreqless \frac{\bar{\theta}^1(1-\lambda) + \lambda - \beta}{(1-\bar{\theta}^1)\lambda}\,\omega$$

Using (2.21) this is satisfied if and only if

$$-\frac{P_\lambda}{2} - \sqrt{\frac{P_\lambda^2}{4} - Q_\lambda} - \frac{\bar{\theta}^1(1-\lambda) + \lambda - \beta}{(1-\bar{\theta}^1)\lambda} \gtreqless 0$$

with P_λ and Q_λ defined in equations (2.22) and (2.23). The value of β for which the expression becomes equal to zero lies between $\bar{\theta}^1$ and $\bar{\theta}^1(1-\lambda) + \lambda$ as stated in Proposition 4.

A.7 Proof of Proposition 5

We need to find out how k, given in equation (2.21) changes with the proportion of dividends that are appropriated by owner 1 as private benefits λ. In a preliminary step we calculate the derivatives of P_λ and Q_λ as given in equations (2.22) and (2.23) with respect to λ

$$\begin{aligned}
\frac{\partial P_\lambda}{\partial \lambda} &= \frac{\delta(1-\bar{\theta}^1)(1-\alpha)(\bar{\theta}^1-\beta)}{(\delta^{-1}+\alpha)\left[(1+\delta)\bar{\theta}^1 + \delta\lambda(1-\bar{\theta}^1)\right]^2} \\
\frac{\partial Q_\lambda}{\partial \lambda} &= \frac{\alpha\delta(1-\bar{\theta}^1)(\bar{\theta}^1-\beta)}{(\delta^{-1}+\alpha)\left[(1+\delta)\bar{\theta}^1 + \delta\lambda(1-\bar{\theta}^1)\right]^2}
\end{aligned}$$

Next, we prove that P_λ is a negative number. Note that the denominator in equation (2.22) is positive, but the numerator and therefore P_λ is negative because

$$(\delta^{-1}+\alpha)(1+2\delta)\bar{\theta}^1 + (2\alpha\delta+1)\lambda(1-\bar{\theta}^1) > 2\bar{\theta}^1 > (1-\alpha)\beta$$

(Recall that by assumption $\bar{\theta}^1 \geq 0.5$, $\alpha \in (0,1)$ and $\beta \in [0,1]$.) Now we calculate from equation (2.21) the derivative of k with respect to λ:

$$\frac{\partial k}{\partial \lambda} = \left[-\frac{1}{2}\frac{\partial P_\lambda}{\partial \lambda} - \frac{1}{2}\left(\frac{P_\lambda^2}{4} - Q_\lambda\right)^{-\frac{1}{2}}\left(\frac{1}{2}P_\lambda\frac{\partial P_\lambda}{\partial \lambda} - \frac{\partial Q_\lambda}{\partial \lambda}\right)\right]\omega \tag{45}$$

- Suppose that $\bar{\theta}^1 > \beta$. In this case we have $\frac{\partial P_\lambda}{\partial \lambda} > 0$ and $\frac{\partial Q_\lambda}{\partial \lambda} > 0$. In order to prove that in this case $\frac{\partial k}{\partial \lambda} > 0$, one can see from (45) that it suffices to show that $\frac{1}{2}\left(\frac{P_\lambda^2}{4} - Q_\lambda\right)^{-\frac{1}{2}} P_\lambda < -1$. This is done in the proof in Appendix A.3, part (i) — all what we need is that $Q_\lambda > 0$. This can be easily verified using equation (2.23).

- Suppose that $\bar{\theta}^1 < \beta$. In this case we have $\frac{\partial P_\lambda}{\partial \lambda} < 0$ and $\frac{\partial Q_\lambda}{\partial \lambda} < 0$. With the same argument as in the previous case it can be shown that $\frac{\partial k}{\partial \lambda} < 0$.
- In the remaining case $\bar{\theta}^1 = \beta$, we have $\frac{\partial P_\lambda}{\partial \lambda} = 0$ and $\frac{\partial Q_\lambda}{\partial \lambda} = 0$, and it follows directly from (45) that $\frac{\partial k}{\partial \lambda} = 0$.

A.8 Final ownership stakes and private benefits

Write the optimal level of investment as $k = C\omega$ where C is given in equations (2.21)-(2.23). Using expression (44) we have

$$\theta^1(k) - \bar{\theta}^1 = \frac{\beta - \bar{\theta}^1}{(1+\delta)(1-\lambda)(1-C)} - \frac{\lambda\left(1-\bar{\theta}^1\right)}{(1+\delta)(1-\lambda)}$$

Using this expression we derive the effect of a higher fraction of private benefits λ on the final ownership stake of the controlling owner.

$$\frac{\partial \theta^1(k)}{\partial \lambda} = \frac{\left(\beta - \bar{\theta}^1\right)\left[1 - C + (1-\lambda)\frac{\partial C}{\partial \lambda}\right] - \left(1-\bar{\theta}^1\right)\lambda(1-C)^2}{(1+\delta)(1-\lambda)^2(1-C)^2}$$

For the case $\bar{\theta}^1 \geq \beta$ this expression becomes clearly negative (recall from Proposition 5 that $\partial C/\partial \lambda \geq 0$ in this case). We do however not derive a condition when the effect becomes zero or positive. This would just be a complicated function of the model parameters without great insight. We conjecture that for large β the expression might become positive.

A.9 Equilibria in the two-period model with private benefits and proof of Proposition 6

We derive the solutions for cases A, B, C and D backwards in time. Attention is restricted to interior solutions.

Case A. The first-order conditions for the optimal stakes at date $t = 1$ read

$$\frac{\partial U^1}{\partial \theta_1^1} = \frac{-p_1}{\left((1-\lambda)\theta_0^1 + \lambda\right)Ak_0^\alpha + \left(\theta_0^1 - \theta_1^1\right)p_1 - \theta_0^1 k_1} + \frac{\delta(1-\lambda)}{(1-\lambda)\theta_0^1 + \lambda} = 0 \tag{46}$$

$$\frac{\partial U^2}{\partial \theta_1^2} = \frac{-p_1}{(1-\lambda)\theta_0^2 Ak_0^\alpha + \left(\theta_0^2 - \theta_1^2\right)p_1 - \theta_0^2 k_1} + \frac{\delta}{\theta_0^2} = 0 \tag{47}$$

Imposing the market clearing condition ($\theta_1^1 + \theta_1^2 = 1$) yields the optimal ownership stakes and the value of the firm at time $t = 1$

$$p_1 = \delta(1-\lambda)(Ak_0^\alpha - k_1) \tag{48}$$

$$\theta_1^1(k_0, \theta_0^1, k_1) = \theta_0^1 + \frac{(1-\theta_0^1)\lambda k_1}{(1+\delta)(1-\lambda)(Ak_0^\alpha - k_1)} \tag{49}$$

$$\theta_1^2(k_0, \theta_0^2, k_1) = \theta_0^2 - \frac{\theta_0^2 \lambda k_1}{(1+\delta)(1-\lambda)(Ak_0^\alpha - k_1)} \tag{50}$$

We see that the ownership stake of the owner with private benefits is increasing in the last trading period. This proves Proposition 6 for case A. Next, we derive the investment decision at $t = 1$.

In the present case, owner 1 decides on the level of investment k_1 no matter what her ownership stake θ_0^1 is. The first-order condition for optimal investment reads

$$\frac{\partial U^1}{\partial k_1} = -\frac{\theta_0^1 + \delta(1-\lambda)(\theta_0^1 - \theta_1^1)}{\left((1-\lambda)\theta_0^1 + \lambda\right) Ak_0^\alpha + \left(\theta_0^1 - \theta_1^1\right) p_1 - \theta_0^1 k_1} + \frac{\delta\alpha}{k_1} = 0 \tag{51}$$

Using (48) to (50) this yields the interior solution for k_1 in terms of the previously determined variables k_0 and θ_0^1, given by the following expression

$$k_1 = \left(-\frac{P_1}{2} - \sqrt{\frac{P_1^2}{4} - Q_1}\right) Ak_0^\alpha \tag{52}$$

where

$$\begin{aligned} P_1 &= -\frac{\delta\alpha(1+2\delta)\left[(1-\lambda)\theta_0^1 + \lambda\right] + \left[1 + \delta(1+\alpha)\right]\theta_0^1}{(1+\delta\alpha)\left[(1+\delta)\theta_0^1 + \delta\lambda(1-\theta_0^1)\right]} \\ Q_1 &= \frac{\delta\alpha(1+\delta)\left[(1-\lambda)\theta_0^1 + \lambda\right]}{(1+\delta\alpha)\left[(1+\delta)\theta_0^1 + \delta\lambda(1-\theta_0^1)\right]} \end{aligned}$$

Note that we get a similar solution to the one-period model (just replace the endowment ω by first-period production Ak_0^α and owner 1's wealth share β by $(1-\lambda)\theta_0^1 + \lambda$ in equations (2.22) and (2.23).)

Going back in time, we can derive the optimality conditions for the demand for shares of each owner at $t = 0$. The first-order condition for owner 1 reads

$$\frac{\partial U^1}{\partial \theta_0^1} = \frac{-p_0}{\beta\omega + \left(\bar{\theta}_0^1 - \theta_0^1\right) p_0 - \bar{\theta}_0^1 k_0} + \frac{\delta\left[(1-\lambda)Ak_0^\alpha + p_1 - k_1\right]}{\left((1-\lambda)\theta_0^1 + \lambda\right) Ak_0^\alpha + \left(\theta_0^1 - \theta_1^1\right) p_1 - \theta_0^1 k_1} = 0$$

Note that we used the FOC for k_1 (equation (51)) and the FOC for θ_1^1 (equation 46) to cancel terms involving the derivatives of k_1 and θ_1^1 with respect to θ_0^1. Using expressions (48) to (50) we derive the optimal demand for shares of owner 1 at $t = 0$ as a function of p_0, k_0 and k_1:

$$\theta_0^1 = \frac{\delta(1+\delta)}{1+\delta+\delta^2}\,\frac{\beta\omega + \bar{\theta}_0^1(p_0 - k_0)}{p_0} - \frac{\lambda\left[(1+\delta)Ak_0^\alpha - \delta k_1\right]}{(1+\delta+\delta^2)\left[(1+\delta)(1-\lambda)(Ak_0^\alpha - k_1) - \lambda k_1\right]} \tag{53}$$

The first-order condition for owner 2 reads

$$\begin{aligned} \frac{\partial U^2}{\partial \theta_0^2} &= \frac{-p_0}{(1-\beta)\omega + \left(\bar{\theta}_0^2 - \theta_0^2\right) p_0 - \bar{\theta}_0^2 k_0} \\ &+ \frac{\delta\left[(1-\lambda)Ak_0^\alpha + p_1 - k_1 + \left((\theta_0^2 - \theta_1^2)\frac{\partial p_1}{\partial k_1} - \theta_0^2\right)\left(-\frac{\partial k_1}{\partial \theta_0^1}\right)\right]}{(1-\lambda)\theta_0^2 Ak_0^\alpha + \left(\theta_0^2 - \theta_1^2\right) p_1 - \theta_0^2 k_1} + \frac{\delta^2\alpha\left(-\frac{\partial k_1}{\partial \theta_0^1}\right)}{k_1} = 0 \end{aligned} \tag{54}$$

Again, we used the FOC for θ_1^2 (equation 47) to cancel terms involving the derivatives of θ_1^2 with respect to θ_0^2. For owner 2, however, we cannot use the FOC for k_1 to cancel terms involving

the derivative of k_1 with respect to θ_0^2 since k_1 is not chosen optimally from the viewpoint of owner 2. Owner 2 has to take the effect of his demand for shares today on investment tomorrow into account explicitly. Therefore, the derivative shows up in the previous equation. (Note that $\frac{\partial k_1}{\partial \theta_0^2} = -\frac{\partial k_1}{\partial \theta_0^1}$.)

Expression (54) can be simplified to

$$\begin{aligned}\frac{\partial U^2}{\partial \theta_0^2} &= \frac{-p_0}{(1-\beta)\omega + \left(\bar{\theta}_0^2 - \theta_0^2\right) p_0 - \bar{\theta}_0^2 k_0} + \frac{\delta(1+\delta)}{\theta_0^2} \\ &+ \delta\left(\frac{\delta\alpha}{k_1} - \frac{(1+\delta)(Ak_0^\alpha - k_1) + \delta\lambda k_1}{(Ak_0^\alpha - k_1)\left[(1+\delta)(1-\lambda)(Ak_0^\alpha - k_1) - \lambda k_1\right]}\right)\left(-\frac{\partial k_1}{\partial \theta_0^1}\right) = 0 \end{aligned} \tag{55}$$

The derivative expression in (55) is calculated from (52) and reads

$$\frac{\partial k_1}{\partial \theta_0^1} = \left[-\frac{1}{2}\frac{\partial P_1}{\partial \theta_0^1} - \frac{1}{2}\left(\frac{P_1^2}{4} - Q_1\right)^{-\frac{1}{2}}\left(\frac{1}{2}P_1\frac{\partial P_1}{\partial \theta_0^1} - \frac{\partial Q_1}{\partial \theta_0^1}\right)\right] Ak_0^\alpha \tag{56}$$

where

$$\begin{aligned}\frac{\partial P_1}{\partial \theta_0^1} &= -\frac{\delta(1+\delta)(1-\alpha)\lambda}{(1+\delta\alpha)\left[(1+\delta)\theta_0^1 + \delta\lambda(1-\theta_0^1)\right]^2} \\ \frac{\partial Q_1}{\partial \theta_0^1} &= -\frac{\delta(1+\delta)\alpha\lambda}{(1+\delta\alpha)\left[(1+\delta)\theta_0^1 + \delta\lambda(1-\theta_0^1)\right]^2}\end{aligned}$$

Now we have a system of three nonlinear equations — for the optimal investment(52), and the two first-order conditions for optimal ownership stakes (53) and (55). Using also the market clearing condition, i.e. substituting θ_0^2 by $1-\theta_0^1$ in (55), and the expression for the derivative (56) we can solve this system numerically to obtain values of k_1, θ_0^1 and p_0 for any given value of k_0. It remains only to maximize the indirect utility function of the initial majority owner 1 with respect to k_0 to obtain the full solution.

Case B. Since owner 1 always receives the private benefits, the budget constraints are unchanged with respect to case A. Hence, equations (48) to (50) for the share price and ownership stakes at $t=1$ apply, which proves Proposition 6 also for case B.

Suppose that owner 1 holds a majority after the first round of trading, i.e. $\theta_0^1 \geq 0.5$. Then the solution of case A applies also here (owner 1 decides on investment k_1 and extracts private benefits at $t=2$).

Now suppose that $\theta_0^1 < 0.5$, i.e. owner 2 decides on k_1. The optimal amount of investment in this case is given by:

$$k_1 = \left(-\frac{P_{B2}}{2} - \sqrt{\frac{P_{B2}^2}{4} - Q_{B2}}\right) Ak_0^\alpha$$

where

$$\begin{aligned} P_{B2} &= -\frac{(1+\delta)(1+2\delta\alpha)-(1+2\delta)\delta\alpha\lambda}{(1+\delta\alpha)[1+\delta(1-\lambda)]} \\ Q_{B2} &= \frac{\alpha\delta(1+\delta)(1-\lambda)}{(1+\delta\alpha)[1+\delta(1-\lambda)]} \end{aligned}$$

The two equations characterizing the optimal demand for shares at $t=1$ read

$$\begin{aligned} \theta_0^1 &= \frac{\delta(1+\delta)}{1+\delta+\delta^2}\frac{\beta\omega+\bar{\theta}_0^1(p_0-k_0)}{p_0} - \frac{(1+\delta)\lambda\left(Ak_0^\alpha-k_1\right)+\lambda k_1}{(1+\delta+\delta^2)\left[(1+\delta)(1-\lambda)\left(Ak_0^\alpha-k_1\right)-\lambda k_1\right]} \\ \theta_0^2 &= \frac{\delta(1+\delta)}{1+\delta+\delta^2}\frac{(1-\beta)\omega+\bar{\theta}_0^2(p_0-k_0)}{p_0} \end{aligned}$$

The market-clearing price is

$$p_0 = \frac{\delta(\omega-k_0)\left[(1+\delta)(1-\lambda)\left(Ak_0^\alpha-k_1\right)-\lambda k_1\right]}{Ak_0^\alpha-k_1}$$

Substituting the solution for k_1 here, and then substituting the price back to one of the demand equations yields the ownership stakes as a function of k_0 only. So we obtain again a system of three equations leading to a solution for k_1, θ_0^1 and p_0 as functions of k_0.

Now it remains to maximize the indirect utility function of the initial majority owner 1 with respect to k_0. If the result for the ownership stake of owner 1 is indeed , then the first solution (with assumption $\theta_0^1 \geq 0.5$) is a consistent one. If $\theta_0^1 < 0.5$, then the optimal level of investment k_0 is calculated using the second solution (with assumption $\theta_0^1 < 0.5$).[34] In this way we get the optimal values of investment, shareholdings and prices at dates 0 and 1.

Case C. Suppose that $\theta_0^1 \geq 0.5$. Again, owner 1 decides on investment k_1 and extracts private benefits at $t=2$. Hence, equations (48) to (50) apply, and we follow the solution of case A.

Now suppose that $\theta_0^1 < 0.5$. Now private benefits go to owner 2, as described by equations (2.24), (2.25), (2.26) and (2.27). Optimal ownership stakes and the value of the firm at time $t=1$ are given by

$$p_1 = \delta(1-\lambda)(Ak_0^\alpha-k_1) \tag{57}$$

$$\theta_1^1(k_0,\theta_0^1,k_1) = \theta_0^1 + \frac{\lambda(Ak_0^\alpha-\theta_0^1k_1)}{(1+\delta)(1-\lambda)(Ak_0^\alpha-k_1)} \tag{58}$$

$$\theta_1^2(k_0,\theta_0^2,k_1) = \theta_0^2 - \frac{\lambda(Ak_0^\alpha-\theta_0^1k_1)}{(1+\delta)(1-\lambda)(Ak_0^\alpha-k_1)} \tag{59}$$

[34] We do not prove the existence of an equilibrium here. There is a potential problematic case where θ_0^1 turns out to be less than 0.5 when we assume that it is greater or equal, and $\theta_0^1 \geq 0.5$ when we assume $\theta_0^1 < 0.5$. However, in all numerical solutions, the ownership stake with the second solution is smaller than with the first one, which means that always one of the two solutions is consistent with the assumption on θ_0^1.

Note that the expression for the firm value is unchanged with respect to the first solution where $\theta_0^1 \geq 0.5$. Although the expressions for the ownership stakes are different from the first solution, but they prove that Proposition 6 is true also for case C — the owner who initially holds a majority and receives private benefits at $t = 1$, increases her stake.

A different set of optimality conditions obtains for k_1 (determined by owner 2), θ_0^1 and θ_0^2.

$$k_1 = \left(-\frac{P_{C2}}{2} - \sqrt{\frac{P_{C2}^2}{4} - Q_{C2}} \right) A k_0^\alpha$$

where

$$\begin{aligned} P_{C2} &= -\frac{\delta\lambda + (1-\theta_0^1)\left[(1+\delta)(1+2\delta\alpha) - \lambda\delta\alpha\right]}{(1+\delta\alpha)\left[\delta\lambda\theta_0^1 + (1+\delta)(1-\theta_0^1)\right]} \\ Q_{C2} &= \frac{\delta\alpha(1+\delta)(1-\lambda)(1-\theta_0^1) + \delta^2\lambda\alpha}{(1+\delta\alpha)\left[\delta\lambda\theta_0^1 + (1+\delta)(1-\theta_0^1)\right]} \end{aligned}$$

We obtain two equations characterizing the optimal demand for shares at $t = 1$:

$$\theta_0^2 = \frac{\delta(1+\delta)}{1+\delta+\delta^2} \frac{(1-\beta)\omega + \bar{\theta}_0^2(p_0 - k_0)}{p_0} - \frac{\delta\lambda(Ak_0^\alpha - k_1)}{(1+\delta+\delta^2)\left[(1+\delta)(1-\lambda)(Ak_0^\alpha - k_1) - \lambda k_1\right]}$$

$$\begin{aligned} \frac{\partial U^1}{\partial \theta_0^1} &= \frac{-p_0}{\beta\omega + \left(\bar{\theta}_0^1 - \theta_0^1\right)p_0 - \bar{\theta}_0^1 k_0} + \frac{\delta(1+\delta)\left[(1+\delta)(1-\lambda)(Ak_0^\alpha - k_1) - \lambda k_1\right]}{\theta_0^1(1+\delta)(1-\lambda)(Ak_0^\alpha - k_1) + \lambda(Ak_0^\alpha - \theta_0^1 k_1)} \\ &+ \delta\left(\frac{\delta\alpha}{k_1} - \frac{\left((1+\delta)\theta_0^1 - \delta\lambda\right)Ak_0^\alpha - \theta_0^1[1+\delta(1-\lambda)]k_1}{(Ak_0^\alpha - k_1)\left[\theta_0^1(1+\delta)(1-\lambda)(Ak_0^\alpha - k_1) + \lambda(Ak_0^\alpha - \theta_0^1 k_1)\right]}\right)\left(\frac{\partial k_1}{\partial \theta_0^1}\right) = 0 \end{aligned}$$

The derivative $\partial k_1/\partial\theta_0^1$ is of the same form as (56) with P_1 and Q_1 substituted by P_{b2} and Q_{b2} and

$$\begin{aligned} \frac{\partial P_{C2}}{\partial \theta_0^1} &= -\frac{\delta^2\lambda[\lambda(1-\alpha) + 2\alpha(1+\delta)}{(1+\delta\alpha)\left[\delta\lambda\theta_0^1 + (1+\delta)(1-\theta_0^1)\right]^2} \\ \frac{\partial Q_{C2}}{\partial \theta_0^1} &= -\frac{(\delta\lambda)^2\alpha}{(1+\delta\alpha)\left[\delta\lambda\theta_0^1 + (1+\delta)(1-\theta_0^1)\right]^2} \end{aligned}$$

Together with the market clearing condition, these variables as well as p_0 can be determined as functions of k_0. It remains to optimize with respect to k_0 and to choose the consistent one of the two solutions as described for case B.

Case D. The optimal stakes and the price at $t = 1$ can be seen directly from equations (48) to (50) setting $\lambda = 0$: we get $\theta_1^i = \theta_0^i$ and $p_1 = \delta(Ak_0^\alpha - k_1)$. There is no reason to trade shares at $t = 1$ since the ownership stake and the share that every owner gets from period 0 production are identical by assumption (the case of proportional endowments in the basic one-period model).

This implies the simplified budget constraints

$$\begin{aligned} c_1^i &= \theta_0^i(Ak_0^\alpha - k_1) \\ c_2^i &= \theta_0^i Ak_1^\alpha \end{aligned}$$

Both owners are unanimous about investment in period 1 and would choose

$$k_1 = \frac{\alpha\delta}{1+\alpha\delta} Ak_0^\alpha$$

Stakes and the price at $t = 0$ are

$$\begin{aligned} p_0 &= \delta(1+\delta)(\omega - k_0) \\ \theta_0^1 &= \frac{\left(\beta + \delta(1+\delta)\bar{\theta}_0^1\right)\omega - (1+\delta+\delta^2)\bar{\theta}_0^1 k_0}{(1+\delta+\delta^2)(\omega - k_0)} \end{aligned}$$

The investment decision at $t = 0$ is made by owner 1, the original majority owner and leads to

$$k_0 = \left(-\frac{P_0}{2} - \sqrt{\frac{P_0^2}{4} - Q_0}\right)\omega$$

where

$$\begin{aligned} P_0 &= -\frac{\left(1+\alpha\delta+(\alpha\delta)^2\right)\left(1+2\delta+2\delta^2\right)\bar{\theta}_0^1 - (1+\delta-\alpha(1+\alpha\delta))\delta\beta}{\left(1+\alpha\delta+(\alpha\delta)^2\right)(1+\delta+\delta^2)\bar{\theta}_0^1} \\ Q_0 &= \frac{\alpha\delta(1+\alpha\delta)\left(\beta+\delta(1+\delta)\bar{\theta}_0^1\right)}{\left(1+\alpha\delta+(\alpha\delta)^2\right)(1+\delta+\delta^2)\bar{\theta}_0^1} \end{aligned}$$

B The complete markets version of the basic model

In this appendix, we present a benchmark model with complete markets. The assumptions are those of the basic model outlined in section 2.2, except that here owners are allowed to trade a bond which pays (an exogenous) interest rate r in addition to the firm shares. The amount of bonds is denominated by b^i. With this modification, owners can borrow without limit to invest in the shares of the firm. The models are therefore not comparable quantitatively in terms of the amounts invested. But the complete markets model is useful to show qualitative differences to our setup, in particular the necessary conditions for the Fisher separation theorem to hold.

The budget constraints, here presented with a general neoclassical production function $F(k)$, are modified as follows:

$$c_0^i = \omega^i + \left(\bar{\theta}^i - \theta^i\right)p - \bar{\theta}^i k - b^i \tag{60}$$

$$c_1^i = \theta^i F(k) + (1+r)b^i \qquad i = 1,2 \tag{61}$$

Time-additive expected utility with a standard instantaneous utility function $u(c)$ is given by

$$U^i = u(c_0^i) + \delta u(c_1^i) \tag{62}$$

The two pairs of first-order conditions for the optimal ownership stake and bondholdings of each owner read

$$\begin{aligned} \frac{\partial U^i}{\partial \theta^i} &= -pu'(c_0^i) + \delta F(k)u'(c_1^i) = 0 \\ \frac{\partial U^i}{\partial b^i} &= -u'(c_0^i) + \delta(1+r)u'(c_1^i) = 0 \end{aligned}$$

From these conditions, the share price is $p = \frac{F(k)}{1+r}$. Since the firm technology exhibits decreasing returns to scale and returns of shares and bonds have to be the same, the price has to increase with the level of investment k. Given this price, both assets are equivalent (have the same return). Therefore, the optimal bond and shareholdings cannot be uniquely determined.[35]

One basic result is that in complete markets, the decisions on share trading and investment can be done separately. Namely, maximizing with respect to the level of investment k gives the following first-order condition:

$$\frac{\partial U^i}{\partial k} = \left[\left(\bar{\theta}^i - \theta^i \right) \frac{F'(k)}{1+r} - \bar{\theta}^i \right] u'(c_0^i) + \delta \theta^i F'(k) u'(c_1^i) = 0$$

which yields the rule for optimal investment

$$F'(k) = 1 + r \tag{63}$$

Note that this is equivalent to the maximization of the net value of the firm or discounted profits $\max_k p - k = \max_k \frac{F(k)}{1+r} - k$. This equivalence is an instance of the Fisher separation theorem. The owners agree on a level of investment which maximizes the value of the firm and then trade bonds and shares towards their preferred consumption-saving point.

What would change if we endogenized the interest rate? That means that the two owners can only borrow and lend from each other and the interest rate is determined by the market clearing condition, $b^1 + b^2 = 0$. This implies, for the case of log utility and a Cobb-Douglas production function, that the gross interest rate satisfies $1 + r = \frac{Ak^\alpha}{\delta(\omega - k)}$. Still, individual asset holdings are not determined. There is now a fundamental change for the unanimity result: When the interest rate is endogenous, it depends on the investment decision: if k is high, then there are relatively few resources available at $t = 0$ and many resources available at $t = 1$, so the interest rate would be relatively low. That means there is no asset which payoffs are independent of the investment decision. That makes the Fisher separation theorem break down - shareholders will not agree on investment.

[35] Technically, after determining the price, we have left two optimality conditions plus one market clearing condition for shares ($\theta^1 + \theta^2 = 1$), but we have four unknown variables – bonds and ownership stakes of each owner. Thus, the solution to this system of equations is not unique.

C The basic model with CRRA preferences

In this appendix, we analyze the basic model with the power utility function with constant relative risk aversion coefficient γ. We assume that owners are risk-averse or risk-neutral, i.e. $\gamma \geq 0$. The expected utility function of owner i reads:

$$U^i = \tfrac{1}{1-\gamma}(c_0^i)^{1-\gamma} + \tfrac{\delta}{1-\gamma}(c_1^i)^{1-\gamma} \tag{64}$$

where δ is the discount factor. Recall that the limit of the equivalent instantaneous utility function $\frac{1}{1-\gamma}c^{1-\gamma} - 1$ when $\gamma \to 1$ is $\ln c$, i.e. the log utility function used in the main text is a special case of the power utility.

Solving for the exchange equilibrium provides us with optimal ownership stake of each owner as a function of the firm value and investment:

$$\theta^i(k,p) = \frac{\omega^i + \bar{\theta}^i(p-k)}{\delta^{-\frac{1}{\gamma}}(Ak^\alpha)^{-\frac{1-\gamma}{\gamma}}p^{\frac{1}{\gamma}} + p}$$

After imposing market clearing ($\theta^1 + \theta^2 = 1$) we obtain the share price

$$p(k) = (\omega - k)^\gamma \delta (Ak^\alpha)^{1-\gamma}$$

Note that k may affect the price in a positive or negative manner, depending on the coefficient of relative risk aversion γ:

$$\frac{\partial p(k)}{\partial k} = \delta A^{1-\gamma} k^{\alpha(1-\gamma)-1} (\omega - k)^{\gamma-1} \left[\, \alpha(1-\gamma)(\omega - k) - \gamma k \,\right] \tag{65}$$

For moderate and high levels of risk aversion ($\gamma \geq 1$), or, more appropriate for a model of certainty, moderate and low levels of elasticity of intertemporal substitution, the term in brackets and therefore the whole expression become negative. For low levels of γ, near to zero (risk neutrality) however the effect of investment on firm value may become positive.[36] In this case, owners are not interested in smoothing consumption between both periods, so a high investment and high returns are preferred.

Substituting in the previous equations for the optimal stakes,

$$\theta^i(k) = \frac{\omega^i + \bar{\theta}^i(p(k) - k)}{\omega + p(k) - k} \tag{66}$$

$$= \frac{\omega^i + \bar{\theta}^i \left[(\omega - k)^\gamma \delta (Ak^\alpha)^{1-\gamma} - k \right]}{\omega + (\omega - k)^\gamma \delta (Ak^\alpha)^{1-\gamma} - k} \tag{67}$$

Proposition 1 in the main text also holds with CRRA preferences.

[36] $\lim_{\gamma \to 0} \frac{\partial p(k)}{\partial k} = A\alpha\delta k^{\alpha-1} > 0$.

In order to solve for the production-exchange equilibrium we have to find the optimal level of initial investment. As stated in problem (2.6) we maximize the indirect utility function of owner 1 (since by assumption $\bar{\theta}^1 \geq 0.5$):

$$V^1(k) = \frac{1}{1-\gamma}\left[\beta\omega + \left(\bar{\theta}^1 - \theta^1(k)\right)p(k) - \bar{\theta}^1 k\right]^{1-\gamma} + \frac{\delta}{1-\gamma}\left[\theta^1(k)Ak^\alpha\right]^{1-\gamma} \tag{68}$$

Disregarding the non-negativity constraints, the first-order condition reads

$$\begin{aligned}\frac{\partial V^1(k)}{\partial k} &= \left[\left(\bar{\theta}^1 - \theta^1(k)\right)\frac{\partial p(k)}{\partial k} - \bar{\theta}^1\right]\left[\beta\omega + \left(\bar{\theta}^1 - \theta^1(k)\right)p(k) - \bar{\theta}^1 k\right]^{-\gamma} \\ &+ \delta\alpha(\theta^1(k))^{1-\gamma}A^{1-\gamma}k^{\alpha(1-\gamma)-1} = 0\end{aligned}$$

where $\frac{\partial p(k)}{\partial k}$ is given in equation (65). In general, problem (2.6) has to be solved numerically. Still one can see from the first-order condition that the desired level of investment k of owner 1 depends on her endowments. A similar condition holds for owner 2, and since endowments may be different both optimality conditions will, in general, not coincide. Our simulations for reasonable values of γ confirm the results of Proposition 2.

Proportional Endowments. We consider the case where $\beta = \bar{\theta}^1$. In equilibrium, there is no share trade such that $\bar{\theta}^i = \theta^i\,, \quad i = 1, 2$. The indirect utility function for owner 1 becomes

$$U^1(k) = \frac{1}{1-\gamma}\left[\beta(\omega - k)\right]^{1-\gamma} + \frac{\delta}{1-\gamma}\left(\beta Ak^\alpha\right)^{1-\gamma}$$

with first-order condition

$$0 = (\alpha\delta)^{-\frac{1}{\gamma}}A^{-\frac{1-\gamma}{\gamma}}k^{\frac{1-\alpha(1-\gamma)}{\gamma}} + k - \omega \tag{69}$$

In this special case, the optimal level of investment k does not depend on the individual variables β and $\bar{\theta}^1$, so shareholders will be unanimous. The same result would be obtained if a single owner maximizes utility.[37]

Next, we study how the optimal investment implicitly given by (69) changes when agents become more or less willing to substitute consumption across time (smaller or larger value of γ). Let F be the right-hand side of equation (69) and $G = (\alpha\delta)^{-\frac{1}{\gamma}}A^{-\frac{1-\gamma}{\gamma}}k^{\frac{1-\alpha(1-\gamma)}{\gamma}}$, the first term of the right-hand side. Then

$$\frac{dk}{d\gamma} = -\frac{\partial F/\partial\gamma}{\partial F/\partial k} = -\frac{\partial G/\partial\gamma}{\partial G/\partial k + 1}$$

For the partial derivatives we find the following signs

$$\begin{aligned}\frac{\partial G}{\partial k} &= (\alpha\delta)^{-\frac{1}{\gamma}}A^{-\frac{1-\gamma}{\gamma}}\frac{1-\alpha(1-\gamma)}{\gamma}k^{\frac{1-\alpha(1-\gamma)-\gamma}{\gamma}} > 0 \\ \frac{\partial G}{\partial\gamma} &= G\frac{\partial(\ln G)}{\partial\gamma} = \frac{G}{\gamma^2}[\ln(\alpha\delta A) - (1-\alpha)\ln k] \\ &\lesseqgtr 0 \quad \text{if} \quad k \gtreqless (\alpha\delta A)^{\frac{1}{1-\alpha}}\end{aligned}$$

[37] Note that one could cancel β from the indirect utility function above.

Since $\partial G/\partial k$ is positive, the sign of $dk/d\gamma$ is the opposite of $\partial G/\partial \gamma$, for example for the case $k > (\alpha\delta A)^{\frac{1}{1-\alpha}}$ we have that k is increasing in γ. If we use (69) again, we can derive the following condition:

$$(\alpha\delta A)^{\frac{1}{1-\alpha}}\left[1+(\alpha\delta)^{\alpha}\right]-\omega \lesseqgtr 0 \quad \Leftrightarrow \quad k \gtreqless (\alpha\delta A)^{\frac{1}{1-\alpha}} \quad \Leftrightarrow \quad \frac{dk}{d\gamma} \gtreqless 0 \tag{70}$$

An agent with low γ would make the investment decision mainly according to the return of the technology. If the technology has relatively low returns (low A) or the endowment ω is relatively large, an owner with low γ would invest few amounts, while an owner with higher desire to smooth consumption (high γ) would invest more – investment is increasing in γ.

Special Case $\gamma = 0$. It is instructive to specialize further to the case where $\gamma = 0$, i.e. the agents do not care about consumption smoothing at all. The optimal level of investment in this case is $k = (\delta A\alpha)^{\frac{1}{1-\alpha}}$ (while it does not exceed ω). Note that this is the same investment rule as under complete markets (appendix B), only with the market discount factor $\frac{1}{1+r}$ replaced by the subjective discount factor δ.

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