The Dynamics of Ownership and Redistribution

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To my father.

Abstract

The objective of this dissertation is to contribute to the understanding of the interaction between ownership and efficiency when sequential decisions are taken by majority voting.

The first chapter analyzes the influence of dynamic voting in the productive efficiency of a firm. Inefficiencies arise as a result of conflict in decision making concerning two decisions: technology choice and distribution of aggregate production. Two distinct constitutions are considered: employee and outside ownership. When the initial constitution turns out to be inefficient, the firm's owners can hand over control rights to efficient investors in exchange for a selling price. Constitutional change, by allowing current owners to internalize social surplus, would in principle increase efficiency. Yet constitutional change will never take place, giving rise to institutional inertia.

The second chapter considers the effect of redistribution on efficiency in a the framework of a general cooperative where both the set of alternatives and the preference profile of voters is unrestricted. Efficiency is defined by a public decision, i.e. the implementation of a productive technology, as well as by a collection of individual investment decisions, i.e. employees' choice of effort. The first result provides conditions that, by restricting conflicts of interest in redistribution, ensure the existence of equilibrium in collective choice. It turns out that, provided that an equilibrium exists, the technology implemented in the firm is always Pareto efficient. This result holds even if it may lead to greater distortions in employees' choice of effort. The remaining analysis compares the direct effect of redistribution on efficiency via employees' individual investment with its indirect effect via distortions on technology choice.

The last chapter investigates the effect of privatization on the efficiency of a public firm within the context of a representative democracy. Public decisions are implemented by a self-interested government selected by majority voting. Collective choice is embodied by the firm's regulation policy as well as by the tax shedule imposed on citizens. Provided privatization takes place, two polar ownership structures are analyzed: concentrated and dispersed ownership. The main result is that concentrated ownership, by favoring the participation of lobbies in the political game, may increase the efficiency of

a regulated firm. This result is robust to both a hidden information model and a moral hazard approach.

Contents

0.1 Introduction

This dissertation addresses the question of how the ownership of a firm may affect its efficiency when the distribution of total surplus is decided by majority voting. This section will first present the general framework of analysis. Then it will introduce the specific applications that are developed throughout the thesis. Finally, it will briefly present the main results under the light of the related literature.

Voting as a mechanism to aggregate individual preferences over collective decisions has been justified using different lines of argument. First, from an axiomatic approach, majority rule is the only decision procedure that meets the test of decisiveness, positive responsiveness, anonymity of voters and neutrality of alternatives (May, 1952). Second, making a collective decision through voting is supported by the belief that individuals will reveal their preferences when casting their vote, thus leading to the determination of which public activity is worth pursuing. Revelation of preferences can be achieved with different mechanisms such as a demand-revealing process (Groves and Leyard, 1977). Third, policy choice in representative democracies can be regarded as the outcome of a voting mechanism. A classical application of majority voting is the choice of a redistributive tax rule in a society of heterogenous voters (Roberts, 1977). The political process can be interpreted as the delegation of authority in the public domain to particular citizens that compete to acquire power through an electoral process (Besley and Coate, 1997). A major drawback of majority voting is however, the possibility of creating cycles whereby any alternative belonging to the feasible set can be defeated by another alternative in a majority contest (Black, 1958). We shall consider two different applications of voting. First, voting by a firm's stakeholders in the context of an enterprise (chapters I and II). Second, voting by citizens in the political arena (chapter III).

The decision of how to distribute aggregate surplus can only create inefficiencies as long as there is some friction preventing perfect contracting. We shall assume the presence of asymmetric information between the parties involved in a transaction. In particular, we will consider two different impediments leading to inefficiencies. The existence of private information received after the contract has been signed (chapters I-III), giving rise to hidden knowledge, and the non verifiability of the action taken by the agent that influences either the benefit from a productive decision (chapter II) or the distribution function of a random variable (chapter III). Both situations are encompassed in a model of moral hazard.

Failure to internalize total surplus may induce two main types of inefficient behavior. First, a distortion in an agent's individual investment. This source of inefficiency has been widely recognized in the literature on public choice –distortionary taxation induces an inefficiently low level of labor supply–, as well as in the literature on transaction costs where an agent may underinvest in firm specific skills driven by the anticipation of future expropriation.

The second inefficient behavior that we shall analyze is the distortion in collective choice on a public decision. Asymmetric information in this setting will prevent the application of Coasian bargaining to restore efficiency. This type of distortion has been analyzed in the literature on social choice –the fact that an activity is favored by a majority does not imply that its benefits exceed its costs– and in the literature on contract theory, where the existence of asymmetric information at the trading stage may prevent agents from reaching an efficient decision, thus neglecting gains from trade.

We will focus the analysis on two different types of collective decisions. Namely, the implementation of a productive decision within a firm (chapters I and II) and the design of a contract specifying a regulation schedule (chapter III). We shall assume that the collective decision is implemented by the individuals endowed with control rights to exercise authority. This assumption is in line with the literature on public choice where citizens delegate authority to a representative government through an electoral process. Also, it is consistent with the literature on incomplete contracts where the allocation of property rights award residual rights of control to the holder of ownership. We therefore rule out the application of implementation theory to determine collective choice and the justification is twofold. The first reason draws on the inability of the contracting parties to foresee all future contingencies as well as the limited efficacy of mechanism design to improve efficiency when information is only partially revealed ex-post and renegotiation is allowed (chapters I and II). The second reason lies on the rules of the game observed in representative democracies where the government appointed by the electorate is not committed to implement specific policy choices. Even though his performance is in practice restricted by the anticipation of the rewarding or penalizing voting behavior of the electorate in the next election. In principle, we might consider the design of a contract between the government and its electorate whereby the actions taken by the government on each potential state of nature is determined in advance. But we can envisage a main problem inherent to the public domain, namely the existence of free riding problems among citizens to enforce such a contract (chapter III).

We shall consider two notions of ownership. First, the possession of residual control rights over a physical asset. That is, the ability to decide how the asset should be used in all contingencies where any prior contract remains silent, as defined by Grossman and Hart (1986) and Hart and Moore (1990). Ownership may lead to the inefficient allocation of resources in a public decision as long as different alternatives provide agents with different protective shields against the owner's opportunism to expropriate their transferable utility. Protection may come from the agents' outside opportunity which is in turn determined by the existence of a competitive market or alternatively, from the anticipation of different sharing rules under different public decisions, which are implemented using a majority voting rule (chapters I and II).

Moreover, it may also lead to underinvestment in individual decisions driven by the anticipation of expropriation following the bargaining game that allocates total surplus among the various contracting parties (chapter II).

Second, in the context of a regulated industry, we shall define ownership as the endowment of residual income rights from a physical asset. This definition is driven by the assumption that regulation implies that control rights are *de facto* held by the government irrespective of the ownership structure of the firm. Still ownership may influence efficiency by changing the preferences of the government towards regulation. This change in preferences may be due to a change in the cost imposed to the electorate under alternative ownership structures or alternatively, to a change in the benefits from regulation that are internalized by the government motivated by the actions taken by organized groups of citizens (chapter III).

When individuals holding control rights fail to act efficiently, we allow for the existence of two mechanisms that potentially may restore efficiency.

The first instrument that we consider is the feasibility of a change in the initial constitution of the firm whereby control rights would be transferred to efficient owners (chapter I). There is a limited literature on the theory of the firm that endogenizes the allocation of control rights among a firm's stakeholders.

The second mechanism that we allow to restore efficiency consists of a lobbying game played between the government and the minority group of citizens that are excluded from political life (chapter III). Lobbying, by allowing citizens to reveal their preferences towards collective choice, will in principle help the government to internalize total surplus. The influence of organized groups in collective decision making has been analyzed in the literature of political economy. Typically, a lobby forms with one of the following objectives in mind. Either to contribute resources to increase the winning prospects of its preferred political party or alternatively, to offer contingent contributions to the incumbent government in order to influence policy choice.

Also, we shall analyze how the existence of uncertainty at the productive stage regarding the power of each party to set future redistribution, may affect the efficiency of a firm. Uncertainty will be explicitly analyzed in chapter I, where the identity of individuals forming the majority group at the redistribution stage is not revealed until the productive decision has been implemented. We shall explore the impact of this source of 'political uncertainty' under the assumption of individuals' risk neutrality. Uncertainty will also be implicitly considered in chapter III, where the behavior of an incumbent government is driven by its fear to lose power in future elections.

More specifically, we will analyze in this thesis the effect of ownership on efficiency in three different applications.

First, consider the behavior of a firm governed by its initial constitution. The role of a constitution is to assign control rights to the owners of physical assets. Control rights will be exercised with respect to the technology to be implemented in the firm. Once the technology has been implemented, ownership will also give control rights to decide how to distribute aggregate surplus. In the presence of heterogenous preferences decisions are taken by majority voting. Consider the special case where control rights are held by the employees of a cooperative. Each employee acknowledges that the outcome of the first vote will determine the formation of the winning coalition at the date of the second vote. Hence forward looking employees, anticipating the influence of technology choice on redistribution, will vote strategically to influence future voting outcomes. Dynamic voting will impinge upon the efficiency of the firm via distortions in technology choice.

Provided the voting outcome on technology is inefficient, employees may decide to change the ownership structure of the firm by transferring property rights to an efficient outsider. Assume the most favorable case conducive to constitutional change where employees hold all the bargaining power at the selling stage. Under this assumption, the selling price would account for the expropriation which is anticipated under the new ownership structure. Yet we shall see that the feasibility of constitutional change will not help to overcome inefficient technology choice. Then we consider a new informational environment regarding the information available to each employee at the time of technology choice. More specifically, we shall assume that each employee only knows the probability distribution over his productivity type under the efficient technology. This uncertainty will carry over to the second voting stage where redistribution is decided. Will this 'political uncertainty' have any impact on efficiency under the assumption of employees' risk neutrality? This is the subject of analysis of chapter I.

Chapter II considers a more general set up that encompasses a richer choice set than the model analyzed previously. This generalization is carried over along two dimensions. First, in the expansion of the set of employees' productivity types as well as in the set of available technologies. In particular, both sets will include an unrestricted yet finite number of alternatives. Second, in the addition of a new choice variable defined as a collection of employees' choice of effort. That is, whereas in chapter I efficiency is entirely determined by the technology implemented in the firm, in chapter II efficiency is defined as a function of two variables: a vector of employees' individual decisions, namely effort choice, as well as the outcome of a joint investment decision, namely technology choice. This characterization urges for an analysis on the relative impact of these two variables on the firm's efficiency. Moreover, a majority voting rule in a setting with more than two types of preferences and more than two alternatives may cause inefficiencies not only through an inferior choice of investment but also through the inability to reach an equilibrium decision. This additional cost will also be accounted for in the analysis presented in chapter II.

Last, chapter III considers an alternative set up that characterizes the productive firm as a natural monopoly which implements a public project. Also, it defines the stakeholders of the firm as the set of heterogenous citizens that extract a positive surplus from consuming the project. The constitution that governs a state-owned firm can be interpreted as the outcome of a political contest that delegates political authority to a representative government chosen by majority voting. This government will be endowed with control rights to regulate the natural monopoly. It will act to maximize its prospects of reelection (incomplete contracting). In particular, the government will exercise authority regarding two decisions. First, which transfer scheme should be offered to the firm in order to cover the cost of the project (productive decision). Second, which tax system should be imposed on citizens to raise funds (redistributive decision). The choice of regulation echoes the productive decision taken by the owners of a firm as explored in chapters I and II. Likewise, the choice of discriminatory taxation mirrors the choice of redistribution. Suppose that the cost of the project depends on two variables, i.e. the state of nature and the effort exerted by the manager of the firm. Assume that effort is non-verifiable. First, suppose that the manager has private information over the state of nature that has realized. In this setting, the transfer scheme offered to the firm will serve not only to cover the cost of the project but also to induce the manager to reveal the truth (hidden information). Second, consider an alternative setting where the manager can influence the distribution function over the realized state of nature that is publicly observed. Now the transfer scheme received by the manager will also serve as an incentive mechanism to exert effort (moral hazard). In both cases, the efficiency of the firm is defined by the effort invested by the manager in cost reduction.

Suppose that the government can change the ownership structure of the firm by transferring property rights over the assets of the firm to a group of citizens. Remember that the project is defined as a natural monopoly. This means that the firm will be regulated by the government irrespective of its ownership structure. That is, the government will hold control rights over the regulation of the firm even after it has been privatized. Therefore, privatization can be defined as the transfer of income rights to a group of prospective investors. The natural question that arises is whether ownership may influence the efficiency of a regulated firm. The answer can only be positive as long as ownership is relevant to pin down the preferences of the government towards regulation. A self-interested government will represent the preferences of the majority group towards regulation but will neglect the preferences held by the minority group. Hence, it will implement a distributive rule that expropriates the surplus enjoyed by the minority through tax discrimination. Also, it will offer a regulatory outcome that minimizes the cost of taxation levied upon its electorate. Yet suppose that the minority group decides to constitute a lobby and bargain over the regulatory scheme offered by the government. As the minority will typically be formed by a large group of citizens, the existence of free riding problems will preclude the formation of such an organized group. But free riding problems may be overcome as long as each citizen has a sufficiently high stake in the rents accruing to the firm. In other words, provided each investor has a non-negligible share of the firm's income rights. To achieve concentrated ownership, the process of privatization will be addressed to a core group of institutional investors. In this context, the final outcome on regulation will be driven by the preferences exhibited by the majority group through voting together with the preferences of the minority group revealed through lobbying. Yet there is a key difference between voting and lobbying. In particular, the role of voting is to fix the status quo outcome that will prevail at the negotiation stage between the government and the organized group. There are two questions that arise from this framework. First, which ownership structure will be observed in equilibrium? Second, what is the combined effect of majority voting and lobbying on efficiency? The monetary contribution offered by the lobby plays a similar role to the price offered by outside investors in chapter I. Yet whereas the lobbying game may lead to privatization -despite the fact that the lobby captures all surplus from the government-, the selling game will always lead to the continuation of the status quo -even when employees hold all the bargaining power in front of investors-.

In the remainder of the introduction we will discuss some of our results in connection with the relevant literature.

The effect of ownership on efficiency when productive decisions are taken by majority voting has been analyzed in the incomplete contract literature. Hart and Moore (1998) focus on the voting behavior of a cooperative where the source of inefficiency lies either on the cost advantage enjoyed by the cooperative or otherwise on the conflicts in decision making among employees. Our chapter however, highlights how conflicts in collective choice are emphasized by dynamic voting. It will turn out that the anticipation of ex-post transfers via redistribution will generate vested interests ex-ante in favor of the status quo project irrespective of the efficiency of a new technology. Such vested interests might even lead a firm to neglect a Pareto improving technology. Moreover, we endogenize the choice of ownership structure. In particular, we allow the owners of an inefficient firm to transfer ownership to an efficient third party as a device to capture efficiency gains. Whereas in chapter I the cooperative votes on constitutional change, in chapter III the government decides whether to relinquish income rights on a state-owned firm. In the former case, a cooperative will *never* sell off the firm to efficient investors. In the second case by contrast, the government may decide to privatize the firm. Yet the motivation that prevents constitutional change is the same that underlies the decision of the government to hand over ownership rights to investors: the protection of power to set future redistribution. On the one hand, it is the fear to lose power in future voting decisions that induces the winning coalition to block the transfer of ownership to efficient investors in chapter I. Yet when there exists uncertainty over the composition of the majority group that will prevail in future voting decisions, inefficient owners may sell off the firm as an insurance policy that covers against the loss of political power under the initial constitution despite employees' risk neutrality. On the other hand, although chapter III does not model explicitly future political campaigns, it is the prospect to expropriate the losing side from the forthcoming election that leads the incumbent government to accept the monetary contribution offered by a lobby at the privatization stage.

Technology choice and efficiency in the presence of uncertainty links with the literature on economic reform and growth. In both cases, decisions are taken by majority voting. Fernandez and Rodrik (1991) analyze how majority voting may lead citizens to neglect an efficient reform in order to keep the benefits generated by the status quo. In their model, the reason why an efficient reform may be foregone draws on the existence of an upfront payment which is imposed on all citizens even if they may not benefit from reform. This contrast with our analysis where the cost of a new technology is normalized to zero. Moreover, they do not allow for ex-post transfers among citizens. Thus, a status quo bias can only arise in a dynamic setting in which citizens vote twice on economic reform. Yet in our analysis, ex-post transfers lie at the heart of inefficient decision making. Furthermore, it is the feasibility of redistribution that generates the status quo bias arising in a static setting where citizens vote on technology choice only once.

Our results also relate to the literature on 'political failure' where the incumbent government may fail to adopt a public investment that is potentially Pareto improving when it may change the identity of future policy makers in a way that is detrimental to the current government (Besley and Coate, 1998). However this prediction lies on the assumption that the policy outcome involves two sequential votes on redistribution, before and after the investment has been implemented. In Besley and Coate (1998), citizens face a trade-off between accruing future efficiency gains from the implementation of an efficient investment and gaining redistributive gains today from their current power to set the tax policy. This trade-off would no longer hold in a setting where redistribution was decided only once, after the investment had been implemented. Yet this is the case in our analysis, where the Pareto inefficiency is driven not by the gain realized under the status quo but by the uncertainty of holding power under the new investment.

The existence of organized interest groups trying to influence a political party's platform or the government's policy choice has been recently analyzed in the political economy literature. A lobby will typically offer a monetary contribution contingent on policy choice. The payoff accruing to the government is assumed to increase with the contribution received from the lobby, and the reason can be twofold. The government can either use contributions to finance future electoral campaigns that may swing votes of indecisive voters. Or it may use contributions for its own future consumption. Bernheim and Whinston (1986) model the lobbying game as a menu auction game in which each lobby bids a monetary contribution contingent on the action implemented by the government. Likewise, the government takes an action to maximize its prospects to be reelected given the contribution schedules offered by the lobbies. They show that the menu action game has an efficient equilibrium. Dixit, Grossman and Helpman (1996) generalize this framework to a setting of non-transferable utility across lobbies. They show not only that a truthful Nash equilibrium is Pareto efficient but also that the government will use a non distortionary policy instrument such as lump sum transfers as opposed to inefficient policies such as commodity taxes or subsidies. Their results are based on the assumption of a benevolent government that maximizes total welfare as well as on the availability of policy instruments that are non-distortionary. In Grossman and Helpman (1994) the government, although still benevolent, is however restricted to use policy instruments that are inevitably distortionary. This assumption together with the existence of just one lobby representing the interest of a specific industry induces protection for this sector hence generating inefficiencies in a world characterized by free trade otherwise. To summarize the above arguments, the participation of lobbies in political life can only induce inefficient outcomes. By contrast, our results show that the lobbying game may rise efficiency. In particular, it may induce first best incentives in the regulation of a privatized utility. This suggests that in the absence of lobbying, the policy outcome is inefficient. Indeed, inefficiencies arise due to two factors. First, to the presence of private information that makes the rents accruing to the firm an increasing function of efficiency. Second, to the constraint imposed to the government in the use of regulation by confining its choice to the design of a distortionary tax policy. We shall see that only a self-interested government seeking to be reelected may value sufficiently monetary contributions that are in turn an increasing function of informational rents, to favor increased efficiency.

Throughout this dissertation, individuals exhibiting heterogenous preferences are compelled to make a collective decision. In particular, in chapters I and II, employees varying in their productive abilities decide which technology to implement in the firm and how to distribute total surplus. Likewise, chapter III introduces a representative democracy where citizens, enjoying a different surplus from the consumption of a public project, delegate authority to a government to implement policy choice. In all cases, the mechanism used to aggregate heterogeneous preferences into a social preference relation is majority voting. Additionally in chapter III, we allow a bargaining game between the government and a minority group of consumers. In chapters I and III, the use of majority voting always induces a transitive social preference relation by assumption. In effect, either the set of feasible alternatives has been restricted –in chapter I, there are only two available technologies– or the number of types among voters has been restricted –it is the case of chapter III where there are only two types of citizens–.

In chapter II we generalize both the number of voters and the number of technologies to an unrestricted number of alternatives. In a general framework, a majority voting equilibrium may fail to exist, giving rise to instability or cycling. The literature on social choice has provided two types of conditions to guarantee the existence of equilibrium. First, restrictions in the dimensionality of the policy domain. Second, limitations on the preference types of voters. Yet chapter II considers a two dimensional voting game defined over the choice of a technology and the choice of a linear redistributive schedule, with no prior weak ordering among pairs of alternatives. This implies that we cannot apply the results proposed by Roberts (1977) on hierarchical adherence nor the analysis provided by Gans and Smart (1996) who show that single-crossing preferences in a one dimensional space is a sufficient condition for the existence of equilibrium by majority voting. Instead we propose a condition that, by restricting the characterization of technologies, pins down an equilibrium sharing rule that reduces the extent of conflict among voters, hence ensuring the existence of equilibrium in technology choice. Also we explore the interaction between different sources of inefficiency with redistribution. Specifically, we show that the direct effect of redistribution on efficiency via individual underinvestment, although negative, is limited by an upper bound. However the indirect effect of redistribution via technology distortion, although it may generate unbounded efficiency losses, it may also lead to an increase in efficiency. The reason is that redistribution, despite causing free ride problems, helps however to internalize total surplus.

Chapter 1

Institutional Inertia

1.1 Introduction

The aim of this chapter is twofold. First, to explain how vested interests may arise among a firm's stakeholders; second, to show how the existence of such vested interests may prevent not only the choice of an efficient technology, but also the adoption of an efficient constitution.

To illustrate the type of inefficiencies that will be discussed in the chapter, consider the following example. A group of 15 explorers sets off to extract the mineral resources from some island. To this end, they will need access to equipment. There are two alternative ownership structures. Either they could organize themselves as an independent expedition; i.e. they could own the equipment as a cooperative, with decisions taken by majority vote. Or they could become a royal mission, whereby the king would own the equipment and take all decisions.

There are two decisions to be taken. First, which kind of mineral to extract: they can either settle on an island with diamonds or on an island with gold. Second, how the spoils should be divided. Crucially these decisions are to be taken in sequence: they have to choose the island, and then they have to split the surplus. Also, neither decision can be contracted upon in advance.[1]

[1]The idea that decisions cannot be contracted upon in advance and that the owner of the equipment has the right to decide how it is used, first appeared in Grossman and Hart (1986).

In the spirit of subgame perfection, suppose that the expedition has already landed on, say, the diamond island, and that the question is now how to share the profit. On this island, only 7 out of the 15 explorers are productive (let us say that the other 8 suffer from claustrophobia and cannot go underground). Each of the productive explorers has a productivity of 12. The unproductive have zero productivity. The productivity of each explorer is privately known before they set foot on the island, but becomes public information after they disembark.

If the mission is run as an independent expedition, the unproductive explorers will have a majority of the votes and so they will be able to expropriate productive explorers by denying them access to the equipment. To put a limit on expropriation, we suppose that the productive explorers have an outside option whereby they can get a payoff of 7 (that is, they have a productivity of 12 with access to the equipment, and 7 without). The winning proposal in the vote will thus be to leave 7 of the 12 in the hands of the 7 productive explorers, and divide the rest, 35, equally among the 8 unproductive.[2] That is, the unproductive will get a payoff of $4\frac{3}{8}$.

Had the king been in command of the expedition, he would simply expropriate all the explorers as much as possible, reducing their payoff down to their outside options (7 and zero for the productive and the unproductive types respectively). This would yield the king a payoff of 35.

Now let us suppose the expedition landed on a gold island. There are productive and unproductive explorers in this island too. But now the productive types are in the majority. Specifically, 8 of them have a productivity of 10, whereas the remaining 7 have a productivity of zero (we might suppose that they suffer from vertigo and cannot hike into the mountains searching for gold). In other words, there are more productive people on a gold island than on a diamond island, but their individual productivities are lower. For ease of comparison, let us continue to suppose that the productive explorers have an outside option of 7.

In an independent expedition, as the productive types are in the majority, there will be no expropriation on the gold island. The payoff accruing to each explorer will equal his own productivity, that is 10 or zero. Under royal

[2]We suppose equal treatment within a group of explorers of the same productivity type. Various auxiliary assumptions could be made to rationalize this.

authority, however, the king would expropriate the productive explorers, just as he did in the diamond island. Each of the 8 would have their payoff pushed down from 10 to their outside option 7. The king's payoff will be 24.

Having established the various' parties payoffs on each of the two islands, we can now move back to the first decision: which island to choose. Under royal authority, the king will obviously choose the diamond island, as the payoff, 35, exceeds the payoff of 24 from the gold island.

In the case of an independent mission, the choice of island is more intricate because there are four categories of explorers with competing interests: those who are productive on both islands, those who are productive on only one island, and those who are unproductive on both islands. Note that at this stage the question of who is in which category is private information, which precludes Coasian bargaining. Instead, the decision over which island to choose is made by a straight vote. Consider the payoff of an explorer who is productive on the gold island. His payoff, 10, is greater than the payoff he would get on the diamond island irrespective of whether he is productive there or not (7 or $4\frac{3}{8}$ respectively). Therefore, he will vote for the gold island. But there are 8 such explorers, so they will win the vote.[3]

Given that the decision over which island to choose varies across ownership structures, we might ask which organization performs better. The wealth of the diamond island is $7 \cdot 12 = 84$. The wealth of the gold island is $8 \cdot 10 = 80$. So efficiency calls for diamond extraction. The fact that the independent mission votes for the gold island whereas the royal mission chooses the diamond island means that, in this example, outside ownership performs better than common ownership.

Of course, before the vote on choice of island is taken, the independent expedition should recognize that it would perform better under royal governance. This suggests that they should negotiate with the king for a transfer of ownership. Take the 'best' case where the explorers have all the bargaining power. They would demand a transfer price of 35, the king's maximum payoff. This amount would be divided equally among the 15 of them. Will they vote to sell to the king? No! The winning coalition formed by the 8 explorers

[3]Interestingly, the decisive factor in determining the outcome of this vote is the fraction of productive explorers on each island, not the exact numbers of explorers in each of the four categories.

who are productive on the gold island will block it. Under the status quo – independent mission –, they each get 10, as a result of the vote to extract gold. Under royal governance, the king would choose the diamond island and their overall payoff would be the sum of their outside option (either 7 or zero) plus their dividend ($\frac{35}{15}$) from the transfer – in total less than 10. Here we have an illustration of what we call *institutional inertia*: the failure of an inefficient organizational form to evolve into an efficient organization.

So, certainly, outside ownership is more efficient than common ownership in the above example. But this is by no means always the case. Consider a minor change to the example. Keep all the numbers the same except for the gold island where a productive type now has a productivity of 11 instead of 10. The gold island is then the efficient island as $8 \cdot 11 = 88$ is greater than $7 \cdot 12 = 84$. Applying the previous logic, it is straightforward to confirm that an independent expedition will still choose the gold island whereas the king will select the diamond island. In this modified example then, common ownership is more efficient than outside ownership.

Thus both forms of ownership structure can be efficient, depending on the circumstances. But can we say anything general about the biases away from efficiency? It turns out that we can. One thing to notice from the previous examples is that the independent expedition seems to have a tendency to vote for islands where there are more productive explorers albeit each has a smaller productivity. We might term such islands as 'egalitarian'. By contrast, the king seems to be inclined to choose islands where the productive explorers have higher productivity even though there are fewer of them. We might term these islands as 'polarized'. In the chapter we prove the following general result about the *relative* bias of the two ownership structures.

A cooperative is more biased towards egalitarian projects than is an outside-owned firm. That is, if an outside-owned firm chooses an inefficient egalitarian project then so too does a cooperative. Correspondingly, an outside-owned firm is more biased towards polarized projects than is a cooperative. That is, if a cooperative chooses an inefficient polarized project then so too does an outside-owned firm.

It is important to note that this is a general result. It does not depend on the fact that one island has a majority of productive types and the other has a majority of unproductive types (as in the above examples). It might be the case that both islands have a majority of unproductive types – so that there is always redistribution.

Let us remind ourselves about the informational assumptions we have made so far. At the time when the island is chosen, explorers privately know their productivity on both islands. It is only by the time of the second decision, concerning redistribution, that this private information has become public. Of course there are many other possible informational assumptions that we might make. For instance, it could be that some of the explorers do not have a clear idea about their productivity on the islands. Consider the following example. Suppose that, at the time of the first decision, there are only two (not four) categories of explorers. The first category privately know their productivity: they know that they will be productive on both islands. Let us say that their productivity is always 12, and that there are 7 explorers in this category. The second category of explorer, who are in the majority, are uncertain about their productivity. They know that they will be unproductive on the diamond island, but that there is some chance they may be productive on the gold island. Exactly one of the 8 of them – at this point they do not know which – will turn out to be productive and have a productivity of 12 too (the rest will be unproductive). Notice that, given these numbers, in technological terms the gold island Pareto dominates the diamond island. Whereas on the diamond island there are only 7 productive explorers, on the gold island not only are these 7 explorers productive but also one additional explorer is productive. In all cases individual productivity is 12, and the reservation payoffs of the productive explorers is 7.

It is clear that the king will choose the gold island. Prima face, one would think that the independent mission would too. Surprisingly, this is not the case. Consider the payoff of an explorer who is unproductive on the diamond island. His payoff from this island, $4\frac{3}{8}$, is greater than his payoff from the gold island which, under the assumption of risk neutrality, equals his expected productivity $\frac{7}{8} \cdot 0 + \frac{1}{8} \cdot 12 = \frac{3}{2}$. Therefore, he will vote in favor of the diamond island. As there are 8 such explorers, they will win the vote, and the expedition will make a Pareto dominated choice. This voting outcome results from what we call *political risk aversion*: the failure of a cooperative to be efficient when the power of the current winning majority is jeopardized. And this result holds despite the explorers' underlying risk neutrality.

Given this extreme form of inefficiency, it might be supposed that the independent expedition will choose to change their constitution and sell to the king. But even this turns out not to be true! The king would pay them his expected payoff $8(12-7) = 40$. Since at the time on the decision of whether or not to sell there are only two categories of explorers, the majority group will have their way. Under the current constitution they get a payoff of $4\frac{3}{8}$, given that the diamond island is chosen If they sell to the king, the king will choose the gold island and, their overall payoff will be the sum of their expected outside option, $\frac{7}{8} \cdot 0 + \frac{1}{8} \cdot 7 = \frac{7}{8}$, plus their dividend, $\frac{40}{15}$, from the transfer – in total $3\frac{13}{24}$, which is less than $4\frac{3}{8}$. Again this is an illustration of institutional inertia, of an extreme form: a failure to choose a new ownership structure that would yield, in technological terms, a Pareto improvement.

Individual uncertainty is not all bad news, however. It can reduce the scope for institutional inertia. For the case of no individual uncertainty, we prove a rather surprising result: if a cooperative chooses an inefficient technology (whereas an outside owner would not), the cooperative will *never* sell to the outsider. Yet this is not the case when there is individual uncertainty. The transfer price, accrued by the members of the cooperative as an upfront payment, may act as an insurance policy which compensates for the loss of political power.

The chapter is organized as follows. The basic model is presented in Section 2 where the relative efficiency of employee and outside ownership is analyzed. Section 3 allows for the possibility of constitutional change. Section 4 introduces individual uncertainty. Section 5 analyzes the predictions of the model in the light of the empirical evidence. Section 6 presents a discussion of the hypotheses of the model and suggests some governance provisions to increase efficiency. It concludes with a revision of the related literature. The concluding remarks are presented in Section 7.

1.2 Basic model

We consider a firm with I heterogeneous employees, where I is an odd number. At date 0 the firm is defined by the assets required to implement a productive technology. Two potential technologies are revealed by nature: project i and project j.

The firm decides at date 1 which project to undertake. The cost of either project is normalized to zero. Once the technology has been implemented, the firm determines at date 2 how to distribute aggregate surplus among the firm's participants.

Contracts are incomplete. In particular, owners cannot commit at date 0 to a date 1 technology choice. Also, they cannot commit at date 1 to a date 2 sharing rule. It is this dynamic interaction between production and redistribution that can lead to inefficient decisions.

We consider two ownership structures: cooperative and outside ownership. In a one-member-one-vote cooperative, each employee is assigned one control right; decisions are taken by majority voting. As employees are heterogeneous, conflicts in decision-making are likely to arise. By contrast, in an outside-owned firm, investors are assumed to be homogeneous because they take decisions to maximize profits; as a result, their interests are aligned and the allocation of control rights among them is thus irrelevant. We discuss these two structures in turn.

1.2.1 The Cooperative

Consider a one-member-one-vote cooperative where both decisions, namely the technology choice at date 1 and the redistribution at date 2, are decided by majority voting. The characterization of employees is as follows. Under project i, employees can either be low productivity types, with productivity normalized to zero, or high productivity types with productivity $x_i > 0$. Under project j, low types still accrue zero productivity whereas high types accrue productivity $x_j > 0$. We do not impose any ordering of employees across projects in terms of their individual productivity; that is, a low type under project i might be a high type under project j and viceversa. Thus at the voting stage at date 1, there are four types of employees, $\{ll, lh, hl, hh\}$, where (ll) denotes the group of employees whose productivity is low under both project i and project j, (lh) denotes the group of employees who are low types under project i but high types under project j, and so on. The fraction of these four types of employees is denoted by g_{ll}, g_{lh}, g_{hl} and g_{hh} respectively. We assume that there is a strictly positive fraction of all types; i.e. $g_{ll}, g_{lh}, g_{hl}, g_{hh} > 0$. The productivity of employees across projects is summarized in the following table:

Employee's type	Productivity (project i)	Productivity (project j)	Fraction
ll	0	0	g_{ll}
lh	0	x_j	g_{lh}
hl	x_i	0	g_{hl}
hh	x_i	x_j	g_{hh}

Note however that at date 2, once the technology choice has been undertaken, there are only two types of employees, namely low and high productivity types. Denote by f_i and f_j the fraction of high types under projects i and j respectively. The relation between the fractions of employees at date 1 and at date 2 is as follows:

$$g_{hl} + g_{hh} = f_i, \text{ and } g_{lh} + g_{hh} = f_j.$$

Notice that there are many combinations of g_{ll}, g_{lh}, g_{hl} and g_{hh}, which yield the same f_i and f_j.

Different types of employees will exhibit different preferences at each voting stage. At date 1, it is unlikely for one single type of employee to be in the majority; rather, different types of employees will form coalitions in order to win the vote. At date 2 by contrast, there will always be a majority formed by either low types or high types.

We assume the existence of a spot market at date 2 offering a reservation wage to employees. We assume that as low types are unproductive inside the firm, their outside wage is zero. By contrast, once the technology has been implemented, high types develop skills that are only partially firm specific. We assume that their outside wage is contingent on technology choice, i.e. w_i and w_j; we also assume that for each project, the outside wage is strictly higher than zero, but strictly lower than high types' inside productivity, that is, $0 < w_i < x_i$ and $0 < w_j < x_j$. The effect of the outside market is to put a limit on expropriation at date 2. Low types cannot be expropriated. High types cannot be pushed below their outside wage.[4]

[4]There is an alternative way to motivate the assumption of partial expropriation. Assume that high types need to exert effort in order to be productive. If effort is costly and non-verifiable, the anticipation of expropriation will lead to underinvestment in effort. In equilibrium, expropriation, if positive, will be limited so as to induce high types not to shirk. This moral-hazard approach has been explored in Chapter II.

In the analysis that follows, we characterize the technology and the redistributive schedule which is chosen in equilibrium. Each employee votes to maximize his expected payoff. As it is a two-stage voting game, we solve backwards.

Redistribution (date 2 vote)

Suppose that project i was chosen at date 1. At date 2, we assume that voting is "anonymous", in the sense that employees of the **same** type must be treated equally: coalitions cannot gang up on individual(s). Nonetheless, when low types are in the majority ($f_i < \frac{1}{2}$), they can expropriate high types. We assume, however, that their payoff remains lower than high types' payoff, even after expropriation. That is:

$$w_i > \frac{f_i (x_i - w_i)}{1 - f_i}.$$

Here, the LHS denotes high types' payoff following expropriation (i.e. their outside wage). The RHS denotes the expropriation receipts accrued by each low type; the numerator shows the individual expropriation suffered by high types, multiplied by the fraction of high types; the denominator shows the fraction of low types in the firm. The same applies when instead project j is chosen. These inequalities can be written more simply as:

(A1) $w_i > f_i x_i$ and $w_j > f_j x_j$

Technology choice (date 1 vote)

As there is no ordering of employees, we cannot apply the median voter theorem at date 1. Notice, however, that a stable voting outcome always exists as the technology set has been restricted to two projects.[5] To determine the equilibrium outcome, we should instead look at the formation of coalitions at this voting stage. Under majority voting, the winning coalition will be formed by at least $\frac{I+1}{2}$ employees. It turns out that coalition formation depends on which group is in a majority at date 2. We can thus distinguish three cases:

[5] A general environment with J projects and I employee types is analyzed in Chapter II.

(Case H): High types' power: $f_i > \frac{1}{2}, f_j > \frac{1}{2}$

(Case L): Low types' power: $f_i < \frac{1}{2}, f_j < \frac{1}{2}$

(Case S): Split balance of power: either (a) $f_j < \frac{1}{2} < f_i$, or (b) $f_i < \frac{1}{2} < f_j$

Notice that in case H, type (hh) is on the winning side in the date 2 vote, whichever project was chosen at date 1. That is, if project i was chosen, he would be productive and, since productive types are in a majority, they would vote against redistribution. The same applies if project j was instead chosen at date 1. Likewise, in case L, type (ll) is decisive in the date 2 vote, whichever project was chosen at date 1. Finally, look at case S. Under S(a), an employee of type (hl) is always on the winning side in the date 2 vote; if project i was chosen, he would be productive and, since productive types are in a majority $(f_i > \frac{1}{2})$, they would vote against redistribution; whereas if project j was chosen, he would be a low type and, since low types are in a majority $(f_j < \frac{1}{2})$, they would vote in favor of redistribution. Similarly, in case S(b), type (lh) is always decisive in the date 2 vote.

It turns out that, apart from an exceptional case, an employee who is always on the winning side at date 2, will always be able to form a winning coalition at date 1 too. Let us now examine in detail the argument whereby this is true.

Look first at case H, where type (hh) always wins the date 2 vote and there is no redistribution at date 2. Because there is no redistribution, type (hl) always prefers project i and type (lh) always prefers project j. This implies that if (hh) prefers project i, he will join (hl) to form a winning coalition at date 1 since $g_{hh} + g_{hl} = f_i > \frac{1}{2}$. On the other hand, if (hh) prefers project j, he will form a coalition with (lh) employees. This coalition will also win as $g_{hh} + g_{lh} = f_j > \frac{1}{2}$. In short, (hh) wins the vote at date 1, whichever his preferences between project i and j.

Consider now case L, where type (ll) is always on the winning side at date 2 and there is always redistribution. At date 1, if (ll) prefers project i, this means that $\frac{f_i}{1-f_i}(x_i - w_i) > \frac{f_j}{1-f_j}(x_j - w_j)$. By A1, (hl) will also prefer project i since he anticipates a payoff of w_i under project i which is strictly higher than $\frac{f_j}{1-f_j}(x_j - w_j)$ under project j. If (ll) prefers project j instead, then type (lh) will also prefer project j, using the same argument. Hence there are two potential winning coalitions at date 1. Either $\{ll, hl\}$ wins, because $g_{ll} + g_{hl} = 1 - f_j > \frac{1}{2}$, or $\{ll, lh\}$ wins since $g_{ll} + g_{lh} = 1 - f_i > \frac{1}{2}$. As a result, type (ll) wins the date 1 vote, irrespective of his preferences across projects i and j.

Finally, look at case S. As we have seen, in case S(a), type (hl) always wins the date 2 vote; moreover, there is redistribution under project j but not under project i. Look now at coalition formation at date 1. Type (ll) always votes for project j; although his individual productivity is zero under both projects, he gains through ex-post redistribution under project j. The voting preference of a type (hl) is in principle ambiguous. If redistribution receipts under project j are high enough to outweigh his loss in individual productivity with respect to project i, he will join (ll) type at date 1. They will form a winning coalition since $g_{hl} + g_{ll} = 1 - f_j > \frac{1}{2}$. Yet again, we find that the winner of date 2 vote, also wins date 1 vote. Alternatively, (hl) may prefer project i over project j and, the reason can be twofold; either because the value of x_i is relatively high, or because the value of redistribution under project j is small . In this case, coalition formation will depend on (hh)'s preferences. If (hh) prefers project i, i.e. $x_i > w_j$, the date 1 winning coalition will be formed by $\{hl, hh\}$, since $g_{hl} + g_{hh} = f_i > \frac{1}{2}$; thus (hl) will also win the date 1 vote. By contrast, if (hh) prefers instead project j, i.e. $w_j > x_i$, (hl) may not be able to form a majority group in favor of project i. This is the exceptional case in which a type who always wins the vote at date 2 may fail to win the vote at date 1.[6] As we want to rule out this exceptional case, we make the following weak assumption:

(A2) Whenever $f_j < \frac{1}{2} < f_i$ and $x_i \geq \frac{f_j}{1-f_j}(x_j - w_j)$, it must be the case

[6]As an illustration, consider two projects i and j, characterized as follows. Under project i, $f_i = 0.7$, $x_i = 6$ and $w_i = 4$. Alternatively, under project j, $f_j = 0.4$, $x_j = 10$ and $w_j = 8$. Moreover, assume that $g_{hl} < 0.5$. This technology set satisfies case S(a) since $f_j < \frac{1}{2} < f_i$.

Type (hl) prefers to be a high type under project i rather than a low type under project j as $6 > \dfrac{0.4}{0.6}(10 - 8) = 1.33$. But notice that type (hh) prefers project j as $8 > 6$. Likewise, type (ll) prefers project j in order to enjoy positive redistribution, in particular $1.33 > 0$. Finally, type (lh) will clearly vote for project j as $8 > 0$.

Given that type (hl) is in the minority, the winning coalition will be formed by $\{ll, lh, hh\}$ in favor of project j at date 1, despite the fact that (hl) is always decisive at date 2.

that $x_i \geq w_j$.

–and similarly, with the subscripts i and j reversed in the symmetric case S(b).

Notice that, we only need this assumption when type (hl) favors project i. A2 guarantees that (hl) always wins the date 1 vote, irrespective of his preferences. Thus we have proved:

Lemma 1 *Under A1 and A2, an employee who always wins the vote at date 2, also wins the vote at date 1.*

As A2 is an intricate assumption, we can instead propose two sufficient conditions which are simpler to interpret and still ensure Lemma 1. The first condition is to assume that the high types' outside wage is never greater than their inside productivity, irrespective of the project, that is $w_j \leq x_i$ (and $w_i \leq x_j$). This implies that, an employee who is always a high type, weakly prefers the project which guarantees no redistribution at date 2.

Alternatively, we could restrict the outside wage to be the same across projects, namely $w_i = w_j = w$. By A1, a high type always prefers the project that leads to no redistribution at date 2; hence, type (hh) will always be willing to join type (hl) in favor of project i.

The above analysis has shown that, assuming A1 and A2, for a given f_i and f_j, the pivotal employee is decisive irrespective of the particular combination of g_{ll}, g_{lh}, g_{hl} and g_{hh}, i.e. regardless of the ex-ante distribution of employees across the four types. This has the interesting implication that equilibrium outcomes will only depend on the ex-post distribution of types, f_i and f_j.

Now that we know how coalitions form at date 1, we can ask whether employee ownership is an efficient institution. We shall see that the outcome of the date 1 vote can be inefficient. The reason is that employees who are better off under the efficient project, cannot commit at date 1 to compensate employees who are worse off under the efficient project. An employee can be worse off under the efficient project not only when his individual productivity is lower, but also when he anticipates to be in a minority at the redistribution stage.[7]

[7]One may wonder why there is no Coasian bargaining at date 1. We have in mind

As a benchmark, consider the first-best case, where it is feasible to commit to a date 2 redistribution. In this case, it is efficient to choose the project maximizing aggregate production. Without loss of generality, we suppose that:

Projects i is **efficient**, that is: $f_i x_i > f_j x_j$

Notice that a project is characterized not only by its level of efficiency, but also by the fraction and productivity of its high type employees. These two variables pin down the nature as well as the extent of redistribution at date 2; therefore, they will also prove to be crucial to determine the voting outcome at date 1. Given project i characterized by $\{f_i, x_i\}$, project j can necessarily be classified as one of the following.

First, project j may be a *dominated* project, when it delivers fewer high types and they have lower productivity than under project i, that is, $f_j < f_i$ but $x_j < x_i$. Alternatively, project j might be characterized as a *polarized* technology, when it generates fewer high types but who each has greater productivity in comparison with project i, that is, $f_j < f_i$ but $x_j > x_i$. Finally, project j might be described as an *egalitarian* technology, when it delivers a bigger fraction of high types, but who each has a lower productivity in comparison with project i, namely $f_j > f_i$ and $x_j < x_i$. As the last two cases are more interesting than the first, we restrict project j to be either polarized or egalitarian.

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a world in which an employee's type is private information at this stage. For a large I, free riding would preclude transfers at date 1 and hence inefficient outcomes might arise in equilibrium; see Mailath and Postlewaite (1990). However, we are assuming that, once the technology has been implemented, an employee's productivity becomes public knowledge (witness the fact that the outside market can then distinguish between low and high types). So the date 2 vote takes place under symmetric information. We recognize that the tools provided by mechansim design could help to disclose private information at date 1; although its power would be limited by employees' participation constraint (i.e. their outside wage) and, by the fact it is only possible to screen on what high types' productivity turns out to be under the technology chosen on the equilibrium path but not off the equilibrium path. We intend to explore this avenue in future work.

(A3) Project j is either a polarized or an egalitarian technology. That is,

$$\begin{array}{ll} \text{either} & f_j < f_i \text{ and } x_j > x_i, \\ \text{or} & f_j > f_i \text{ and } x_j < x_i. \end{array}$$

In addition, given that the chapter seeks to explore the effect of redistribution on technology choice, we ignore case H under which there is never redistribution.

(A4) At least one of the projects generates a majority of low types. That is, either case L or S holds.

Now we turn to the main question of this section. Is it possible for a cooperative to select an inefficient project in equilibrium? The answer is positive. Consider the example presented in the introduction, satisfying assumptions A1-A4. An independent expedition of 15 explorers has to decide whether to settle on an island with diamonds or on an island with gold. In the diamond island 7 out of the 15 explorers are productive with individual productivity of 12 and outside option of 7. Positive redistribution yields a payoff of 7 and $4\frac{3}{8}$ for a productive and unproductive explorer respectively. In the gold island, 8 explorers are productive with individual productivity of 10. An explorer's payoff equals his individual productivity. The decisive coalition in technology choice is formed by the 8 productive explorers who are productive in the gold island. They favor gold extraction despite the efficiency of diamond extraction. Note that the inefficient project is egalitarian as it generates more productive explorers ($8 > 7$) albeit each has lower productivity ($10 < 12$). But is this a necessary condition for a cooperative to be inefficient? In other words, can a cooperative also vote for an inefficient polarized project? The following example provides the answer.

Example: Voting for an inefficient polarized technology

Consider a slight variation of the example presented in the introduction. The diamond island is still characterized by 7 productive employees with productivity of 12 and outside option of 7. But now in the gold island 5 explorers are productive with productivity of 16. Their outside option is again 7. Crucially now, unproductive types are in the majority in the gold island. They will thus expropriate productive types via redistribution. The winning proposal in the vote will be to give out 7 to the productive types and divide the rest $5(16-7)=45$ among the 10 unproductive, each accruing $4\frac{1}{2}$.

As the wealth of the diamond island, $7\cdot12=84$ is greater than the wealth of the gold island, $5\cdot16=80$, efficiency calls for diamond extraction. But the cooperative will turn out to be inefficient. In fact, consider the payoff of an explorer who is unproductive in the diamond island. His payoff $4\frac{1}{8}$ is lower than the payoff he would get on the gold island irrespective of whether he is productive or not (7 or $4\frac{1}{2}$). Therefore, he will vote for the gold island. As there are 8 such explorers, they will win the vote. Note that the gold island is polarized as there are fewer productive explorers ($5<7$) but with greater productivity ($16>12$).

The above example illustrates that there is not a clear direction of inefficiencies towards polarized or egalitarian projects. Also, a cooperative might be an inefficient institution even when redistribution is anticipated under the efficient project. More specifically we shall see that only in case L may a cooperative choose an inefficient polarized technology. In case S by contrast, a cooperative will always be efficient provided the inefficient project is polarized.

Yet we can provide a general result concerning the relative bias of a cooperative in relation to an outside-owned firm. Before presenting the argument, let us first analyze technology choice under outside ownership.

1.2.2 Outside Ownership

Consider the behavior of an outside-owned firm. Investors are homogeneous and seek to maximize profits. In this model, profits are defined by the expropriation of employees' productivity. There are two types of participants in the firm. Outside investors, who are endowed with residual control rights and employees who receive a compensation to stay in the firm.

Notice that at date 2, outsiders can differentiate between low and high types. They will thus expropriate high types, obtaining a payoff of $If_i(x_i-w_i)$, under project i. Similarly for project j. Both low and high types will receive their outside options, namely 0 for low types and w_i, w_j for high types under project i and j respectively.

Will an outside-owned firm always choose the efficient project i? Notice that, project i will be chosen if and only if $f_i(x_i-w_i)>f_j(x_j-w_j)$. The fact that investors' payoff increases with project's efficiency may induce outsiders to choose project i as $f_i x_i > f_j x_j$. However, provided $f_i w_i > f_j w_j$, the expropriation effect under project j may dominate the efficiency effect under project i, leading to inefficient technology choice. As an extreme example, consider the case in which high types' inside productivity is almost equal to their outside option under the efficient project (i.e. $w_i \backsimeq x_i$). Outsiders will hence weakly prefer project j, no matter how inefficient this may be. Moreover, the inefficient project j can be selected, irrespective of whether it is polarized or egalitarian relative to project i. However, an egalitarian project can only be selected as long as the high types' outside option under the inefficient project is strictly lower than under the efficient project. To see why, suppose that outside ownership is inefficient, that is, $f_i x_i - f_j x_j < f_i w_i - f_j w_j$. As the LHS of the inequality is positive, this means that $f_i w_i$ must still exceed $f_j w_j$. If project j is egalitarian ($f_j > f_i$), it must be the case that w_j is strictly less than w_i. Yet this constraint does not apply when project j is polarized. This observation may suggest a stronger bias towards polarized projects than towards egalitarian projects. But is the direction of distortion related to the firm's ownership structure?

1.2.3 Cooperatives versus Outside Ownership

The above analysis shows that institutional efficiency depends on the technology set revealed at date 1. A firm can be inefficient irrespective of its constitution; however, the factors leading to inefficiency differ across ownership structures. Whereas in a cooperative, the relative power between low and high types ex-post is crucial to determine efficiency, under outside-ownership the key variable is the firm's specificity of skills. Despite this observation, we can still compare the relative distortions in technology choice between employee and outside ownership. The answer is contained in the following Proposition.

Proposition 1 *Assume A1-A4. A cooperative is more biased towards egalitarian projects than is an outside-owned firm; that is, if an outside-owned firm chooses an inefficient egalitarian project then so too does a cooperative.*

Correspondingly, an outside-owned firm is more biased towards polarized projects than is a cooperative; that is, if a cooperative chooses an inefficient polarized project then so too does an outside-owned firm.

Proof.

Consider the first claim of the proposition. In case S, the characterization of project j as egalitarian implies that $f_i < \frac{1}{2} < f_j$. Assume that an outside-owned firm is inefficient: $f_i(x_i - w_i) < f_j(x_j - w_j)$. But notice that $f_j(x_j - w_j) < f_j(1 - f_j)x_j$, since, by A1, $w_j > f_j x_j$. Also, $f_j(1 - f_j) < (1 - f_j) < (1 - f_i)$. Therefore $f_i(x_i - w_i) < (1 - f_i)x_j$, so that $x_j > \dfrac{f_i(x_i - w_i)}{(1 - f_i)}$. This means that in a cooperative, type (lh) will vote in favor of project j. Remember that, given $f_i < \frac{1}{2} < f_j$, by Lemma 1 type (lh) is pivotal in technology choice. As a result, project j will also be selected by the cooperative.

In case L, project j is egalitarian if $f_i < f_j < \frac{1}{2}$. Note that in case L, by Lemma 1, the pivotal type at date 1 is (ll). Therefore our claim is that, if an outside owner chooses project j, i.e. if $f_i(x_i - w_i) < f_j(x_j - w_j)$, then it follows that $\frac{f_i}{1-f_i}(x_i - w_i) < \frac{f_j}{1-f_j}(x_j - w_j)$. But this claim follows immediately from the fact that $f_i < f_j$.

Let us now turn to the second claim of the proposition. In case S, project j is polarized if $f_j < \frac{1}{2} < f_i$. By Lemma 1, a cooperative will choose project j if the pivotal type (hl) favors it. His expected payoff is x_i and $\frac{f_j}{1-f_j}(x_j - w_j)$ under projects i and j respectively. But notice that, using A1, $\frac{f_j}{1-f_j}(x_j - w_j) < f_j x_j$. And, since j is inefficient, $f_j x_j < f_i x_i$, which in turn is strictly less than x_i. This means that (hl) will always vote for project i. In other words, a cooperative will never choose a polarized project. By contrast, this is not always true under outside ownership. In particular, an outside owner will choose a polarized project as long as the value of w_i is large enough: $f_j(x_j - w_j) > f_i(x_i - w_i)$ if and only if $w_i > \dfrac{f_j w_j + (f_i x_i - f_j x_j)}{f_i}$. (Notice that this last inequality may hold even if $w_i < w_j$, given that $f_j < f_i$.)

In case L, project j is polarized if $f_j < f_i < \frac{1}{2}$. By Lemma 1, a cooperative will choose project j if the pivotal type (ll) prefers it. That is, if $\frac{f_i}{1-f_i}(x_i - w_i) < \frac{f_j}{1-f_j}(x_j - w_j)$. But given $f_j < f_i$, this inequality implies that $f_i(x_i - w_i) < f_j(x_j - w_j)$. Hence the outside owner will also choose the polarized project j.

Q.E.D.

In proving this proposition, we have also shown that, provided employees' power changes across projects (so that we are in case S), and as long as the inefficient project j is polarized, a cooperative is always efficient. This is because an employee always prefers to be a high type under the efficient project rather than a low type under the inefficient project; hence type (hl) favors project i. As (hl) is pivotal, he will always form a winning majority in favor of project i. By contrast, an outside owner will instead be inefficient, whenever his expected expropriation receipts are higher under the inefficient project.[8]

The intuition that underlies Proposition 1 is the following. Suppose that an outside-owned firm chooses an inefficient egalitarian project. Then it must be the case that the inefficient project allows higher expropriation than it does the efficient project. Now consider a cooperative. In case L, type (ll) is pivotal at date 1. He shares similar preferences with outsiders as, by Lemma 1, he is in power under both projects and will thus expropriate high types through redistribution. The only difference in preferences being that, for a given level of expropriation, type (ll) favors projects generating fewer low types as these would allow higher per-capita expropriation. But this is precisely the characterization of an inefficient egalitarian project. The inefficient behavior exhibited by outside owners is thus emphasized in a cooperative. In case S, the fact that the inefficient project is egalitarian means that (lh) is pivotal in technology choice. The inefficient project now looks more attractive to the pivotal type than it did in case L, because it allows him to become a high type, while still being in the majority at date 2. As we know from A1 that, for a given project, an employee prefers to be a high type rather than a low type, (lh)'s preferences for the inefficient project will be stronger vis-a-vis type (ll).

Concerning the strong bias towards polarized projects under outside ownership, note that in case L, if type (ll) favors a polarized project, -generating more low types- it follows that total expropriation is necessarily higher under

[8] This logic might suggest that an employee may also prefer to be a high type under project j, rather than a low type under project i. If this were the case, whenever the inefficient project j was egalitarian, a cooperative would always be inefficient since the pivotal type is then (lh). Yet, this is not always true. If project i is efficient enough - specifically, if $x_i > w_i + \frac{1-f_i}{f_i} x_j$- then the redistribution effect will dominate the individual productivity effect and a cooperative will be efficient.

the inefficient project. Therefore, an outside-owned firm would also be inefficient. Finally, the fact that a cooperative is never biased towards polarized projects in case S completes our result.[9]

1.3 Constitutional Change

So far we have assumed that the firm's constitution is in place from date 0, before the choice of technology at date 1. As we have seen in Proposition 1, the initial constitution may be inefficient. Moreover, the fact that $\{f_i, x_i\}$ and $\{f_j, x_j\}$ are public knowledge means that everyone can anticipate an inefficient technology choice. In this section, we allow the firm to change its initial constitution as a commitment device to increase efficiency. The question is, will the firm's current owners hand over control rights to prospective efficient owners?

As a case in point, consider a cooperative. We know from Proposition 1 that a cooperative may select an inefficient egalitarian project j, even though an outside owner may not. If this is the case, will employees prefer instead to sell off the firm to efficient outsiders?

The context that we have in mind is one of competition among potential outside owners. Therefore the cooperative will extract all the surplus from a sale. A one-member-one-vote cooperative will divide returns equally among its members.[10] Also, the decision on constitutional change will be driven by a

[9]At this point, it is important to emphasize that Lemma 1 underpins Proposition 1. To illustrate why, let us look back at the example presented in footnote 6, where A2 did not hold. In particular, type (hl), although decisive at date 2, failed to win the date 1 vote.

Given that $f_i x_i = 4.2 > 4 = f_j x_j$, project i is efficient. Also, as $x_j > x_i$ and $f_j < \frac{1}{2} < f_i$, project j is polarized. Recall that the date 1 winning coalition was formed by $\{ll, lh, hh\}$, in favor of project j.

On the other hand, notice that an outside-owned firm will choose the efficient project since $f_i\,(x_i - w_i) = 1.4 > 0.8 = f_j\,(x_j - w_j)$. Although the extent of expropriation is the same across technologies, project i delivers a higher number of high types. Thus, here is an example where Lemma 1 fails and the cooperative is more biased towards polarized projects than an outside owner.

[10]One may wonder why dividends are distributed uniformly among employees. In principle, we could envisage a contingent rule whereby dividends were tied to employees's type. But this information is private at the date of the constitutional vote. Following consti-

simple majority vote at date 0.[11] It turns out that, with a mild strengthening of A2, we can show that an employee who is pivotal at dates 1 and 2, will also win the vote at date 0. Replace A2 with the following assumption.

(A2)' Whenever $f_i < \frac{1}{2} < f_j$ and $x_j \geq \frac{f_i}{1-f_i}(x_i - w_i)$, it must be the case that

$$x_j > (1 - f_i) w_i + f_i x_i.$$

–and viceversa, interchanging the subscripts i and j.

A2' resembles A2 except for the RHS of the final inequality, which is now $(1 - f_i) w_i + f_i x_i$ rather than simply w_i. Notice that the value of this convex combination is closer to w_i than to x_i as $f_i < \frac{1}{2}$.

Surprisingly, an inefficient cooperative will never vote to sell off the firm to outsiders. That is, there is institutional inertia.

Proposition 2 *Assume A1, A2', A3 and A4. A cooperative that is currently voting for an inefficient project will never sell to an outside owner in order to restore efficiency.*

Proof

We know from Proposition 1 that if the cooperative is voting for an inefficient project and the outside owner is not, then the inefficient project must be egalitarian, i.e., $f_i < f_j$. When casting his vote at date 0, each employee computes his expected payoff under both employee and outside ownership. Remember that an outside owner is efficient but cannot commit not to expropriate high types ex-post. This implies that the profit of investors under outside ownership is determined by $I f_i (x_i - w_i)$. As the cooperative extracts all surplus from outside owners and divides the returns uniformly among its members, each employee receives $f_i (x_i - w_i)$ as a lump sum at date 0, in

tutional change, employees relinquish their control rights and hence have no incentive to renegotiate. The problem then boils down to the question of why Coasian bargaining fails at date 0 in a world of private information -as explained in foonote 7-. Under the veil of uncertainty, at the time of the initial constitution, a uniform dividend rule seems to be a focal decision rule.

[11]We might think of a more stringent voting rule, i.e. qualified majority. A more inclusive rule would be more conducive to constitutional inertia (as private information rules renders bargaining unfeasible). Our results would then be reinforced.

addition to his salary, under outside ownership. The equilibrium outcome at date 0 depends on the preferences exhibited by the winning coalition.

Under S, project j is egalitarian when $f_i < \frac{1}{2} < f_j$. Provided type (lh) can always form a winning coalition at date 0, the outcome on constitutional change will be robust to any ex-ante distribution of types $\{g_{ll}, g_{lh}, g_{hl}, g_{hh}\}$. The fact that the cooperative is inefficient and that (lh) is decisive in technology choice implies that $x_j \geq \frac{f_i}{1-f_i}(x_i - w_i) > f_i(x_i - w_i)$, where the last term captures the payoff accruing to (lh) upon sale. Thus, type (lh) favors employee ownership. Type (ll) by contrast will vote in favor of constitutional change. Whereas his individual productivity is always zero, the anticipates no redistribution under employee ownership but yet he receives a dividend under outside ownership. Finally, type (hh)'s anticipated payoff following constitutional change is $w_i + f_i(x_i - w_i)$. Given that the cooperative is inefficient, by A2', this payoff is weakly lower than his expected payoff under employee ownership, namely x_j. The winning coalition will thus be formed by $\{lh, hh\}$ in favor of the initial constitution.

Under L, project j is egalitarian when $f_i < f_j < \frac{1}{2}$. Note that if type (ll) prefers employee ownership so too does type (lh). Whereas under outside ownership the payoff of both types is the same - in particular they are both unproductive when the efficient technology is implemented–, under employee ownership the payoff of (lh) is strictly greater than (ll)'s payoff - as the cooperative implements the inefficient project and by A1 $w_j > f_j x_j$ –. Likewise if type (ll) prefers instead outside ownership, so too does type (hl). The argument mirrors the previous logic. In effect, under employee ownership the payoff of both types is the same, but under employee ownership the payoff of (hl) is greater. Therefore, type (ll) can always form a winning majority in favor of his preferred constitution; that is, (ll) is decisive at the date 0 vote. Crucially, as he is also decisive in technology choice, the cooperative can only be inefficient if and only if $\frac{f_j}{1-f_j}(x_j - w_j) > \frac{f_i}{1-f_i}(x_i - w_i)$. But $\frac{f_i}{1-f_i}(x_i - w_i) > f_i(x_i - w_i)$, where the RHS captures (ll)'s payoff under outside ownership. Therefore, the winning coalition will vote in favor of employee ownership.

Q.E.D.

The above result shows that an inefficient cooperative fails to sell off to outsiders even when it holds all bargaining power at the selling stage and hence a take-it-or-leave-it offer would allow all employees to internalize aggregate surplus. The reason why this compensation is not sufficient to guarantee constitutional change draws on the magnitude of the vested interests enjoyed by the pivotal type at the selling stage. These vested interests arise from his decisive role in both technology choice and redistribution. The argument works as follows. A cooperative can only become an inefficient institution when the type who is decisive at date 1 favors the inefficient technology. But he is also decisive at date 2. Therefore he neglects the efficient technology despite his power to set redistribution ex-post. Yet if the firm is sold off to outsiders, not only will the efficient technology be implemented but also he will lose power to expropriate the minority. He will however be compensated through the selling price following a one-vote-one-dividend rule. But this rule treats all employees equally. This implies that his privileged political position under employee ownership is jeopardized under outside ownership. Hence his payoff from the inefficient technology is strictly greater than his payoff from the efficient technology irrespective of the ownership structure of the firm. But the inefficient technology will only be implemented under employee ownership. This explains institutional inertia. In short, the initial constitution is favored by the decisive type as a shield to perpetuate his 'political power'.

1.4 Political Risk Aversion

So far we have assumed that at the time of technology choice at date 1, each employee privately knows what his productivity type will be under both projects. This assumption, coupled with the fact that the fractions of high productivity (f_i and f_j) are public knowledge, allows each employee to anticipate whether he will belong to the majority group at date 2 or not: there is 'political certainty'. In this section we change the informational assumptions of the model to account for uncertainty. The question that we address is whether uncertainty may influence technology choice even though we continue to maintain the assumption of risk neutrality.

The framework that we have in mind is the following. At date 1 there are two feasible technologies, the status quo, project j, and a new technology, project i. Under the status quo, a fraction f_j of the employees are productive with productivity x_j, and the others are unproductive with productivity zero.

Whereas each employee privately knows his productivity under the status quo, he is uncertain about his productivity under the new technology. In particular, a low type under the status quo can become productive under the new technology accruing productivity x_i with probability p. Likewise, a high type under the status quo is also a high type under the new technology accruing productivity x_i with probability q. The values of x_i, x_j, f_j, p and q are all public knowledge. Given a large cooperative, the ex-post realization of types approxiamates the ex-ante distribution of types. Hence the fraction of high types under the new technology equals:

$$f_i = (1 - f_j)\,p + f_j q$$

As we want to explore the interplay between efficiency and uncertainty we continue to assume that project i, the technology about which there is individual uncertainty, is more efficient than project j: $f_i x_i > f_j x_j$. After the technology is implemented at date 1, the productivity of each employee is publicly revealed at date 2. So that redistribution at date 2 takes place under symmetric information.

There are two main differences with respect to the case of certainty. First, there are only two types of employees at date 1, $\{l, h\}$ say, defined by their productivity type under the status quo. This renders the analysis of voting straightforward: technology choice will be simply determined by the larger group. Second, there is 'political uncertainty': a member of the majority group at date 1 may turn out to be in the minority group at date 2. Note that this can only happen if the new technology is implemented. We might expect that under risk neutrality, such uncertainty will not affect technology choice at date 1. That is, if we considered two worlds characterized by the same technology set (i.e. the same x_i, x_j, f_j), with the only difference lying in the information structure of the new project, the choice of technology would remain unaltered. Surprisingly, this intuition is mistaken. We will compare how the cooperative functions with and without individual uncertainty. As the most interesting analysis arises under split balance of power, we shall focus on this case. Replace A4 with the following assumption.

(A4') Case S holds: either $f_j < \frac{1}{2} < f_i$ or $f_i < \frac{1}{2} < f_j$.

The following proposition shows that political uncertainty increases the likelihood of inefficient technology choice. We might say that a cooperative is 'politically risk averse'.

Proposition 3

Assume that A1, A2, A3 and A4' hold. If the efficient project i was chosen under political certainty it may no longer be chosen when it generates political uncertainty. However, if the inefficient project j was chosen under political certainty, it will continue to be chosen under political uncertainty.

Uncertainty has no effect on technology choice as long as the winning coalition under certainty is formed by the same productivity types that comprise the majority group under uncertainty. This is because the expected payoff of an employee belonging to the majority under uncertainty is a convex combination of the payoffs accruing to each type belonging to the winning coalition under certainty. Risk neutrality ensures that the preferences of both groups are then aligned. Therefore, to analyze the influence of uncertainty in technology choice we should look at the composition of the majority group under uncertainty vis-a-vis the composition of the winning coalition under certainty. By A4', there are only two cases to consider.

Suppose first that $f_i < \frac{1}{2} < f_j$. Under uncertainty, the majority group is formed by high types under the status quo. Under certainty, the pivotal type is (lh) by Lemma 1. He may favor either the status quo project or the new technology. If he prefers project i, by A1, (hh) also prefers project i. If he prefers instead project j, by A2, (hh) will favor project j too. Hence the winning coalition at date 1 is always formed by high types under the status quo, irrespective of technology choice. Therefore, the composition of the majority group at date 1 is not affected by the existence of uncertainty. From the above discussion follows that the voting behavior of the cooperative will not be altered by political uncertainty.

Suppose instead that $f_j < \frac{1}{2} < f_i$. Recall that, in the course of proving Proposition 1, we showed that a cooperative is always efficient under certainty. As the pivotal type is (hl), he favors project i. By A2, (hh) also prefers project i. The winning coalition at date 1 is thus formed by high types under the new technology. Under uncertainty however, the majority group is formed by low types under the status quo. Hence, the composition of the majority group under uncertainty varies with respect to the certainty case.

To show that the cooperative is politically risk averse we should then prove that low types may favor the inefficient project under uncertainty. Their voting behavior is the outcome of the following trade-off. On the one hand, a low productivity type likes the new technology. If he succeeds and becomes a high type, this is good news for two reasons: his individual productivity is higher; and, he is in the majority group at date 2. But he also likes the status quo project. If he failed and remained as a low type under the new technology, he would lose his power to set redistribution. If the probability of becoming a high type is low enough, the subsidy effect accrued under the status quo through redistribution will dominate the productivity effect under the new technology. Specifically, this is true whenever $p < \frac{f_j(x_j - w_j)}{(1-f_j)x_i}$. To see why, note that the payoff accruing to a low type from the status quo project, $\frac{f_j}{1-f_j}(x_j - w_j)$, is higher than his expected payoff from the new technology, px_i.

As decisions are taken by majority voting, the fact that uncertainty can generate inefficiencies only when $f_j < \frac{1}{2} < f_i$, means that the uncertainty faced by high types is irrelevant for efficiency. In effect, when the cooperative is efficient under certainty, an employee who is a high type under the status quo yet a low type under the efficient project, favors the new technology. Under uncertainty, there is a positive probability that such an employee becomes a high type under the efficient project. Therefore his efficient behavior is reinforced by the existence of uncertainty. Also, note that uncertainty is binding only when the dispersion between low and high types' payoff increases under the new technology. In effect, whereas the status quo ensures the existence of redistribution, the new technology leads to no redistribution.

Interestingly, there are two channels through which uncertainty feeds into an employee's payoff. First, through his productivity type. Second, through his power to set redistribution at date 2. Yet uncertainty can only create inefficiencies through the political channel. To see why, consider an alternative characterization of the new technology whereby all employees may either succeed and become high types with probability p, or may fail and remain low types with probability $(1-p)$. Hence there is aggregate uncertainty. Suppose that the majority is formed by low types. Although their productivity under the new technology is uncertain, they are certain to be in the majority group at date 2 irrespective of technology choice. It is straightforward to see that the cooperative will always choose the efficient project regardless of whether there is uncertainty or not.

1.4.1 Political Insurance

Proposition 3 has shown that uncertainty can reinforce the extent of a cooperative's inefficient behavior. The assumption that p and q are known at date 1 means that everyone can anticipate inefficient technology choice. In section 3 we saw that a transfer of ownership to efficient outsiders was always blocked by the winning coalition. Will the introduction of uncertainty render constitutional change feasible to restore efficiency?

Consider a technology set such that employee ownership is inefficient. Before the vote on technology choice takes place, the cooperative decides whether to transfer ownership to efficient outsiders through a take-it-or-leave-it offer. The decision on constitutional change will be determined by the preferences exhibited by the larger group at date 0.

Surprisingly now, an inefficient cooperative may sell off the firm to efficient outsiders, as long as the inefficient behavior is driven by political risk. That is, constitutional change may act as an insurance policy protecting the majority group from the loss of vested interests.

Proposition 4

Assume that A1, A2', A3 and A4' hold. Constitutional change may act as an insurance policy. That is, if a cooperative is inefficient under uncertainty but efficient under certainty, it may sell off to outsiders. However, if an inefficient cooperative under uncertainty is also inefficient under certainty, it will never sell off to outsiders.

Consider the first claim of the proposition. Following the discussion of Proposition 3, uncertainty can render an otherwise efficient cooperative into an efficient institution only when $f_j < \frac{1}{2} < f_i$. Low types are decisive for technology choice. We shall then look at their voting behavior at date 0. As the cooperative is inefficient, project j is adopted under employee ownership. Low types' productivity is therefore zero. Given that they win the vote at date 2, their expected payoff is given by $\frac{f_j}{1-f_j}(x_j - w_j)$. Under outside ownership, the firm is efficient by assumption; hence project i is implemented. A low type will become a high type with probability p. His expected outside option is therefore pw_i. Also he will receive an upfront payment from the selling price equal to $f_i(x_i - w_i)$. Therefore, whenever $pw_i + f_i(x_i - w_i) > \frac{f_j}{1-f_j}(x_j - w_j)$, he will vote in favor of constitutional change.[12] Note that this inequality may hold even if project j is to be chosen under employee ownership.

Let us now turn to the second claim of the proposition. Assume that the cooperative is inefficient under certainty. Given A4' it should be true that $f_i < \frac{1}{2} < f_j$. In proving Proposition 2 we showed that the winning majority, blocking constitutional change at date 0, was formed by high types under the status quo. In particular, an employee who was always a high type irrespective of technology choice favored employee ownership. Under uncertainty, the majority group is formed by high types under the status quo. Their expected payoff under outside ownership is strictly lower than the payoff of an employee who is always a high type (given that $q < 1$). Hence the majority will favor employee ownership.

Proposition 4 says that the cooperative may favor project i indirectly under outside ownership even if it favors project j under employee ownership. More specifically, this may happen provided low types form the larger group at date 0. Given that they are also in majority at date 1, what is the intuition for this change in preferences concerning technology choice? The reason is that outside ownership guarantees low types a compensation of $f_i(x_i - w_i)$, irrespective of their productivity type under the new technology. Constitutional change acts as an *insurance policy* against the loss of vested interests provided by date 2 power under employee ownership. This result contrasts with the certainty case, where the power enjoyed by the date 0 pivotal type was independent of technology choice allowing vested interests under the status quo to carry over under the new technology.

It turns out that a low type is indifferent between implementing a technology with probability of success p, and favoring the adoption of a new technology following constitutional change with probability of success $f_i - (f_i - p)\frac{x_i}{w_i}$.

[12]This is equivalent to $f_i x_i > \frac{f_j}{1-f_j}(x_j - w_j) + (f_i - p) w_i$. The LHS of the inequality denotes project i's efficiency, which is partially internalized through date 0 dividends. The first term in the RHS denotes the status quo subsidy and the second term captures the constraint imposed by high types' outside wage which limits the date 0 dividend, although it also rises the payoff of a successful low type.

The difference given by $f_i\left(q-p\right)\frac{x_i-w_i}{w_i}$ can be interpreted as the *price* of the insurance policy provided by outside ownership. Note that a necessary condition for this price to be positive is that $q > p$. As high types' productivity is partially expropriated under outside ownership, the upfront compensation given by $f_i\left(x_i - w_i\right)$ outweighs the expected expropriation of $p\left(x_i - w_i\right)$, only when the probability of success is low enough, namely $p < f_i$ which is equivalent to $p < q$. Therefore, constitutional change may restore efficiency as long as there exists positive correlation of productivity types across technologies.

We have shown that although political risk may turn a cooperative into an inefficient institution, constitutional change may however restore efficiency. But this is not necessarily the case. Remember the last example presented in the introduction as illustrative of two striking remarks. First, uncertainty led a cooperative to reject a Pareto dominant technology under which *all* employees were weakly more productive with probability 1. Second, the cooperative failed to sell off the firm to efficient outsiders.

1.5 How does the model fit the facts?

The purpose of this section is to analyze the theoretical predictions of our model in the light of the evidence provided by the empirical literature. Most of the relevant empirical research falls within two main types of analysis: either the comparison between the aggregated behavior of employee and outside owned firms across industries; or alternatively, the dynamics of firm performance in particular economic sectors as the character of the industry evolves over time. These two lines of study provide a natural ground to test our results which concern the performance of a firm as a function of its ownership structure and, in relation to the technological environment where it operates. Although there exists an extensive empirical literature on cooperatives, most of the comparative results turn out to be contradictory or fail to generate robust evidence on the tested hypotheses. Yet we can still find some empirical regularities that hold in most of the case studies analyzed in the literature as summarized by Bonin, Jones and Putterman (1993) and Hansmann (1996).

(a) Cooperatives present lower wage dispersion and higher productivity compression than outside-owned firms.

There is persistent evidence showing that the wage structure in cooperatives is less dispersed than the differences in productivity across employees. Also, employee-owned firms present less differential wage structures than similar investor-owned firms. For instance, in plywood cooperatives, nearly all employees adhere to a scheme under which all members receive the same rate of pay regardless of their task and seniority. Most law firms share the partnership's earnings equally among partners regardless of their individual productivity even if this is easily measurable. In France, 25 per cent of the surplus is distributed to workers as a bonus payment in all cooperatives. A case in point is the well known Mondragon cooperatives where 30 per cent of an employee's salary is transferred to a collective account.

Further, employee-owners tend to do similar work; rarely they have substantially different types of skill and productivity. In US plywood cooperatives semi-skilled employees commonly rotate over time through various jobs. In other words, not only pay but also productivity is more equalized among employees in cooperatives rather than in outside-owned firms. Even if these decisions engender inflexible technology choice and lack of diversification.

Our model accounts for this fact in Proposition 1. Following a particular technology choice, a cooperative will favor redistribution as long as low productivity types are in the majority. Redistribution under employee ownership narrows the gap in payoffs between employees by comparison with outside-owned firms. Moreover, proposition 1 shows that cooperatives are relatively more biased towards technologies generating more high types with lower individual productivity than investor-owned firms. This result predicts that the productivity among employees is bound to be less dispersed in employee controlled firms, as argued in the empirical literature.

(b) Cooperatives are more inefficient in the presence of uncertainty.

Employee ownership seems to be more common in industries where there is more available information on employees' individual productivity, such as the case of service professions. If we believe that a cooperative is more likely to survive the higher its efficiency, it follows that cooperatives are more efficient in the presence of more precise information on productivity.

Also, in volatile sectors like plywood cooperatives, although membership is marketable, there is evidence of underinvestment in comparison with plywood investor-owned firms, even when financial markets are available. Moreover, these cooperatives have significantly higher capacity utilization.

Finally, Holmstrom (1999) argues that employee dominated firms seem to be less successful in shifting resources to new technologies than shareholders dominated firms in economic environments characterized by higher volatility.

Proposition 3 in our model takes account of this fact by predicting than uncertainty, while increasing the likelihood of inefficient performance in cooperatives, does not affect the behavior of outside-owned firms.

(c) Cooperatives are more likely to change their ownership structure in volatile industries.

When the character of the industry has changed, there is evidence of an increased reversion of ownership from employees to outside investors. The best known examples of constitutional change of cooperatives are documented in the advertising industry and in the investment banking sector. In effect, advertising firms began converting from partnership to investor ownership in the early 1960's. Similarly, investment banking started to abandon the partnership form in the 1970's. Although one obvious reason is the need to attract more capital, this reversion process seems to be correlated with the increase in the complexity of new technologies and greater internal departmentalization, which renders expected productivity under feasible technologies more uncertain.

This empirical observation is accounted form by Propositions 2 and 4 of our model, which predict that a cooperative is more likely to sell off to outsiders in the face of individual uncertainty over employees' productivity.

Finally, there are two empirical regularities concerning both the efficiency of a cooperative and the dynamics of its ownership structure in relation with the mobility of its employees. Such cooperatives typically belong to industries characterized by technological uncertainty.

(d) Under uncertainty, cooperatives are more likely to be inefficient when employees are subject to higher lock-in effects.

In large industrial firms, where employees become more specialized, firms are rarely employee-owned. Conversely, employees are unusually mobile in employee-owned firms that belong to the transportation sector, plywood industries and small service professionals. If higher efficiency increases the likelihood of survival, this empirical observation can be explained by the predictions of our model on the relative efficiency.of both ownership structures.

(e) Under uncertainty, efficient cooperatives selling off to outside investors are more likely to belong to industries with lower lock-in effects.

This is the case in the most prominent example of cooperatives in the US which belong to the plywood industry as well as in some service professions like advertising agencies. Yet efficient cooperatives belonging to less mobile industries such are large law firms have followed an up-or-out system whereby an employee must leave the firm if she has not been made a partner in a specific time horizon. This rule implies that all except more junior lawyers are owners, hence preventing the tendency to substitute employee owners with hired labor prevailing in other industries.

How does our theory account for these last two facts? Note that these two predictions fall within the territory analyzed in Section 4 as the industries analyzed belong to an uncertain economic environment. From proving proposition 4 we know that a cooperative is less likely to behave inefficiently the higher the efficiency of the new technology. But we have not provided any prediction relating the behavior of a cooperative with the firm specificity of its employees' productivity. In addition, although we showed in proposition 4 that inefficient cooperatives may sell off to outsiders in the face of uncertainty, the question of whether an efficient cooperative might change its initial constitution to modify the distribution of payoffs among employees was not addressed. Likewise, there was not any prediction concerning the likelihood of a sell off in relation to the characterization of the industry to which the cooperative belongs.

To analyze these two questions in the light of the empirical evidence, we present an example of the model outlined in Section 4. At date 1, the cooperative chooses between two feasible technologies, the status quo project j and a new technology i. Whereas each employee knows ex-ante his productivity under the status quo, his productivity under the new technology is only revealed ex-post. Project j is characterized by the fraction of high types f_j, their inside productivity x_j, and their outside option w_j. The new technology is characterized by the fraction of low types that will become high types p, the fraction of high types that will remain high types q, and the inside and outside productivity of high types denoted by x_i and w_i respectively. In the present example we simplify this setting by assuming $q = 1$, $x_i = x_j = x$ and $w_i = w_j = w$.

This simplification allows a natural characterization of an industry according to the firm specificity of employees' productivity measured by $(x - w)$. Also it simplifies the set of new technologies as they can be defined by the parameter p.

There are two main implications to be drawn from this example. First, the productivity of each employee is weakly higher under a new technology. In other words, project i Pareto dominates the status quo. Second, by A4, low types are in the majority under the status quo. Therefore, they will be decisive in the vote on technology choice under employee ownership as well as in the vote on constitutional change. Applying the results from Section 4 we also know that uncertainty is detrimental for efficiency. The question to be addressed is whether a cooperative is more or less likely to be efficient the higher the mobility of its employees. To answer this question we first consider a given industry and analyze the performance of the cooperative in relation to the efficiency of the new technology. Then we restrict all technologies to be equally likely and study the likelihood of efficient behavior across industries.

A priori, a technology characterized by a higher value of p is more attractive to low types and the reason is twofold: a high p increases the expected productivity of a low type. Also it rises the efficiency of the cooperative that can be in principle internalized via redistribution. Yet the anticipation of a change in the balance of power following the adoption of a new technology generates a *non-monotonic* relation between the efficient behavior of the cooperative and the efficiency of the new technology. More specifically, a cooperative is Pareto inefficient for intermediate values of efficiency. That is, when $\underline{p} \leq p < \overline{p}$.[13] For low values of p, the balance of power between low and high types under the new technology remains unchanged. All employees will then favor the efficient option. For higher values of p, the balance of power between low and high types under the new technology is reversed. Yet as the probability of a low type becoming high increases, the efficiency effect dominates the political effect and the new technology will be implemented by the cooperative even under unanimity rule.

[13] Where $\underline{p} = \frac{1-2f_j}{(1-f_j)}$ *and* $\overline{p} = \frac{f_j}{1-f_j}\frac{x-w}{x}$.

Now, how does the behavior of the cooperative relates to the characterization of the industry? Note that $\underline{p}$ is a critical value that determines the swing in the redistribution policy in the cooperative and is thus independent of lock-in effects. On the other hand, $\overline{p}$ is an upper bound that trades off the increase in low types' expected productivity against their expected loss in subsidy from current redistribution. We can conclude that if all new technologies are equally likely, the efficient behavior of a cooperative increases with the mobility of its employees. This is precisely the empirical observation presented in (d).

In order to address the fact stated in (e) we will proceed as follows. First, we will consider a particular industry characterized by a measure of lock-in effects given by $(x - w)$. We will then determine the set of technologies for which the cooperative will behave efficiently. And likewise, the set of technologies for which the cooperative will select an inefficient technology. For each of these two cases, we will determine whether constitutional change will take place. Finally, assuming that all technologies are equally likely we will look at the reversion of ownership from efficient cooperatives to investors across industries.

In an industry defined by $(x - w)$, consider a new technology characterized by p, where p satisfies $\underline{p} \leq p < \overline{p}$. Employee ownership is inefficient. Yet low types may vote to sell off the firm to outsiders provided their expected payoff under outside ownership is higher than under cooperative form. This will be the case as long as $\widehat{p} \leq p$[14] The value of $\widehat{p}$ denotes the ratio between the difference in redistribution accrued by the pivotal type under the status quo (where receipts are divided only among low types) with respect to the per capita dividend obtained upon sale, together with the increased benefit of a pivotal type under project i as he may not only become a high type but also receive greater dividends from higher efficiency.

Next we determine the set of technologies that will drive a change in the

[14]A low type will vote in favor of constitutional change as long as $pw + f_i(x - w) > \frac{f_j}{1 - f_j}(x - w)$.

Substituting for the value of f_i and rearranging, it is easy to see that this is equivalent to $p > \widehat{p} = \frac{\frac{(f_j)^2}{1 - f_j}(x - w)}{f_j w + (1 - f_j)x}$.

initial constitution of the firm even if employee ownership is efficient. There are two cases to analyze:

First, consider a new technology i, such that $p < \underline{p}$. Remember that the cooperative is efficient and that there is positive redistribution under project i. It can be easily shown that a majority of employees will vote for employee ownership.[15]

Second, assume a new technology i such that $p > \overline{p}$. Now the cooperative will choose project i at date 1 but there will be no redistribution at date 2. By comparing the payoffs of low types under employee and outside ownership it can be shown that low types will always sell off to outsiders.[16]

Finally, we analyze the interaction between ownership and skills' firm specificity. Consider the definition of $\underline{p}$, $\overline{p}$ and $\widehat{p}$ as a function of w, where $0 < w < x$. The value of $\underline{p}$ is constant for all values of w. Yet $\overline{p}$ is a decreasing linear function of w. More intricate turns out to be the function $\widehat{p}$. However we can still calculate the sign of the partial derivatives with respect to w, namely $\frac{\partial \widehat{p}}{\partial w} < 0$, and $\frac{\partial^2 \widehat{p}}{\partial w} > 0$.[17]

We can extract three main empirical predictions. First, conditional on an efficient technology reverting ownership to outsiders, it is more likely that lock-in effects are lower. This prediction corroborates the empirical anecdote presented in (e). Second, restricting attention to inefficient cooperatives that change their ownership structure, it is more likely that they belong to

[15]In effect, low types will vote in favor of outside ownership as long as

$$pw + f_i(x - w) > pw + (1 - p)\frac{f_i}{1 - f_i}(x - w)$$

Replacing the value of f_i in terms of p, this inequality would only hold if $p > p + f_j(1 - p)$. As $p < 1$, this is a contradiction and hence, cooperative form will remain.

[16]Current low types under the status quo will only sell off the firm to outsiders provided

$$pw + f_i(x - w) > px$$

Again, replacing the value of f_i and rearranging, this inequality is equivalent to $p < p + f_j(1 - p)$, which is always true.

[17]In particular: $\frac{\delta \widehat{p}}{\delta w} = \frac{-\frac{(f_j)^2}{1 - f_j}x}{[f_j w + (1 - f_j)x]^2} < 0$, and $\frac{\delta^2 \widehat{p}}{\delta w} = \frac{2\frac{(f_j)^2}{1 - f_j}x}{[f_j w + (1 - f_j)x]^3} > 0$.

industries with higher lock-in effects. As a result, constitutional change is more likely to restore efficiency for lower values of w, for which the date 2 decisive role of the date 1 pivotal type is more valuable. Finally, employee ownership is more likely bo be observed in industries characterized by greater lock-in effects. To our knowledge, these two last predictions have not been explored in the empirical literature.

Interestingly, and showing a reversed causality with respect to most of the literature on the theory of the firm, the specificity of high types' skills which is assumed to be determined by industrial factors, plays a crucial role on a firm's efficiency through its effect on technology choice.

1.6 Discussion and Related Literature

The above analysis has been placed in an economic environment characterized by technological uncertainty. But how can we justify the existence of uncertainty in a firm? And, could uncertainty also distort investment decisions in an outside-owned firm with heterogenous investors? In what follows, we first motivate the introduction of uncertainty into the model. Next we propose some policies that may circumvent this inefficiency. Also we suggest some testable implications that may lead to future empirical work.

1.6.1 Motivation of Uncertainty

We could think of an increase in the size of the firm or the complexity of its operations as two main factors leading to uncertainty regarding the effect that the project undertaken by the firm will have on an employee's final payoff. We can illustrate this argument with the following examples. First consider an increase in the *size*[18] of the cooperative. We can view size as the replication of productivity across the population of employees. As now there are several employees belonging to the same categories, there may be some

[18] A different effect of size on efficiency is given by Farrell and Scotchmer (1988) where cooperatives are characterized by partnerships with equal-sharing rules. Cooperatives will be smaller than their optimal size so as not to redistribute to lower productivity employees. However as the number of employees belonging to the same category increases the inefficiency generated by suboptimal size vanishes as cooperatives can achieve more homogeneous populations of employees.

reorganization ex-post by which some of these employees will be transferred to job assignments dealing with the new project whereas some other employees will remain performing the same task. This would introduce individual uncertainty at the project voting stage regarding the final productivity of each employee. Alternatively, consider a cooperative in which redistribution is determined by a majority of winning coalitions. An increase in the size of the firm would raise the number of potential coalitions that may form at the redistribution stage, thereby introducing an element of uncertainty in the employees' final payoff. Next, consider an increase in the *complexity* of the operations undertaken by the firm. Following the adoption of a new project, a certain number of employees (movers) will increase their individual productivity. But these employees may be uncertain ex-ante about their own ability to increase their productivity after implementation. If all movers are equally productive under the status quo project, they will share the same beliefs about their own capabilities under the new technology; hence the probability of success for each mover will be the same. Ex-post however, a reduced number of movers will increase their productivity (say, the employees suffering lower individual costs to switching to the new project), whereas the remaining movers will continue being low productivity employees.

In addition, this chapter can throw some light on the source of potential inefficiencies arising from the existence of heterogenous investors in an outside-owned firm. Heterogeneity among shareholders may be introduced when a firm issues "targeted stock". This means that the payoff of each shareholder is tied to the earnings of a particular project. This may in turn create conflicts of interest among investors over the firm's productive decisions. Suppose that, following the implementation of a project, cash-flows could be transferred across different lines of businesses. This would entail ex-ante uncertainty regarding the final benefit accrued by each shareholder. As a result, shareholders may be reluctant to undertake a dominant project when it facilitates the diversion of income to other activities of the firm (due for instance to unobservable or unverifiable earnings). As a consequence, technologically dominated outcomes might also arise. This may help to explain the scarce existence of this type of stock among investor-owned firms (Hansmann, 1996).

1.6.2 Governance Provisions

Regarding potential mechanisms that may circumvent these inefficiencies, the first question we could ask is whether the uncertainty at the voting stage could be eliminated by designing an adequate insurance scheme after the new project has been revealed but before the vote on technology takes place. Employees whose current payoff may be jeopardized by the adoption of a new project would be willing to pay a premium upfront that guarantees the payment of a subsidy in the event of a bad realization. However, this scheme boils down to a system of transfers by which high types compensate the resulting low types. Yet, the limitation imposed by lack of credibility and asymmetric information will render this scheme unfeasible.

We can devise two main governance provisions to solve the inefficiency that arises due to the failure of the cooperative in selecting a dominant technology. One solution is to constrain the domain of projects subject to decision making so as to decrease heterogeneity across employees and thus diminish the degree of conflict. Alternatively, the redistributive policy could be restricted in the constitution of the cooperative. Therefore, employees would not try to manipulate the investment decision so as to favor their preferred redistribution scheme. This seems to confirm empirical evidence. Barzel and Sass (1990) show that projects whose total net value is positive but opinions are likely to be divided, will be excluded from the domain of voting by the developers of condominiums. Likewise Benham and Keefer (1991) state that the constitution of Mondragon cooperatives limits direct voting on controversial issues such as maximum dispersion in wages.

Another possibility is to change the allocation of control rights across employees. Since a superior technology is forgone whenever low productivity employees fear a low redistribution policy following investment, the allocation of more voting rights to high types would mitigate this underinvestment problem. If high types were identified with more senior employees who have accumulated more firm-specific skills to the firm over time, thus increasing their productivity, this ownership structure could then contribute to explain partnerships.

Finally, even under the assumption of a one-member-one-vote cooperative, the voting rule that governs ownership reversion proves to be relevant for efficiency. If we consider a general cooperative in which the productivity of employees varies within a continuous interval, employees with lower productivity will be more entrenched to power. This would implies that more inclusive voting rules would increase the likelihood of survival of inefficient constitutions. Davis (1998) argues that the one-member-one-vote governance rule in cooperatives contributes to the survival of the institution in cooperative form. Here we argue that it is not only the assignment of votes but also the voting rule that is crucial for the survival of cooperatives.

Employee-owned enterprises should be mostly encouraged in sectors characterized by homogenous employees and stable technological environments. In contrast, in volatile technological industries outside ownership should be actively promoted. The design of an appropriate standard statutory form and a complementary income tax schedule for corporate benefits are two potential instruments that may favor the development of the desired ownership structure.

1.6.3 Related Literature

The vast traditional literature on cooperatives has focused on incentive problems arising from a restricted access to capital markets. Employees are by definition suppliers of labor to the firm. Therefore they may lack the wealth to buy enough capital to establish a firm.[19] As a consequence, we would expect that industries which are capital intensive should be dominated by investor owned firms. Yet, this is not necessarily the case. There is no clear correlation between ownership structure and capital intensity.[20]. As Bonin, Jones and Putterman (1993) argue, the effect on internal decision making (i.e. change in decisive coalitions) on new investments should be considered in the analysis of worker cooperatives. Also Barzel and Sass (1990) state that with heterogeneous preferences, voters' interests may diverge, creating opportunities for majorities to capture wealth from minorities through majority voting. Here, we explain how the opportunity of holding power ex-port

[19]Borrowing may be unfeasible or excessively costly due to the high interest rate required as a way to compensate for the potential opportunistic behavior on the part of the employees with full control rights over the decisions of the firm.

[20]For instance, investment banking (with high capital requirements) has been dominated until very recently by employee ownership, whereas restaurants are typically investor owned (Hansmann, 1996).

(which in turn allows appropriation of wealth) may affect productive joint decisions.

The recent literature on ownership within the framework of incomplete contracts has emphasized the distortions on individual investment decisions arising under alternative organizational modes. Kremer (1999) and Bolton and Xu (1998) focus on the ex-ante inefficiencies arising in firms as a consequence of poor private incentives to exert effort or to invest in firm-specific skills. This may be caused either by the anticipated redistribution of individual productivity in cooperatives or by the classical hold-up problem. Depending on which kind of investment (effort or specific skills) is relatively more productive, ownership will be granted to different participants in the firm. Likewise, Roberts and Van den Steen (1999) emphasize distortions in individual investment in both physical and human capital as the main determinants in the composition of corporate control boards. Hart and Moore (1998) emphasize the role of ownership in the ex-post efficiency of the firm. In their model, they analyze a consumer cooperative where the existence of asymmetric information across consumers prevents efficient renegotiation. Conflicts in decision making among heterogenous individuals may lead to distortions in investment. On the other hand outside owners, by targeting the marginal consumer instead of the mean consumer, may also choose an inefficient investment. However they do not allow for endogenous transfers ex-post which are in our chapter the origin of vested interests lying at the heart of inefficient collective choice. Alboeck and Schultz (1997), Barzel and Sass (1990) and Aghion and Bolton (1998) deal with the optimal allocation of votes and/or the voting rule conducive to minimizing the costs of decision making. In contrast to their analysis, we model inefficiencies as being driven by dynamic voting and show their persistence, despite the feasibility of constitutional change.

Within the dynamic voting literature, Besley and Coate (1998) and Roberts (1999) show how the anticipation of future voting decisions by forward-looking individuals may lead the median voter not to choose his preferred policy conditional only on his current period's preferences. Instead, the decision is optimal given the constraint generated by the democratic process and the transition rule for future states respectively. The first paper is applied to the inefficiencies arising in a representative democracy. When current politicians cannot commit to future policy choices, efficient investments may be forgone whenever they change the preferences of policy makers in a way that may hurt the majority today. The second paper shows the dynamics of clubs where future club size is determined by the median voter today.

Finally, Fernandez and Rodrik (1991) and Krusell and Rios-Rull (1996) analyze how majority voting may lead citizens to disregard an efficient reform in order to keep the benefits generated by the status quo. However, they do not consider Pareto dominant decisions nor do they allow ex-post transfers to compensate losers from reform. In particular, there are two crucial differences between Fernandez and Rodrik and our chapter. In their analysis, inefficiencies only arise because citizens should pay a cost up front, in order to enjoy the benefits of reform. Otherwise, a reform would always be undertaken. Moreover, they do not allow for ex-post transfers among citizens to align interests towards reform. By contrast, in our model, there is no cost to be paid under a new technology. And it is precisely the existence of ex-post transfers among employees, via redistribution, which causes big inefficiencies to arise. In other words, it is this interaction between uncertainty and redistribution through dynamic voting, that creates Pareto dominated outcomes. This is why in our model, in contrast with theirs, we can show the existence of a status quo bias within a static setting.

1.7 Concluding Remarks

This chapter explores the efficiency of employee and outside ownership with regard to technology choice. In an incomplete contract framework, decisions are undertaken by the firm's owners. Once the technology is implemented, the firm decides how to distribute aggregate production. Employees are heterogeneous and decisions are taken by majority voting.

The main contributions of this chapter are threefold. First, it shows that, institutional efficiency is contingent on the economic environment faced by the firm. This environment is defined in terms of two variables: the feasible technology set and, the degree of skills' firm specificity. Although the technology set can be constrained so as to ensure efficiency, distortions typically arise, irrespective of the firm's ownership structure. Outside-owned firms are shown to be relatively more biased towards polarized technologies than cooperatives. By contrast, cooperatives prove to be relatively more biased towards egalitarian technologies than outside-owned firms. This may reinforce the wage compression effect caused by redistribution in cooperatives which is acknowledged by the empirical literature.

Provided the current institution is inefficient, a cooperative may decide to transfer ownership to an efficient outsider. Yet we show that the feasibility of constitutional change will not restore efficiency despite the extent of inefficient behavior. This is due to the vested interests enjoyed at the selling stage by the winning coalition as a result of their decisive power to set both technology and redistribution under the current constitution. And this outcome goes through for any bargaining power of employees vis-a-vis outsiders at the selling stage. This result may help to explain institutional inertia.

Second, we show that in a volatile environment, technological uncertainty may constitute a new source of inefficiency in cooperatives. Despite the assumption of employees' risk neutrality, the cooperative exhibits 'political risk aversion'. This means that it may favor a dominated technology, whenever the decisive role of the current winning coalition in future voting outcomes is jeopardized under a dominant technology. However, constitutional change may now take place, provided inefficiencies are sufficiently large. Selling off the firm to outsiders can be regarded as an insurance policy that compensates employees for their potential loss in power under the new technology. Also, we predict a higher likelihood of constitutional change as employees are more mobile across firms. The reason being that the extent of vested interests generated by political power becomes insignificant as the scope for employees' expropriation decreases. These predictions seem to corroborate the empirical anecdote provided by Hansmann (1996), and leads us to our third result. The degree of lock-in effects influences a firm's ownership structure, through its effect on constitutional change.

There are at least two channels in which further research can be directed. First, the model can be extended to analyze labor allocation across firms in a dynamic general equilibrium model. Second, the initial constitution of the firm and the voting rule under employee ownership could be endogenized ex-ante. A possible way to proceed would be to introduce a probabilistic model to characterize the arrival of new technologies.

Chapter 2

Sequential Voting in Cooperatives

2.1 Introduction

In a world of incomplete contracts, economic agents must rely on spot transactions to realize gains from trade. It has been widely recognized in the literature that, when an agent fears expropriation from his trading partner, he may act inefficiently. This situation may induce two main types of inefficient behavior. The first inefficiency known as the hold-up problem includes distortions in relationship specific investments, thus leading to lower aggregate surplus. As the opportunity to invest arises before trading takes place, this type of behavior creates ex-ante inefficiencies (Grossman and Hart, 1986). The second type of inefficiency refers to inefficient trading. Even if agents invest optimally ex-ante, the existence of asymmetric information at the trading stage may prevent agents from reaching an efficient decision ex-post, thus neglecting gains from trade (Hart and Moore, 1998).

In this chapter we consider both types of inefficiencies. In particular, we assume asymmetric information concerning the agent's investment decision. This imperfection will typically lead to underinvestment as long as expropriation is expected in the future. Also, we assume the existence of private information at the trading stage that may generate inefficient trading decisions. Whereas the first decision is taken individually by the agent, the second decision will be the outcome of a collective action taken jointly by all parties involved in the transaction.

We consider $I \geq 3$ heterogeneous agents. As the payoff of an agent is contingent on his type, collective decision making requires the aggregation of individual preferences into a social preference relation. The aggregation mechanism that will be considered in this chapter is majority voting.

Also, the space of trading decisions will be formed by $J \geq 3$ alternatives. Hence a trading equilibrium may fail to exist, giving rise to instability or cycling whereby, for any trading decision, one can find some alternative that beats the previous alternative in a majority contest. The literature on social choice has provided different conditions to ensure the existence of an undominated outcome by majority voting. These conditions are essentially of two types. Either limitations on the preference types among voters or restrictions in the dimensionality of the alternative space. In particular, Gans and Smart (1996) show that single-crossing preferences in a one-dimensional feasible set is a sufficient condition for a majority voting equilibrium to exist. In this chapter however, we consider a two-dimensional space. The first dimension is given by a trading alternative, whereas the second dimension is defined by and expropriation rule. As we do not assume any prior weak ordering among pairs of alternatives, voters' preferences are not restricted in any natural ordering.

More specifically, we define the economic agents as a group of employees forming part of a cooperative. The individual decision taken by each employee is how much effort to invest in the cooperative. The trading decision taken by majority voting is which productive technology to implement. Expropriation, when favored by a majority of employees, will take the form of a linear sharing rule levied on employees' individual productivity. Redistribution will imply that the share from aggregate surplus accruing to a high type is lower than his contribution to the firm.

In a cooperative, employees play a double role. As owners they hold control rights to take all public decisions as the future unveils[1]. In particular, a one-member-one-vote cooperative will assign one control right to each employee and collective decisions will be taken by majority voting. Also,

[1]In the spirit of the incomplete contract literature initiated by Grossman and Hart (1986), future decisions cannot be contracted upon in advance and instead the owners of the physical assets hold control rights to decide.

employees are characterized as workers and thus will decide individually how much effort to invest to increase productivity. The efficiency of a cooperative will therefore be determined by the technology implemented by the firm and by employees' choice of effort.

The anticipation of expropriation may distort efficiency through two main channels. Directly, through its impact on effort choice. And indirectly, through its effect on technology choice. The first effect results from the existence of moral hazard that creates a friction to perfect contracting. More interestingly, consider the latter effect. Different technologies give rise to different expropriation schedules in equilibrium. The reason being that both the cost of expropriation, measured by employees' underinvestment in effort as well as the benefit from expropriation, given by the difference between individual and average productivity, vary across technologies. The anticipation of different sharing rules under different technologies will affect the equilibrium outcome in technology choice and the reason is twofold. First, the sharing rule pins down employees' individual productivity following effort optimization. Also, it defines the relative weight in the payoff function of an employee's individual productivity relative to the firm's aggregate productivity.

Moreover, an additional potential effect of collective decision making on efficiency will be considered, namely the impossibility to find an undominated alternative in a space with more than two alternatives and more than two preference types.

One of the main contributions of this chapter is to provide conditions that guarantee the existence of a majority voting equilibrium in a two-sequential voting game. In particular, we present a set of restrictions that lie on the characterization of the technology set. Yet these restrictions, by constraining the set of sharing rules that may arise in equilibrium, limit the extent of conflicts of interest among employees, leading to a transitive preference relation in technology choice.

Also we show that although expropriation may cause large inefficiencies in technology choice, a cooperative will always choose a Pareto efficient technology, defined in terms of the employees' productivity functions. This result holds even when in equilibrium, a Pareto efficient technology may induce a more severe distortion in effort than alternative technologies. And even if the anticipated sharing rule following the Pareto efficient technology may lead to a decrease in an employee's expected payoff.

Finally, we compare the direct effect caused by redistribution via employees' underinvestment in effort with its indirect effect caused via distortion in technology choice. The direct effect, while always negative, is however limited by an upper bound. The reason is that it only arises when redistribution is positive in equilibrium. But in this case distortions are internalized by employees as their individual payoff is increasing in total surplus. By contrast, the indirect effect of redistribution is in principle ambiguous. It might decrease efficiency significantly, provided redistribution arises only under the inefficient project. But it can also increase efficiency as long as redistribution is anticipated under the efficient project.

The chapter is organized as follows. Section 2 describes the model. In Section 3 we present the equilibrium outcomes with respect to both individual and collective decisions. Section 4 discusses equilibrium existence in connection with the related literature. Section 5 analyzes the relative distortion induced by redistribution on individual choice with respect to collective choice. Section 6 concludes and suggests an agenda for further research.

2.2 The model

Consider a firm defined by the assets required to implement a productive technology. The constitution of the firm assigns residual control rights to its employees. We consider a one-member-one-vote cooperative whereby each employee is endowed with one vote and corporate decisions are taken by majority voting. When the constitution is drawn at date 0, the set of feasible technologies is not yet revealed. Also, the complexity of the environment prevents employees from writing a date 0 contract by which decisions could be made contingent on the prevailing state of nature. Instead they can only commit to a constitution that will govern future decision making. As the future unveils, employees are confronted with two main decisions. As owners, they should decide which technology to implement and how to divide aggregate production. As workers, they should decide how much effort to exert in the firm. As effort is not verifiable, it will be optimally chosen by each employee to maximize his expected payoff. The efficiency of the cooperative is determined by both the technology implemented by the firm as well as by employees' choice of effort.

Timing

We make two crucial assumptions that restrict the sequence of events. First, we assume that employees are unable to commit. As the implementation of a technology is irreversible in the short run whereas a redistributive rule can be reversed at no cost, only credible schedules can be implemented in equilibrium. Second, whereas a technology is defined as a long term investment and thus becomes a one time decision, effort is assumed to be a short term investment which is decided sequentially all throughout the life of the technology. This time structure puts an upper limit on the degree of expropriation that employees may suffer in a one period horizon. Should an employee be fully expropriated once effort is sunk, he would shirk in the future leading to suboptimal aggregate production. These two assumptions can be captured in the following time line.

At date 0 the constitution of a one-member-one-vote cooperative is designed. Corporate decisions are governed by majority voting. The state of nature reveals a set of technologies $\mathcal{J}$.

At date 1, employees vote on technology choice.

At date 2, employees vote on redistribution.

At date 3, each employee chooses a level of effort.

At date 4, surplus is distributed.

The economic environment

Consider a set $\mathcal{J}$ of technologies indexed by $j \in \{1, ..., J\}$ that are available at date 1. Given technology j, the set of employees $\mathcal{I}$ is indexed by $i \in \{1, ..., I\}$, where i denotes the employee's productivity type.[2] Individual productivity, denoted by θ, is not only a function of technology but also a function of effort $e \in E$, with E being a compact set of positive reals. Hence

[2]There are two ways in which we can motivate this assumption. We might consider employees as being born with different abilities that are only productive under a particular technology. Alternatively, we migth regard the effect of technology on employees' productivity as the result of corporate decisions; for instance, in an industrial firm, the introduction of a new production process will only rise the productivity of the employees assigned to the plant in which the technology is installed.

technology $j \in \mathcal{J}$ can be defined by a collection of productivity functions $\{\theta_i(e;j)_{i\in\mathcal{I}}\}$.

(A1) The following relation between productivity and effort holds:

(i) $\theta_i(0;j) = 0$ and,

(ii) $\frac{\partial\theta_i(e;j)}{\partial e} > 0$ and $\frac{\partial^2\theta_i(e;j)}{\partial e^2} < 0$

for $i \in \mathcal{I}$ and $j \in \mathcal{J}$.

When the set of technologies $\mathcal{J}$ is revealed, each employee privately learns his productivity type $\theta_i(e;j)$. Also, the distribution of productivity types generated by each technology is common knowledge. We assume that the cooperative is large enough so that the ex-ante distribution of types is equivalent to the ex-post realization of productivity types. Once the technology is implemented, productivity is revealed so that redistribution takes place under symmetric information.[3]

Given a particular technology $j \in \mathcal{J}$, the marginal effect of effort on productivity will typically differ across employees. Yet for tractability reasons, we assume two regularity conditions. First, for a given technology there is a natural ordering of employees so that the productivity function of an employee is a concave transformation of the productivity function of the previous employee. Also, we assume that for a given employee, the concavity of his productivity function is constant for all levels of effort. This assumption will allow us to characterize a technology in terms of the average concavity of employees' productivity functions. More specifically:

(A2) Assume the following functional relation:

(i) $\frac{\partial\theta_i(e;j)}{\partial e} < \frac{\partial\theta_l(e;j)}{\partial e}$ and,

(ii) $\frac{\partial\theta_h^2(e';j)}{\partial e^2} = \frac{\partial\theta_h^2(e';j)}{\partial e^2}$

for all $j \in \mathcal{J}$; $e, e' \in E$; $i, l \in \mathcal{I}$ such that $i < l$ and all $h \in \mathcal{I}$[4]

[3]As the cooperative is large, free rinding precludes transfers at date 1 among employees; see Mailath and Postlewaite (1990). Hence inefficient outcomes might arise in equilibrium. We recognize that the application of mechanism design would help to reveal information at date 1, although screening at date 2 only takes place along the equilibrium technology.

[4]The following numerical example satisfies A1-A2:

We assume that there is some friction that prevents employees from accruing their marginal product in the spot market. As a consequence, employees may be subject to expropriation ex-post in the form of redistribution. However, there is an upper bound to the extent of expropriation that employees may suffer inside the firm. We have assumed a moral hazard approach, under which productivity depends on the unverifiable level of effort exerted by an employee. Under assumption 1, expropriation will induce underinvestment in effort due to free riding. This effect is equivalent to the classical application of redistributive income taxation and its impact on labor supply decisions in the public choice literature. As in the case of distortionary taxation, total expropriation will not generally desirable in order to induce positive effort.[5]

As a simplifying assumption, we restrict the redistribution policy to be linear. It can be regarded as a productivity tax denoted by $s \in [0,1]$.

Distribution of payoffs

An employee's payoff is determined by his individual share of aggregate production, net of his cost of effort.

Given the structure of the model, the preferences of an employee are defined with respect to three variables: his choice of effort which is privately decided, and two public variables, i.e. the technology implemented in the firm and the redistribution policy.

We do not restrict the correlation of employees' types across technologies. This implies that the payoff of an employee depends crucially on the technology selected by the firm for two reasons. First, it defines his productivity type. Second, it pins down his realized productivity following effort optimization which depends on the equilibrium redistribution policy that is contingent upon technology choice. Following the linearity of the sharing

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$\theta_i(e;j) = \alpha_i e - \frac{e^2}{2}$ with $\alpha_i > e$ for $e \in E$ and $\alpha_i < \alpha_l$ for $i < l$.

In effect, $\frac{\partial \theta_i(e;j)}{\partial e} = \alpha_i - e$ and $\frac{\partial^2 \theta_i(e;j)}{\partial e^2} = -1$.

[5] An alternative motivation for limited expropriation is an outside wage interpretation. Suppose that, there exists a spot market for employees offering a reservation wage. Also, assume that, once the technology has been implemented, employees develop skills that are typically firm specific. Therefore, employees' reservation wage will always be lower than their inside productivity. This model has been explored in chapter I.

rule (complemented by a budget restriction), the payoff of employee i under project j can be expressed as a convex combination of both his individual productivity and the technology's mean productivity, weighted by the redistributive rule and net of his cost of effort:

$$u_i(j, s, e) = (1 - s)\,\theta_i(e; j) + s\frac{\sum_{l=1}^{I} \theta_l(e; j)}{I} - e$$

We are concerned with the efficiency of the cooperative measured by its aggregate surplus as defined below:

Definition 1 *Project $k \in J$, is first-best or efficient when it maximizes total surplus, that is, when:*

$$k = argmax_{j \in \mathcal{J}} \sum_{i=1}^{I} \left(\theta_i(e_i; j) - e_i\right)$$

The first question that we address is whether a majority voting rule will ensure the existence of equilibrium in both technology choice and redistribution. Second and provided that an equilibrium exists, we analyze the distortions in efficiency induced by redistribution. As efficiency depends on both the technology implemented by the firm as well as on employees' choice of effort, we will compare the relative effect of redistribution on technology choice (indirect effect) with respect to its effect on employees' choice of effort (direct effect).

2.3 Equilibrium Outcomes

Given the time line of the model, the equilibrium outcome of the game can be worked out backwards, solving first for the individual decision and thereafter for the voting decision.

2.3.1 Individual Choice

Employee i chooses effort in order to maximize his final payoff. At date 3, both the investment project and the redistribution schedule are publicly known.

Therefore, the private decision of employee i is determined by the following maximization problem:

$$Max_{e_i} u_i(j, s, e_i) = (1 - s)\,\theta_i(e_i; j) + s\frac{\sum_{l=1}^{I} \theta_l(e_l; j)}{I} - e_i$$

F.O.C.

$\left[1 - s\left(1 - \frac{1}{I}\right)\right] \dfrac{\partial \theta_i(\hat{e}_i; j)}{\partial e} = 1$

As the cooperative is large enough:

$\dfrac{\partial \theta_i(\hat{e}_i; j)}{\partial e} = \dfrac{1}{1-s}$

By assumption 1, $\hat{e}_i < e_i^*$, for $s > 0$

where $\dfrac{\partial \theta_i(e_i^*; j)}{\partial e} = 1$ defines the first-best level of effort e_i^*.

Also, by assumption 2, $\hat{e}_i(s; j) < \hat{e}_l(s; j)$ for $i < l \in \mathcal{I}$

The above equation shows effort as an implicit function of the sharing rule chosen by the cooperative. We can analyze the sensitivity of effort to changes in redistribution, by applying the implicit rule of differentiation. This analysis will be relevant to characterize employees' voting behavior at the redistribution stage.

$$\frac{\partial \theta_i^2(\hat{e}_i(s; j); j)}{\partial e^2} \frac{\partial \hat{e}_i(s; j)}{\partial s} = \frac{1}{(1-s)^2}$$

Therefore,

$$\frac{\partial \hat{e}_i(s; j)}{\partial s} = \frac{1}{\delta_i(j)(1-s)^2} < 0$$

where $\delta_i(j) = \dfrac{\partial \theta_i^2(e; j)}{\partial e^2}$, denotes the concavity of employee i's productivity function with respect to effort, given technology j. By A2, $\delta_i(j)$ is constant for any choice of effort.

Hence the effect of redistribution on effort depends on two values: the concavity of $\theta_i(e; j)$ with respect to effort and, the initial value of s. In particular, the more concave $\theta_i(e; j)$, the lower the effect of redistribution on effort. This is due to the larger effect on the marginal productivity function of a decrease in effort. As this marginal effect is partially internalized by each employee, as long as $s < 1$, he will choose a lower distortion on effort.

Also, the marginal effect of redistribution on effort increases with the value of the sharing rule. When s is higher, employees internalize to a lower extent changes in the marginal benefit of effort on productivity.

2.3.2 Public Choice

There are two possible interpretations to the sequential voting that takes place in the cooperative.

The first interpretation is the use of strategic voting at date 1. Before casting their votes, forward-looking employees anticipate future voting outcomes. Employees may be better off voting for an inefficient project at the first stage in order to influence redistribution at the second stage.

The investment decision taken at date 1, could be alternatively regarded as the outcome of a multidimensional sincere voting process. Preferences for redistribution at date 2 would be embedded in the first period preferences for technology. We assume the former interpretation in the analysis that follows.

This dynamic voting problem boils down to a two stage voting process. Hence we solve backwards starting at date 2. At this date, employees vote on their preferred redistribution policy contingent on the project selected at date 1. At stage 1, forward-looking employees vote strategically anticipating the equilibrium redistribution policy at date 2.

Voting over Redistribution

The first question is whether a voting equilibrium exists on redistribution. We know from standard results that when voters' preferences are single-peaked, an equilibrium outcome always exists under majority voting. But when aggregate production changes with the redistributive scheme, single-peakedness is not guaranteed. Gans and Smart (1996) provide a milder condition to guarantee the existence of equilibrium. In particular, they show that as long as the payoff function of employees is single-crossing with respect to the choice variable, i.e. $s \in [0, 1]$, an equilibrium will exist. The following Lemma shows that our assumptions satisfy this condition.

Lemma 1 *Given A1-A2, a majority voting equilibrium on redistribution exists.*

Proof: See Appendix

The intuition is as follows. Given A1-A2, employees can be ordered according to their optimal choice of effort. It turns out that an employee who chooses a higher level of effort is also a higher productivity type so that his realized productivity is larger. As this is true for any choice of effort, the ordering is invariant to the sharing rule chosen in equilibrium. Hence the Hierarchical Adherence Condition proposed by Roberts (1977) is satisfied. He shows that if the ordering of individuals' choice of labor is the same irrespective of the tax policy adopted, an equilibrium exists for a linear tax schedule chosen by majority voting.[6]

Next, we determine which redistributive schedule will be selected in equilibrium by the cooperative.

Employee i will vote for the redistribution policy that maximizes his expected utility $u_i(j, s, e_i)$:

$$\max_s u_i(j, s, \hat{e}_i) = (1-s)\,\theta_i(\hat{e}_i(s;j);j) + s\frac{\sum_{l=1}^{I}\theta_l(\hat{e}_l(s;j);j)}{I} - \hat{e}_i(s;j)$$

F.O.C.

$$-\theta_i(\hat{e}_i(s;j);j) + (1-s)\frac{\partial\theta_i(\hat{e}_i(s;j);j)}{\partial e}\frac{\partial\hat{e}_i(s;j)}{\partial s} + \frac{\sum_{l=1}^{I}\theta_l(\hat{e}_l(s;j);j)}{I} + s\frac{1}{I}\sum_{l=1}^{I}\frac{\partial\theta_l(\hat{e}_l(s;j);j)}{\partial e}\frac{\partial\hat{e}_l(s;j)}{\partial s} - \frac{\partial\hat{e}_i(s;j)}{\partial s} = 0$$

By the envelop theorem, only the direct marginal effects of s on utility are relevant. Denote by $\overline{\theta}(\hat{e}(s;j);j)$ the mean productivity of the cooperative when each employee i exerts effort $\hat{e}_i(s;j)$ and technology j is implemented. Then:

$$\overline{\theta}(\hat{e}(s;j);j) - \theta_i(\hat{e}_i(s;j);j) = -s\frac{1}{I}\sum_{l\neq i}^{I}\frac{\partial\theta_l(\hat{e}_l(s;j);j)}{\partial e}\frac{\partial\hat{e}_l(s;j)}{\partial s}$$

From the individual optimization problem, the slope of the productivity function at the optimal choice of effort is constant across employees. That is:

[6]And in the case of a linear tax schedule, the Hierarchical Adherence Condition is equivalent to single-crossing, as shown by Gans and Smart (1996).

$$\frac{\partial\theta_i\left(\hat{e}_i\left(s;j\right);j\right)}{\partial e}=\frac{\partial\theta_l\left(\hat{e}_l\left(s;j\right);j\right)}{\partial e}=\frac{\partial\theta\left(\hat{e}\left(s;j\right);j\right)}{\partial e}$$

However, the sensitivity of effort to redistribution depends on the concavity of the employee's productivity function which, by A2, is different for each employee.

Therefore, for a large cooperative:

$$\overline{\theta}\left(\hat{e}\left(s;j\right);j\right)-\theta_i\left(\hat{e}_i\left(s;j\right);j\right)=-s\frac{\partial\theta\left(\hat{e}\left(s;j\right);j\right)}{\partial e}\frac{\sum_{l\neq i}\frac{\partial\hat{e}_l\left(j\right)}{\partial s}}{I}$$

At employee i's preferred redistribution schedule, the marginal benefit of redistribution (given by the LHS and positive for low types) equals the marginal cost of redistribution (given by the RHS, i.e. employees' underinvestment in effort). Note that whereas the marginal benefit of redistribution is decreasing in an employee's individual productivity, the marginal cost of redistribution is the same for all employees. Given technology j, by A1-A2 employees can be ordered according to their preferences for redistribution. As this ordering is preserved under any sharing rule, the redistributive policy preferred by the median type is a Condorcet winner.[7]

To solve for the equilibrium sharing rule, substitute:

$$\frac{\partial\theta\left(\hat{e}\left(s;j\right);\right)}{\partial e}=\frac{1}{\left(1-s^*\right)}\text{ and,}$$

$$\frac{\partial\hat{e}_l\left(j\right)}{\partial s}=\frac{1}{\left|\delta_l\left(j\right)\right|\left(1-s^*\right)^2}$$

Therefore, the equilibrium sharing rule is given by:

$$s^*\left(j\right)=\min\left\{\max\left(0,\frac{\overline{\theta}\left(\hat{e}\left(s^*;j\right);j\right)-\theta_m\left(\hat{e}_m\left(s^*;j\right);j\right)}{\frac{1}{\left|\overline{\delta}\left(j\right)\right|\left(1-s^*\right)^3}.}\right),1\right\}$$

[7]We assume that voting takes place by pairwise comparison of two linear schedules. The winner of this contest is confronted with a third candidate. It is straightforward to show that, the schedule that survives the last round is the redistributive rule preferred by the median productivity employee.

where $\overline{\delta}(j) = \frac{\Sigma\delta_i(j)}{I}$ denotes the average concavity of employees' productivity functions under technology j.

Note the endogenous relation between the choice of effort and redistribution. A low value for the sharing rule leads employees to a high choice of effort. By A2, a high choice of effort gives rise to a greater dispersion between the mean and the median productivity. But greater dispersion increases the benefit accruing to the median employee from redistribution thus leading him to choose a higher value for the sharing rule. Yet we can apply the fixed point theorem to guarantee the existence of an equilibrium in redistribution.[8]

The determination of the equilibrium sharing rule, draws on two variables that characterize technology j: the concavity of employees' productivity functions and its equilibrium average skewness. Provided the distribution is positively skewed, a more concave technology leads to higher redistribution. The reason is that the cost of redistribution in terms of effort distortion is lower as employees' marginal benefit from increased effort will is higher leading to lower effort distortions.[9] Second, a more positively skewed distribution induces higher redistribution. Whereas the marginal benefit from increased redistribution accruing to the median employee is higher the cost of redistribution remains the same.

Voting over Projects

Given the technology set $\mathcal{J}$, employee i will cast his vote in favor of project k provided it maximizes his expected payoff:

$$k = \arg\max_{j \in \mathcal{J}} u_i\left(j, s_j^*, \hat{e}_i\left(s_j^*; j\right)\right)$$

We shall address two main issues. First, whether there is an equilibrium in technology choice under majority voting. The answer to this question is

[8]The fix point theorem can be applied given the characterization of the set S as a non-empty, compact and convex set. Also, the function $f : S \rightarrow S$ can be shown to be continuous from the linearity of the sharing rule in the payoff function. Hence there is a value s^* such that $s^* = f(s^*)$.

[9]In effect, if concavity increases so that $\left|\overline{\delta}(j)\right|$ rises, $\frac{s^*}{(1-s^*)^3}$ should increase to maintain the equality. As $\frac{\partial \frac{s^*}{(1-s^*)^3}}{\partial s} = \frac{2s^*+1}{(1-s^*)^4} > 0$, then s^* will be higher.

not straightforward with sequential voting and a number of projects $J \geq 3$. Second and provided an equilibrium does exist, whether the technology is efficient.

(i) Existence of Equilibrium

Consider the following assumption:

(A3) The set of technologies $\mathcal{J}$ can be ordered as follows: $k > j$, where j is positively skewed and k is a mean preserving spread[10] of technology j for all $e \in E$.

In the analysis that follows we assume that A3 holds.[11] Interestingly, A3 does not order the preferences of employees for technology choice and the reason is twofold. First, preferences are defined not only with respect to individual productivity but also in relation to redistribution. Second, even if the productivity type of an employee is higher under a technology his realized productivity as well as the firm's aggregate productivity may be lower provided the distortions on effort are sufficiently high.

The fact that for the same level of effort, aggregate productivity is the same for all technologies has the following implication. The concavity of each employee's productivity function is the same for all technologies. The next lemma states this result.

Lemma 2 *For a technology set defined by A3, the sensitivity of an employee's productivity to effort is the same across projects. That is:*

$$\frac{\partial \theta_i (e; j)}{\partial e} = \frac{\partial \theta_i (e; k)}{\partial e} \text{ for all } i \in I \text{ and } j, k \in J$$

Proof: See Appendix

This result has the following implication. As the marginal effect of effort in productivity is the same for all technologies, for the same sharing rule, an

[10]We define a mean preserving spread as follows. For a given a choice of effort, an employee whose productivity is lower than the mean productivity decreases his productivity. Similarly, an employee whose productivity is greater than the mean productivity rises his productivity.

[11]A3 implies that only technology j satisfies A1 (i). Otherwise, the definition of mean preserving spread would not hold for $e = 0$.

employee's choice of effort would be independent of technology choice. But the sharing rule is determined by the median employee. And his preferences depend both on the concavity and on the skewness of the technology. From Lemma 2, the individual concavity of each technology is the same, i.e. $\delta_i(j) = \delta_i(k)$ for all $i \in I$ and $j, k \in J$. Hence $\overline{\delta}(j) = \overline{\delta}(k) = \overline{\delta}$. Yet the degree of skewness typically differs across technologies. As a result, both the sharing rule as well as employees' level of effort will vary across technologies. Without further restrictions on the technology set, we cannot ensure the existence of an equilibrium in project choice. But an additional restriction on the concavity of the technology set with respect to effort is sufficient to guarantee the existence of a majority voting equilibrium.

Proposition 1 *Under A1-A3, an equilibrium in technology choice exists, provided the concavity of productivity with respect to effort is either too low or too high. That is:*

$$\overline{\delta} < \overline{\delta_l} \text{ or } \overline{\delta} > \overline{\delta}_u$$

Proof: See Appendix

To understand Proposition 1, let us restrict attention to the voting behavior of a 3 member cooperative. Suppose that employees have to choose among three projects h, j and k, that satisfy A3. That is, projects are ordered according to their degree of dispersion. It follows that the ordering of employees with respect to their productivity is invariant to project choice. This ordering defines a low, a median and a high productivity type. As h is positively skewed, the individual productivity of the median employee is decreasing with the dispersion of the technology. Also, the benefit from increased redistribution is greater under project k whereas the cost of redistribution is the same across projects; therefore, $s_k^* > s_j^* > s_h^*$.

As the median employee is decisive to set redistribution, it can be shown that his utility is maximum under project h and minimum under project k. Hence, a necessary condition for the intransitivity of social preferences is that the other two employees exhibit reverse preferences relative to the median type. In particular, both the low and the high type should prefer project k over project h. The productivity of a low type is relatively lower under project k given both the skewness of the project and the more severe underinvestment in effort. Yet he would be willing to favor project k as long as the increase in the equilibrium sharing rule under project k is high enough in relation to project j. On the other hand, the productivity type of the high type is relatively higher under project k. Yet he will only vote for project k as long as the anticipated sharing rule is relatively low by comparison with project j. And the reason is twofold. First, high redistribution may induce lower productivity through greater distortions in effort. Second, his residual claim on individual productivity is lower. As the sharing rule is pinned down by the concavity of employees' productivity function, it can be shown that only for intermediate values of concavity the preferences of the low and the high type can be aligned. This implies that for extreme values of concavity, the social preference relation induced by majority voting will be transitive.

(ii) Efficiency

The first question to ask is whether a cooperative may forego a Pareto efficient technology driven by the conflicts of interest generated by dynamic voting. To address this question we constrain the feasible technology set according to the following definition.

Definition 2 *A project j defined by the distribution of productivity functions $(\theta_1(e;j), \theta_2(e;j), ...\theta_I(e;j))$ is Pareto efficient if there is not another project $k \in J$ with associated distribution $(\theta_1(e;k), \theta_2(e;k), ...\theta_I(e;k))$ such that for a given vector of efforts $e \in E$, the following is true:*

$\theta_i(e;k) \geq \theta_i(e;j)$ for all $i = 1....I$, and;

$\theta_i(e;k) > \theta_i(e;j)$ for some $i \in \mathcal{I}$

The answer is not obvious. The reason is that the preferences of employee i are determined not only by his individual productivity but also by the sharing rule anticipated in equilibrium. Moreover, his individual productivity under project k will be pinned down by the equilibrium choice of effort under project k. Lower effort following greater redistribution will lead to lower realized productivity. As both the optimal effort choice as well as the equilibrium sharing rule vary across technologies, employee i may be better off under a Pareto dominated project. Yet the following result shows that there will always exist a majority of employees favoring a Pareto efficient project.

Proposition 2 *Let $\{j^*, s_j^*\}$ be the equilibrium outcome of the two-stage sequential voting that takes place in the cooperative. Under A1-A2, project j^* is Pareto efficient.*

Interestingly, proposition 2 holds for any correlation of employees' productivity functions across projects. That is, irrespective of whether the ordering of employees in terms of their productivity is contingent or not on technology choice.

Although project k is Pareto efficient given e, the equilibrium choice of effort under project k and j are typically different. Then it is possible that the productivity of employee i under project k might be lower than his productivity under project j. Given the definition of Pareto efficiency, a necessary condition is that $\widehat{e}_i\left(s_k^*;k\right) < \widehat{e}_i\left(s_j^*;j\right)$. This inequality may arise for two reasons.

First, for a fixed sharing rule, when the marginal productivity of i's productivity function given project k and evaluated at $\widehat{e}_i\left(s_j^*;j\right)$ is lower than under project j. Yet given A2, this condition would contradict the characterization of k as Pareto efficient.

To see why, fix e_0 small enough, i.e. $e_0 < \varepsilon$. As k is Pareto efficient, $\frac{\partial\theta_i\left(e_0;k\right)}{\partial e} > \frac{\partial\theta_i\left(e_0;j\right)}{\partial e}$.

Consider $\widehat{e}_{ij} = \widehat{e}_i\left(s_j^*;j\right)$. By A2, the following relation holds:

$$\frac{\partial\theta_i\left(\widehat{e}_{ij};k\right)}{\partial e} = \frac{\partial\theta_i\left(e_0;k\right)}{\partial e} + \int_{e_0}^{\widehat{e}_{ij}} \frac{\partial^2\theta_i\left(e;k\right)}{\partial e^2}de = \frac{\partial\theta_i\left(e_0;k\right)}{\partial e} + \delta_i\left(k\right)\left(\widehat{e}_{ij} - e_0\right).$$

Likewise:

$$\frac{\partial\theta_i\left(\widehat{e}_{ij};j\right)}{\partial e} = \frac{\partial\theta_i\left(e_0;j\right)}{\partial e} + \int_{e_0}^{\widehat{e}_{ij}} \frac{\partial^2\theta_i\left(e;j\right)}{\partial e^2}de = \frac{\partial\theta_i\left(e_0;j\right)}{\partial e} + \delta_i\left(j\right)\left(\widehat{e}_{ij} - e_0\right).$$

Given that $\delta_i\left(j\right), \delta_i\left(k\right) < 0$, for $\frac{\partial\theta_i\left(\widehat{e}_{ij};k\right)}{\partial e} < \frac{\partial\theta_i\left(\widehat{e}_{ij};j\right)}{\partial e}$ to be satisfied, a necessary condition is $\left|\delta_i\left(k\right)\right| > \left|\delta_i\left(j\right)\right|$. But then for e sufficiently high, i.e. $e >> M$, $\theta_i\left(e;k\right) < \theta_i\left(e;j\right)$, which contradicts the definition of k as Pareto efficient.

Second, $\widehat{e}_i\left(s_k^*;k\right) < \widehat{e}_i\left(s_j^*;j\right)$ may hold when the equilibrium sharing rule under project k is higher than under project j. In this case, an employee may prefer project j for two reasons. First, because his realized productivity at the optimal choice of effort might be higher under project j. Also because the extent of redistribution is larger under project k. To analyze the voting behavior of the winning coalition at date 1, consider the preferences of the median employee under project k. He is by definition pivotal to set redistribution at date 2, had project k been implemented. We show next that he is always better off under the Pareto efficient project. Let us suppose that he sets $s_k = s_j^*$. Given the definition of Pareto efficiency, $u_m\left(k, s_j^*, \hat{e}_{mj}\right) > u_m\left(j, s_j^*, \hat{e}_{mj}\right)$. If he prefers $s_k > s_j^*$, then $u_m\left(k, s_k, \hat{e}_{mk}\right) > u_m\left(k, s_j^*, \hat{e}_{mj}\right)$. Putting the previous inequalities together we obtain the result.

The question is: will he be able to form a majority coalition in favor of his preferred project? The answer is positive. To see why consider the preferences of a low productivity employee under project k, given the sharing rule s_j^*. From concavity and Pareto efficiency, it follows that:

$\theta_i\left(\widetilde{e}_{ij}; k\right) > \theta_i\left(\widehat{e}_{ij}; j\right)$ and
$\overline{\theta}\left(\widetilde{e}_j; k\right) > \overline{\theta}\left(\widehat{e}_j; j\right)$

where $\widetilde{e}_{ij} = \widehat{e}_i\left(s_j^*; k\right)$

This implies that $u_i\left(k, s_j^*, \widetilde{e}_{ij}\right) > u_i\left(j, s_j^*, \widehat{e}_{ij}\right)$

As $s_k^* \geq s_j^*$, there is an additional cost generated by project k in terms of increased underinvestment in effort. Yet as m is decisive in redistribution, this means that the benefit accruing to m from a higher sharing rule is greater than the cost induced by lower incentives to exert effort. For $i < m$, the benefit of increased redistribution is higher than for m, whereas the cost is the same (in a large cooperative), therefore the payoff of i would increase with a higher redistributive schedule. Given that the sharing rule is linear in the payoff function, by continuity, $u_i\left(k, s_k^*, \widehat{e}_{ik}\right) \geq u_i\left(k, s_j^*, \widetilde{e}'_{ij}\right) > u_i\left(j, s_j^*, \widehat{e}_{ij}\right)$.

When $s_k^* \geq s_j^*$, the date 1 winning coalition will be formed by all employees with weakly lower productivity than the median employee under project k, that is $i \in \mathcal{I}$ such that $i < m$. They will favor the efficient project despite the additional inefficiency caused by increased underinvestment in effort generated by a higher equilibrium sharing rule.

On the other hand, when $s_k^* < s_j^*$, given concavity and Pareto efficiency, $\theta_i\left(\widehat{e}_{ik}; k\right) > \theta_i\left(\widehat{e}_{ij}; j\right)$. Yet an employee may favor project j as it allows for higher redistribution. However there will always be a winning coalition in favor of the efficient project. This coalition will be formed by all employees whose productivity under project k is weakly higher than the median employee's productivity. More specifically, consider the preferences of high productivity employees under project k, that is $i \in \mathcal{I}$ such that $i > m$.

Suppose that the equilibrium sharing rule under k was given by s_j^*. From concavity and Pareto efficiency, it follows that:

$\theta_i\left(\widetilde{e}_{ij};k\right) > \theta_i\left(\widehat{e}_{ij};j\right)$ and
$\overline{\theta}\left(\widetilde{e}_j;k\right) > \overline{\theta}\left(\widehat{e}_j;j\right)$

This implies that $u_i\left(k, s_j^*, \widetilde{e}_{ij}\right) > u_i\left(j, s_j^*, \widehat{e}_{ij}\right)$

As $i > m$, the cost of redistribution is the same but the benefit from a lower sharing rule is higher than for the median employee. Hence employee i's payoff decreases with the value of the sharing rule. Given that the sharing rule is linear in the payoff function, by continuity, $u_i\left(k, s_k^*, \widehat{e}_{ik}\right) \geq u_i\left(k, s_j^*, \widetilde{e}'_{ij}\right)$.

In short, there will always be a winning coalition at date 1 in favor of the Pareto efficient project. This coalition will be formed by $i \leq m$ (where this ordering is defined under project k) as long as $s_k^* \geq s_j^*$. Otherwise, when $s_k^* < s_j^*$, the winning coalition will be formed by $i \geq m$.

2.4 Discussion on Equilibrium Existence

The existence of a Condorcet winner under majority voting has been explored by Roberts (1977), where voting is applied to the selection of a tax schedule. He proposes a hierarchical adherence condition that guarantees a transitive preference relation over tax policies. Hierarchical adherence is satisfied when individuals' ordering in terms of their income is invariant to the tax policy adopted.

In principle, we might think that an equivalent condition applied to the ordering of employees according to their individual productivity would ensure a majority voting equilibrium in technology choice.

A revisited hierarchical adherence condition would imply that employees's ordering after optimizing on effort choice holds irrespective of technology choice. Replace A2 by the following assumption:

(A2') $\theta_i\left(\widehat{e}_i;j\right) < \theta_l\left(\widehat{e}_l;j\right) \Leftrightarrow \theta_i\left(\widehat{e}_i;k\right) < \theta_l\left(\widehat{e}_l;k\right)$ *for all* $i,l \in I$ *and, all* $j,k \in J$

In Roberts (1977), hierarchical adherence is not only sufficient for the existence of equilibrium, but it also guarantees that the median voter theorem is satisfied. Yet, we shall see that A2' is neither necessary nor sufficient for the median voter theorem to hold in technology choice. More interestingly, it does not even guarantee the existence of a majority voting equilibrium in technology choice. The following examples illustrate such claim.

Example 1: (A2') is not necessary for the MVT to hold in technology choice

Consider a cooperative with three employees $\{i, m, l\}$ and with a technology set given by $\mathcal{J} \equiv \{j, k\}$. To simplify the analysis, assume that there are no effort distortions from redistribution.

As $J = 2$, a date 1 equilibrium exists in technology choice. The median voter theorem could only be applied provided the median productivity employee m, is the same under both projects. Now assume that A2' does not hold. This imply that the productivity ordering between i and l is reversed across projects. Without loss of generality assume that $\theta_i(j) < \theta_l(j)$ but $\theta_i(k) > \theta_l(k)$. From definition, m is always decisive in redistribution at date 2, irrespective of the technology. That is, the median voter theorem holds at date 2. The question is whether the median voter theorem also holds at date 1. Suppose first that the median employee favors project k. We shall explore whether project k is always chosen in equilibrium.

Interestingly, m will always form a winning coalition with i at date 1 in favor of project k, irrespective of the redistributive policy chosen at date 2. If m favors positive redistribution, $\{l, m\}$ will win the vote at date 2. Alternatively if m votes for no redistribution, $\{i, m\}$ will join the winning coalition at date 2. Consider first the case whereby $s_k^* = 0$. If $s_j^* > 0 \Rightarrow u_i(j) = u_m(j) = \overline{\theta}(j)$. As $s_k^* = 0$ and m prefers project k then $u_i(k) = \theta_i(k) \geq \theta_m(k) > \overline{\theta}(k) = u_i(j)$. Otherwise if $s_j^* = 0 \Rightarrow u_i(k) = \theta_i(k) \geqslant \theta_m(k) > \theta_m(j) \geqslant \theta_i(j) = u_i(j)$. A similar analysis applies when $s_k^* > 0$. In this latter case, m will still form a date 1 winning coalition with i. Yet he will change coalition partners at date 2.

By symmetry, if m prefers instead project j, the winning coalition at date 1 will be formed by $\{l, m\}$ and project j will always be chosen by majority voting.

■

Notice that A2' does not restrict the relative gain or loss of employees' productivity across projects. As the voting behavior of an employee at date 1 is determined by this productivity differential, is not surprising that assumption 2 is not sufficient to ensure the decisive role of the median productivity employee. What is more surprising though, is that the median employee may be in the minority coalition at date 1 even if assumption 2 holds and for an overwhelming majority of employees, i.e. $(I-1)$, their individual productivity under the project favored by the median employee rises. The next example illustrates such a case.

Example 2: (A2') is not sufficient for the MVT to hold in technology choice

Consider a cooperative with seven employees $\{1, ..., 7\}$. The firm has to decide whether to implement technology 0 or 1. In our notation $\mathcal{J} \equiv \{0, 1\}$. The following table provides the productivity of each employee under each project, after optimizing in their effort level:

θ_1	1	2
θ_2	1	2
θ_3	1	2
θ_4	4	6
θ_5	8	7
θ_6	9	10
θ_7	9	12
$\sum \theta$	33	41

Notice that the mean productivity of projects 0 and 1 is $\overline{\theta}(0) = 4.7$ and $\overline{\theta}(1) = 5.8$ respectively.

As there are only two projects, we know that an equilibrium technology exists at date 1. Given that the ordering of employees by their productivity is constant across projects, A2' holds. Employee 4 is the median productivity employee and hence will be decisive to set redistribution irrespective of the project chosen at date 1. However, he may not be able to form a majority at date 1. The reason being the change in the composition of the majority group at date 2.

Note that to simplify the analysis, we have not provided the characterization of employees' productivity functions. Though we assume implicitly that the difference in the optimal level of effort across projects is not very significant. Hence preferences for technology choice will not be driven by differences in cost of effort.

Let us start by the equilibrium at date 2. As $\theta_4(0) < \overline{\theta}(0) \Rightarrow s_0^* > 0$; however as $\theta_4(1) > \overline{\theta}(1) \Rightarrow s_1^* = 0$. If project 0 was chosen at date 1, employee 4 would form a date 2 winning majority with low types. Similarly, if project 1 was chosen at date 1, he would form a date 2 winning coalition with high types. But this change in the balance of power ex-post will prevent employee 4 from forming a winning majority for technology choice. Consider employees' voting behavior at date 1.

For $s_0^* > 0.27$ redistribution effects are more important than individual effects for low productivity employees ($i < 4$) since $1 + s_0^* 3.7 > 2$. Therefore, they will be willing to sacrifice their gain in individual productivity under project 1 in order to obtain positive redistribution under the status quo. To form a majority, they require at least one high type being better off under the status quo. Notice that employee 5 will accrue a higher payoff under the status quo for $s_0^* \leq 0.3$; in effect, for this range of values $8 - s_0^* 3.3 > 7$. As a result, for redistribution policies $s_0^* \in [0.27, 0.3]$, the date 1 winning coalition will be formed by $\{1, 2, 3, 5\}$. Not only will the median employee lose the vote at date 1 but also the cooperative will choose the inefficient project 0.

The above argument brings to light the following comparative statics analysis. For higher s_0^*, the loss in efficiency induced by a change in the redistribution policy can be bigger. This is because the redistribution effect under the inefficient project becomes more significant. Similarly as N rises (keeping the proportion between low and high types constant) the loss in efficiency can increase as the date 1 winning coalition formed by low types does not internalize the increase in high types' productivity under the efficient project.

■

Now let consider the second part of our claim. It says that despite imposing an ordering of employees across projects, the existence of equilibrium in project selection is not guaranteed. The following example illustrates this result.

Example 3: (A2') does not guarantee the existence of equilibrium in technology choice

Let consider a cooperative with three employees $\{1,2,3\}$. The firm decides at date 1 which technology to implement from a set $\mathcal{J} \equiv \{0,1,2\}$. The productivity of each employee under each technology, after optimizing on his effort level is depicted as follows:

	0	1	2
θ_1	1	2	1
θ_2	4	8	7
θ_3	20	9	12
$\sum \theta$	25	19	20

It is easy to see that for all $i, l \in \mathcal{I}$ and all $j, k \in \mathcal{J}$ with $i < l : \theta_i(j) < \theta_l(j) \Rightarrow \theta_i(k) < \theta_l(k)$ so that A2' holds.

Notice that the equilibrium sharing rules are $s_0^* > 0$, and $s_1^*, s_2^* = 0$.

To simplify the analysis we shall maintain the implicit assumption discussed in Example 2 whereby technology choice is not driven by differences in cost of effort across projects. Hence, the final payoff of employee i under project j is given by:

	0	1	2
u_1	$1+s_0^*7.3$	2	1
u_2	$4+s_0^*4.3$	8	7
u_3	$20-s_0^*11.7$	9	12

For $s_0^* \in (0.68, 0.7)$, there exists an intransitive social preference relation of projects in the cooperative when decisions are taken by majority voting. Given the definition of s_0^*, this condition is satisfied when the average concavity of employees' productivity functions under project 0 falls between the interval $\overline{\delta}(0) \in [4.8, 6.0]$. In this case, employee 1 shows the preference relation $0 \succsim_1 1 \succsim_1 2$, whereas employee 2 prefers $1 \succsim_2 2 \succsim_2 0$ and employee 3's preference ordering is $2 \succsim_3 0 \succsim_3 1$.

■

But, why is A2's ordering condition not sufficient to ensure equilibrium in project selection? Because the preferences of employees are not determined solely on the basis of their individual productivity but also on the expected redistribution policy under each technology. That is, employees vote along two dimensions $(j, s_j^*) \in \mathcal{J}U[0,1]$, with no prior weak ordering between the pairs (j, s_j^*) and (k, s_k^*). We know from standard results that a majority voting equilibrium exists provided voters' preferences are single-crossing after optimizing over private choices; in particular, the ideal point of the median productivity employee would be a preference induced equilibrium. However, when voting over more than one dimension arises, an outcome is stable under majority voting only if it is a median point in all dimensions. This requirement imposes very stringent conditions on the symmetry of preferences across individuals (Plott, 1967). Otherwise, existence is not guaranteed when employees vote over a set with two variables which does not form a chain, that is, which is not ordered. All employees weakly prefer more efficient projects, that is, projects with high mean productivity values $\overline{\theta}(j)$. But they will typically exhibit conflicts of interest concerning the other two variables, that is, the distribution of individual productivity under each project and its degree of skewness. Ceteris paribus, an employee favors the project that maximizes his individual productivity. But the distribution of employees' productivity may not be aligned across projects. In addition, low types prefer projects with high positive skewness (to increase redistribution), whereas high types prefer projects with negative skewness (to avoid redistribution).

Note that the extent of inefficiencies are emphasized by dynamic voting, as example 2 illustrates. The threat of a change in the balance of power in the cooperative following the adoption of a new project induces employees to forego a very efficient technology under which all employees except one increase their productivity whereas the loser only decreases slightly his productivity. Remarkably, this result goes through despite the feasibility of endogenous transfers across employees via redistribution.

Yet Proposition 2 provides a limit to the inefficient behavior that may be observed in the cooperative. Even if a cooperative may be very inefficient in terms of aggregate productivity it will never choose a Pareto dominated technology.

2.5 Redistribution and Efficiency

In this section we explore how the feasibility of redistribution may influence the efficiency of a cooperative. Given A1, positive redistribution always decreases the efficiency of a cooperative through underinvestment in effort. Also, by changing the composition of the winning coalition at date 1, it may influence the efficiency of a cooperative through its impact on technology choice. Interestingly, this effect could lead to the choice of a more efficient technology. This is because redistribution allows to internalize aggregate production. In effect, when redistribution is not feasible, the voting behavior of an employee will be entirely determined by the ranking of his individual productivity across projects net of his cost of effort. By contrast, when redistribution is feasible, his payoff will be determined by a convex combination between his individual productivity and the mean productivity of the project, weighted by the equilibrium sharing rule and net of his cost of effort. As a case in point that illustrates a positive effect of redistribution on technology choice, consider two technologies, such that under the first technology the productivity of $\frac{N-1}{2}$ employees is much higher than under the second technology, whereas the productivity of $\frac{N+1}{2}$ employees is slightly higher under the first technology. In the absence of redistribution, the cooperative would choose the first technology. Yet if redistribution was feasible and $\theta_m < \overline{\theta}$, the second technology would be selected in equilibrium.

In short, redistribution may influence the efficiency of the cooperative through two channels: (i) directly, via employees' choice of effort, and (ii) indirectly, via employees' choice of the technology. We shall next compare the relative size of these two effects on efficiency. By A1 redistribution always induces an inefficient choice of effort. Yet as we have seen in the previous example it may lead to efficient technology choice.[12] We define the direct and indirect effect of redistribution below.

Definition 3 *The Direct Effect (DE) of redistribution captures the change in surplus due to employees' underinvestment in effort. Given the equilibrium outcome* $\{j^*, s_j^*\}$*:*

$$DE = \sum_{i \in \mathcal{I}} \left[u_i \left(j^*, s_j^*, \widehat{e}_{ij} \right) - u_i \left(j^*, e_{ij}^* \right) \right]$$

where e_{ij}^* *is employee i's optimal level of effort given project j.*

Alternatively,

Definition 4. *The Indirect Effect (IE) of redistribution captures the change in surplus due to a change in technology choice. Given the equilibrium*

[12] This approach contrasts with Kremer (1999), where only effort underinvestment is considered.

outcome $\{j^*, s_j^*\}$*:*

$$IE = \sum_{i \in \mathcal{I}} \left[u_i \left(j^*, e_{ij}^* \right) - u_i \left(k^*, e_{ik}^* \right) \right]$$

where k^* *is the equilibrium technology chosen in the absence of redistribution.*

Note that the total effect of redistribution on surplus is given by:

$$TE = IE + DE = \sum_{i \in \mathcal{I}} \left[u_i \left(j^*, s_j^*, \widehat{e}_j \right) - u_i \left(k^*, e_{ik}^* \right) \right]$$

Let us consider these two effects in turn.

2.5.1 Direct Effect

Consider the voting equilibrium $\{j^*, s_j^*\}$, where $s_j^* > 0$. Given A1, positive redistribution leads to underinvestment in effort. Yet there is an upper bound to the extent of direct distortions that may occur. The following lemma presents the result.

Lemma 3 *The direct effect of redistribution on efficiency is limited by:*

$$DE < \frac{s_j^*}{1 - s_j^*} \Sigma \left(e_{ij}^* - \widehat{e}_{ij} \right)$$

Proof: See Appendix

Consider the effect of a change in the equilibrium sharing rule on the upper limit of redistribution. When the equilibrium sharing rule increases, the upper bound on efficiency increases and the reason is twofold. First, the marginal benefit from an increase in effort around the equilibrium redistributive schedule is lower. Second, there is a greater underinvestment in effort.

Let us remind ourselves how the equilibrium sharing rule was determined. Remember from Section 2.3 that:

$$\overline{\theta} \left(\widehat{e}; j \right) - \theta_m \left(\widehat{e}_m; j \right) = \frac{s_j^*}{\overline{\delta} \left(j^* \right) \left(1 - s_j^* \right)^3}.$$

Hence both $\Sigma\widehat{e}_{ij}$ and s_j^* are determined by the concavity of employees' productivity function. When relative concavity is high, i.e. $\overline{\delta}(j^*)$ is high, the equilibrium redistribution schedule is high. But as productivity is more sensitive to effort, employees internalize to a larger extent the benefit of increasing effort so that $\Sigma(e_i^* - \widehat{e}_i)$ is low. Otherwise, when concavity is low, employees's benefit from increased effort is low so that $\Sigma(e_i^* - \widehat{e}_i)$ is high but the equilibrium sharing rule is low, thus constraining efficiency distortions.

The inefficiency created directly by redistribution is limited because it only arises when redistribution is positive. But it is precisely in this case when employees internalize total efficiency and therefore the negative effect of underinvestment in effort. This will contrast with the indirect effect of redistribution on efficiency that is analyzed next.

2.5.2 Indirect Effect

Consider the technology set $\mathcal{J}$. Assume that redistribution is not feasible and that $k^* \in \mathcal{J}$ wins the vote on a pairwise comparison among alternative projects. That is, k^* is the equilibrium technology chosen by majority voting. On the other hand, suppose that $\{j^*, s_j^*\}$ is the voting equilibrium when redistribution is feasible.

Given that the indirect effect of redistribution neglects the distortion caused by underinvestment in effort, we measure the inefficiency caused by redistribution as the difference between total productivity under project k and total productivity under project j, where productivity is computed at employees' optimal choice of effort, that is at e_k^* and e_j^* respectively.

First note that there is not a general upper bound to the efficiency distortion created by redistribution on technology choice. The reason is that the indirect effect depends on the relative efficiency of the neglected technologies included in the feasible set. Yet this negative effect on technology choice could be quite large. In particular, it may outweigh the efficiency loss caused by underinvestment in effort. The following example illustrates such a case.

Example 4: The negative indirect effect of redistribution outweighs its direct effect.

Consider a cooperative with five employees $\{1, ..., 5\}$. The firm has to vote on whether to implement technology 0 or 1. The following table provides the distribution of employees' productivity after optimizing in their effort choice. The ordering of employees in terms of their productivity is invariant to project choice.

	0	1
1	θ_1	θ_1
2	θ_2	θ_2
3	θ_3	$\theta_3 + 2\Delta$
4	θ_4	$\theta_4 - 5\delta$
5	θ_5	$\theta_5 + 3\Delta$

where Δ is arbitrarily large, namely $\Delta >> K \in R$.

Note that employees' mean productivity under project 0 and 1 is given by $\overline{\theta}$ and $\left(\overline{\theta} + \Delta - \delta\right)$ respectively.

Suppose that θ_3 is just smaller than $\overline{\theta}$ so that $s_0^* = \varepsilon$ with $\varepsilon \rightarrow 0$. This means that the direct distortion of redistribution on efficiency is negligible. But, could the indirect effect of redistribution be significant? We shall see that the answer is positive.

Assume that employee 4 slightly favors project 0; that is, $\delta - \dfrac{\varepsilon\left(\theta_4 - \overline{\theta}\right)}{5} \rightarrow 0$.

Note that employee 3 favors no redistribution under project 1 as $\theta_3 + 2\Delta > \overline{\theta} + \Delta - \delta$ given that $\theta_3 \simeq \overline{\theta}$. Hence $s_1^* = 0$. This puts a lower limit to the value of θ_4 to ensure that the date 2 winning coalition under project 1 is formed by high types.

At date 1 there will be a majority coalition formed by employees 1, 2 and 4 voting for the inefficient project 0. The resulting efficiency loss will amount to $5\left(\left(\overline{\theta} + \Delta - \delta\right) - \overline{\theta}\right) = 5\left(\Delta - \delta\right) \rightarrow 5\Delta$.

Inefficiencies may be arbitrarily large in technology choice whenever the efficient project is negatively skewed. The reason is that, in this case, the winning coalition does not internalize the size of the forgone project as its associated redistribution policy is zero.

Conversely, the following example shows the case of a cooperative where the indirect effect of redistribution on efficiency is not only beneficial but it also outweighs its negative effect via effort distortion.

Example 5: Positive net effect of redistribution on efficiency.

Characterize the technology set $\mathcal{J}$ as follows. Given the optimal choice of effort e_j^* and e_k^*:

$\theta_i(k) = \frac{\varepsilon}{I}$ for all $i \in \mathcal{I}$, with $\varepsilon \to 0$

$\theta_i(j) = \begin{cases} 0 & i \in S(\mathcal{I}) \text{ for } i \leq \frac{I+1}{2} \\ K & i \notin S(\mathcal{I}) \text{ otherwise} \end{cases}$ with $K >> M \in R$ and for any $j \in \mathcal{J}$ such that $j \neq k^*$

In the absence of redistribution, technology k is selected by majority voting.

Now assume that redistribution is feasible.

Then, $s_k^* = 0$ as $\theta_i(e_{ik}^*) = \overline{\theta}(e_k^*)$

However $s_j^* > 0$, as $\theta_m(e_{mj}^*) < \overline{\theta}(e_j^*)$

By continuity of productivity with respect to effort, there will be some $s > 0$ such that:

$s\overline{\theta}(\widehat{e}_j(s;j)) > \frac{\varepsilon}{I}$.

As s_j^* is preferred to s by the median productivity employee, it follows that in equilibrium: $(1 - s_j^*)\, k + s_j^*\overline{\theta}(\widehat{e}_j(s_j^*;j)) > s_j^*\overline{\theta}(\widehat{e}_j(s_j^*;j)) > s\overline{\theta}(\widehat{e}_j(s;j)) > \frac{\varepsilon}{I}$

Therefore, project j will be chosen even under unanimity.

Given that $\varepsilon \to 0$, the following relation holds:

$IE = \sum_{i \in \mathcal{I}} [\theta_i(j;e_j^*) - \theta_i(k;e_k^*)] = \sum_{i \in \mathcal{I}} \theta_i(j;e_j^*) - \varepsilon >$

$\sum_{i \in \mathcal{I}} [\theta_i(j;e_j^*) - \theta_i(j;\widehat{e}(s^*(j);j))] = DE$

■

The previous example shows that redistribution while always causing a negative impact on efficiency via effort distortion, it may nevertheless rise aggregate efficiency as long as its indirect positive effect on technology is large enough. But is there a necessary condition for the indirect effect on technology to be positive? The following result provides the answer.

Lemma 4 *Let $\{j^*, s_j^*\}$ be the equilibrium outcome of the two-stage sequential game that takes place in the cooperative. A necessary condition for the indirect effect of redistribution on efficiency to be positive is that $s_j^* > 0$.*

Proof: See Appendix

The result implies that positive redistribution may lead to higher aggregate efficiency. That is, a cooperative characterized by the equilibrium voting game$\{j^*, s_j^*\}$ with $s_j^* = 0$ may be dominated in terms of efficiency by another cooperative where $s_j^* > 0$, even if redistribution generates effort distortions.

The above results lead to the following conclusion. Although the direct effect of redistribution on efficiency is negative, its size is constrained by an upper bound. The reason is that when redistribution is positive, employees' payoff increases with total efficiency and hence all employees internalize the distortions induced by effort underinvestment. However, the indirect effect of redistribution on efficiency is unbounded. The reason is that it may arise when redistribution is zero under the efficient project and hence employees fail to internalize the efficiency gains foregone via technology choice. Yet, the indirect effect of redistribution on efficiency can be positive as long as the equilibrium sharing rule is positive under the efficient project. In this case, the feasibility of redistribution can even lead to an increase in the efficiency of a cooperative.

2.6 Concluding Remarks

This chapter has analyzed distortions induced by dynamic voting on a firm's efficiency where efficiency is determined by both a collective decision (technology choice) and a collection of individual decisions (employees' effort choice).

This analysis extends chapter I in two directions. First it generalizes the voting model to a general cooperative and a general economic environment. This generalization is carried out along two dimensions. In particular, it allows for the existence of an unrestricted policy set containing more than two alternatives and also for an unrestricted number of voters, containing more than two types. As it has been widely recognized in the social choice literature, an equilibrium by majority voting may fail to exist in such a setting. Moreover, we cannot apply the results provided by the standard literature that focuses on the existence of equilibrium in one-dimensional models. This is because in our model, voters' preferences are defined in relation to two voting decisions. Instead we propose a restriction on the technology set that, by decreasing conflicts of interest in redistribution, guarantees an equilibrium in technology choice.

Second, this chapter allows for a collection of individual investment decisions represented by employees' choice of effort. The introduction of moral hazard permits to compare the direct effect of redistribution on efficiency in the form of effort underinvestment (individual distortion), with its indirect effect in the form of inefficient technology choice (public distortion). We show that whereas the direct effect is always negative but bounded, the indirect effect can be negative and unbounded as it is defined in relation to the technology set. But it can also lead to increased efficiency, provided redistribution is positive under the efficient project.

By contrast, the property rights literature typically focuses on hold-up problems in the form of distortions in individual investment decisions, hence assuming efficient bargaining or otherwise, it considers efficient investment decisions allowing for inefficient trading outcomes. In this chapter however, we analyze both sources of inefficiencies. Also, we assume that collective decisions are taken by majority voting as opposed to bargaining. This analysis is in line with Hart and Moore (1998), where they study ex-post inefficiencies in a cooperative where decisions are taken by majority voting. But in contrast with their paper, we allow for conflicts in decision making concerning redistribution as well as for individual investment decisions.

Alternatively, the literature on social choice generally considers conflicts in public decisions but assumes away individual decisions, e.g. the choice of a public project. Or it deals with distortions on individual decisions but excludes inefficient collective choice, e.g. the choice of distortionary taxation.

We conclude by suggesting several ways in which we can extend this analysis. First, we have denied employees to agree on a mechanism at date 0, whereby decisions could be made contingent on information arriving at date 1. Although the efficacy of such a mechanism would be limited by the participation constraint of employees and the existence of asymmetric information regarding employees' productivity function, mechanism design would help to increase efficiency. Second, this model focuses on the effect of employee ownership on efficiency. Employees, by anticipating conflicts of interest in technology choice, could in principle sell off the firm to efficient investors and hence internalize increased efficiency via the selling price. Third, we have considered that collective decision making is implemented by majority voting. This choice rule turns out to be inefficient as it neglects the preferences of the minority. It would be interesting to consider alternative mechanisms that aggregate heterogenous preferences such as bargaining, although the analysis would be more complicated given the existence of multiple players and asymmetric information.

2.7 Appendix

2.7.1 Proof of Lemma 1

Consider two employees $i, l \in \mathcal{I}$ such that $i < l$ and $s \in (0,1]$. From the optimization problem:

$$\frac{\partial \theta_i(\hat{e}_i; j)}{\partial e} = \frac{\partial \theta_l(\hat{e}_l; j)}{\partial e} = \frac{1}{1 - s^*}$$

Given A2, this implies that:

$$\hat{e}_i < \hat{e}_l$$

Fix s^* and apply A1-A2:

$$\theta_i(\hat{e}_i; j) = \int_0^{\hat{e}_i} \frac{\partial \theta_i(e; j)}{\partial e} de < \int_0^{\hat{e}_i} \frac{\partial \theta_l(e; j)}{\partial e} de < \int_0^{\hat{e}_l} \frac{\partial \theta_l(e; j)}{\partial e} de = \theta_l(\hat{e}_l; j)$$

Given redistributive schedule s^*, employees can be ordered in terms of their final productivity. As this ordering is invariant to s, it follows that employees' preferences over feasible redistributive rules are single-crossing in $(s, \geq)$, where $\geq$ denotes the ordering of employees'productivity after optimizing over effort. This allows us to apply the result provided by Gans and Smart (1996) that show that single-crossing is a sufficient condition to guarantee transitivity in the social preference ordering induced by majority voting.

■

2.7.2 Proof of Lemma 2

Consider two projects $j, k \in \mathcal{J}$. By A3, $\sum \theta_i(e; j) = \sum \theta_i(e; k)$ for any $e \in E$. Consider two values $e_1, e_2 \in E$ such that $e_1 < e_2$. Plugging the values of $\theta_i(e_2; j)$ and $\theta_i(e_2; k)$ in terms of $\theta_i(e_1; j)$ and $\theta_i(e_1; k)$ respectively:

$\sum \theta_i(e_1; j) + \sum \int_{e_1}^{e_2} \frac{\partial \theta_i(e; j)}{\partial e} de = \sum \theta_i(e_1; k) + \sum \int_{e_1}^{e_2} \frac{\partial \theta_i(e; k)}{\partial e} de$. By A3, this is equivalent to:

$$\sum \int_{e_1}^{e_2} \frac{\partial \theta_i(e;j)}{\partial e} de = \sum \int_{e_1}^{e_2} \frac{\partial \theta_i(e;k)}{\partial e} de$$

Consider employee i and a value of effort $e > e_1$. The following relation holds:

$$\frac{\partial \theta_i(e;j)}{\partial e} = \frac{\partial \theta_i(e_1;j)}{\partial e} + \int_{e_1}^{e} \frac{\partial \theta_i^2(e;j)}{\partial e^2} de$$

By A2:

$$\int_{e_1}^{e} \frac{\partial^2 \theta_i(e;j)}{\partial e^2} de = \delta_i(j)(e - e_1)$$

Now substitute:

$$\int_{e_1}^{e_2} \frac{\partial \theta_i(e;j)}{\partial e} de = \int_{e_1}^{e_2} \left[\frac{\partial \theta_i(e_1;j)}{\partial e} + \delta_i(j)(e - e_1) \right] de =$$

$$\frac{\partial \theta_i(e_1;j)}{\partial e}(e_2 - e_1) + \delta_i(j) \frac{(e_2 - e_1)^2}{2} - \delta_i(j) e_1 (e_2 - e_1)$$

Summing over all employees, we get the following expression:

$$\sum \int_{e_1}^{e_2} \frac{\partial \theta_i(e;j)}{\partial e} de = \sum \frac{\partial \theta_i(e_1;j)}{\partial e}(e_2 - e_1) + \sum \delta_i(j) \left[\frac{(e_2 - e_1)^2}{2} - e_1(e_2 - e_1) \right]$$

As this relation holds for any e_1, assume that $e_1 = 0$ and $e_2 = e$. The above equality becomes:

$$\sum \int_{0}^{e} \frac{\partial \theta_i(e;j)}{\partial e} de = \sum \frac{\partial \theta_i(0;j)}{\partial e} e + \sum \delta_i(j) \frac{e^2}{2}$$

Performing a similar analysis for a mean preserving spread project k:

$$\sum \frac{\partial \theta_i(0;j)}{\partial e} e + \sum \delta_i(j) \frac{e^2}{2} = \sum \frac{\partial \theta_i(0;k)}{\partial e} e + \sum \delta_i(k) \frac{e^2}{2}$$

As this relation holds for any $e \in E$, $\delta_i(j) = \delta_i(k)$ and $\frac{\partial \theta_i(e;j)}{\partial e} = \frac{\partial \theta_i(e;k)}{\partial e}$ for all $i \in I$

■

2.7.3 Proof of Proposition 1

For simplicity, consider a cooperative with three employees and a set of technologies $\mathcal{J}$.

A3 implies that the ranking of employees in terms of their productivity is constant across projects. That is, if we denote by $\mathcal{I} \equiv \{i, m, l\}$, then:

$\theta_i(e;j) < \theta_m(e;j) < \theta_l(e;j)$ for any $e \in E$ and any $j \in \mathcal{J}$

Consider three projects $h, j, k \in \mathcal{J}$ such that $h < j < k$ according to assumption 3.

As h is positively skewed $\theta_m(e;h) < \overline{\theta}(e;h)$.

Given the characterization of j it must be the case that for the same level of effort $e \in E$: $\theta_m(e;h) \geq \theta_m(e;j)$.

The productivity of all projects is the same for a fixed level of effort, namely $\overline{\theta}(e;h) = \overline{\theta}(e;k)$.

Fix $e = \widehat{e}_{mj}$ where $\widehat{e}_{mj} = \widehat{e}_m(s_j^*; j)$.

Given the definition of an employee's payoff and the above inequality:

$u_m(h, s_j^*, \widehat{e}_{mj}) \geq u_m(j, s_j^*, \widehat{e}_{mj})$

But the equilibrium sharing rule differs across projects. Yet by Lemma 2, the sensitivity of productivity to effort is the same for all projects so that the cost of redistribution is irrespective of the technology. However the benefit to m from an increase in redistribution rises with the project index, so that $s_h^* \leq s_j^*$. As m is pivotal for redistribution:

$u_m(h, s_h^*, \widehat{e}_{mh}) \geq u_m(h, s_j^*, \widehat{e}_{mj})$

If we put the above inequalities together we infer that m favors project h over project j. By applying the same argument we can show that $h \succsim_m j \succsim_m k$.

We know from standard results that an intransitive preference relation in majority voting arises provided both i and l prefer project k over project h. This will be true as long as:

$u_i(k, s_k^*, \widehat{e}_{ik}) \geq u_i(h, s_h^*, \widehat{e}_{ih})$ and,
$u_l(k, s_k^*, \widehat{e}_{lk}) \geq u_l(h, s_h^*, \widehat{e}_{lh})$

By expressing the above equations in terms of employees' productivity:

$$s_k^* \geq \frac{\{[\theta_i(\widehat{e}_{ih};h)-\theta_i(\widehat{e}_{ik};k)]-(\widehat{e}_{ih}-\widehat{e}_{ik})\}+s_h^*\left[\overline{\theta}(\widehat{e}_h;h)-\theta_i(\widehat{e}_{ih};h)\right]}{\overline{\theta}(\widehat{e}_k;k)-\theta_i(\widehat{e}_{ik};k)} = \underline{\lambda}$$

Likewise:

$$s_k^* \leq \frac{\{[\theta_l(\widehat{e}_{lk};k)-\theta_l(\widehat{e}_{lh};h)]+(\widehat{e}_{lh}-\widehat{e}_{lk})\}+s_h^*\left[\theta_l(\widehat{e}_{lh};h)-\overline{\theta}(\widehat{e}_h;h)\right]}{\theta_l(\widehat{e}_{lk};k)-\overline{\theta}(\widehat{e}_k;k)} = \overline{\lambda}$$

From the definition of s_k^*, the two above inequalities will be satisfied if and only if:

$$\frac{\overline{\theta}(\widehat{e}_k;k)-\theta_m(\widehat{e}_{mk};k)}{\overline{\lambda}} \leq \left|\frac{1}{\overline{\delta}(1-s_k^*)^3}\right| \leq \frac{\overline{\theta}(\widehat{e}_k;k)-\theta_m(\widehat{e}_{mk};k)}{\underline{\lambda}}$$

Renaming $\left[\overline{\theta}(\widehat{e}_k;k)-\theta_m(\widehat{e}_{mk};k)\right](1-s_k^*)^3 = k$, the above inequality can be expressed as:

$$\left|\overline{\delta}_l\right| = \frac{\underline{\lambda}}{k} \leq \left|\overline{\delta}\right| \leq \frac{\overline{\lambda}}{k} = \left|\overline{\delta}_u\right|$$

If productivity is either very sensitive or very insensitive to effort so that $\left|\overline{\delta}\right| < \left|\overline{\delta}_l\right|$ or $\left|\overline{\delta}\right| > \left|\overline{\delta}_u\right|$, there is a transitive preference relation in technology choice induced by majority voting.

■

2.7.4 Proof of Lemma 3

Given project j, denote by $\widehat{e}_j = \widehat{e}\left(s_j^*;j\right)$.

For employee i, the direct effect on redistribution is given by:

$$[\theta_i(e_i^*;j)-\theta_i(\widehat{e}_i;j)]-(e_i^*-\widehat{e}_i) = \int_{\widehat{e}_i}^{e_i^*}\left(\frac{\partial\theta_i(e;j)}{\partial e}-1\right)de < \int_{\widehat{e}_i}^{e_i^*}\left(\frac{\partial\theta_i(\widehat{e}_{ij};j)}{\partial e}-1\right)de$$

where the inequality follows from the concavity of the productivity function.

Notice that both brackets are positive as $\frac{\partial\theta_i(\widehat{e}_i;j)}{\partial e} > 1$ given the equilibrium condition $\frac{\partial\theta_i(\widehat{e}_i;j)}{\partial e} = \frac{1}{1-s_j^*}$ and $(e_i^*-\widehat{e}_i) > 0$ from concavity.

By substituting this value into the previous equation and summing up across all employees, we obtain the result.

■

2.7.5 Proof of Lemma 4

We will show this result by contradiction. Suppose that the indirect effect is positive and yet $s_j^* = 0$. Denote by k^* the project that would be chosen in equilibrium in redistribution was unfeasible. For redistribution to influence technology choice it must be the case that $s_k^* > 0$. This implies that $\theta_m\left(e_m^*; k\right) < \overline{\theta}\left(e^*; k\right)$.

As project k^* is chosen in the absence of redistribution, this means that there is a majority of employees for which $u_i\left(k, e_i^*\left(k\right)\right) > u_i\left(j, e_i^*\left(j\right)\right)$.

But project j^* is chosen when redistribution is feasible, therefore for a majority of employees $u_i\left(j, e_i^*\left(j\right)\right) > u_i\left(k, s_k^*, \widehat{e}_i\right)$.

Consider the preferences of a low type i under project k^*, that is $i \in \mathcal{I}$ such that $i < m$. The fact that $\theta_m\left(e_m^*; k\right) < \overline{\theta}\left(e^*; k\right)$ and that the cost of redistribution in terms of effort distortions is the same for all employees whereas the benefit is higher for low types, implies that $u_i\left(k, s_k^*, \widehat{e}_i\right) \geq u_i\left(k, e_i^*\left(k\right)\right)$. And this inequality holds for at least $\frac{N+1}{2}$ employees. Hence there is a majority of employees for whom:

$$u_i\left(j, e_i^*\left(j\right)\right) > u_i\left(k, s_k^*, \widehat{e}_{ik}\right) \geq u_i\left(k, e_i^*\left(k\right)\right)$$

This means that it is not possible that k^* was chosen by majority voting in the absence of redistribution.

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Chapter 3

Privatization in a Political Voting Game

3.1 Introduction

Public ownership has been regarded as a mechanism that facilitates the pursuit of political benefits to the government Boycko, Shleifer and Vishny (1994). Consistent with this observation is the belief that privatization may increase economic efficiency by depolitizing the provision of goods and services. Empirical support to this interpretation is provided by Lopez-de-Silanes, Shleifer and Vishny (1995), where they analyze the privatization of local government services in the United States and show how state laws, by influencing the political benefits of in-house provision by counties, affect the likelihood of privatization. Implicit in this approach is the view that the government does not maximize social welfare but its own political agenda that includes the maintenance of political support by providing benefits to its electorate.

Yet if the preferences of the government follow this characterization, two natural questions arise. First, why will the government design an efficient privatization program while allowing corruption under public ownership? Second, in the context of a regulated industry, why should the scope of control by the government decline following privatization?

Regarding the first question, there is a mixed evidence in the design of privatization schemes implemented following major privatizations in Europe. On the one hand, there is evidence of a popular capitalism structure in which each investor has a small stake in the rents accruing to the company. This policy was followed in the privatization of natural monopolies in Britain. The spreading of ownership was achieved by general underpricing and by the imposition of restrictions in the number of shares acquired per capita. (Suleiman and Waterbury, 1990). On the other hand, in the main privatizations pursued in France, the government targeted at a stable core of institutional investors. Apart from trying to protect the newly private companies from hostile raids, the official justification of such a policy was the limited size of the french capital market. However, there was a oversubscription ex-post which partially undermines this argument.

Concerning the second question, it is not clear why the government can be restrained from subsidizing a privatized firm to keep up the pursuit of political objectives. This argument although recognized by Boycko, Shleifer and Vishny (1994) is partially undermined in their analysis by the assumption that the political cost of foregone profits under state ownership is lower than the cost of subsidies awarded to private firms.

This chapter is concerned with the effect of a firm's ownership structure on the efficiency of a natural monopoly. A natural monopoly is assumed to be heavily regulated by the government irrespective of its ownership structure. Whereas privatization of firms operating in a competitive sector is quite widely agreed upon, public companies are still well regarded when monopoly power or externalities induce a wedge between private and social objectives. Regulation imposes the constraint that ultimately, control rights are always exerted by the government. Yet different ownership structures, by allocating income rights differently, may change the preferences of the government towards regulation. In particular I focus the analysis of ownership on two extreme cases: private and public ownership. Under private ownership, two alternative distribution of shareholdings are considered, i.e. dispersed versus concentrated ownership. In the former, the company is privatized aiming at small shareholders that own a negligible fraction of the total capital of the firm, whereas in the latter the government targets at large institutional investors.

For ownership to influence efficiency, there must be some market imperfection and differences in the solution of this imperfection under alternative ownership structures. I introduce ex-ante asymmetric information about the action taken by the manager of the firm that in turn influences the cost level of implementing a public project. Also, for ownership to be relevant it should be true that complete contracts are unfeasible. Otherwise, any organizational structure could be imposed through the design of a comprehensive contract and therefore ownership of physical assets would be irrelevant (Williamson, 1985, Grossman and Hart, 1986). If the ownership of a company is going to matter, it must be due to the fact that complete contracts cannot be designed at the stage of privatization. The contract incompleteness of the model lies in the inability of the government to propose a regulatory schedule that maximizes total welfare. Instead, it will set regulation to maximize its own interests. In particular, it cannot commit not to appropriate the informational rents accruing to a public company (either for private consumption or to finance future elections).

Within the framework of incomplete contracts, there are several papers in the literature that have tried to explain the influence of ownership on the efficiency of an enterprise.

Schmidt (1996) regards privatization as a commitment device of the government to award some informational rents to the firm. The government wants to commit itself ex-ante not to become informed about the state of the nature which has occurred. It designs a subsidy scheme contingent on the state announced, offering an inefficiently low production level if high costs are reported, in order to limit the informational rents accrued by the firm in the good state of the world. While it reduces allocative efficiency (the amount of production turns out to be too low when a bad state of the nature realizes), it may enhance productive efficiency. The manager has more incentives to increase his effort, assuming that his utility depends on the production level, and therefore reduces the possibility that a bad state of the nature occurs, considering that this probability depends on the effort invested by the manager. This mechanism can not be replicated in a nationalized firm since the government now has access to the information concerning the realized state of the nature and then, it cannot credibly threaten to reduce production ex-ante so as to increase managerial incentives to work hard. As a result, the government imposes a soft-budget constraint in a public company and, conversely, a hard-budget constraint in a privatized company.

However this model relies heavily on the manager accruing private benefits from a high production level; furthermore, the government is assumed to be benevolent and social welfare maximizer which is not very realistic in a political environment. The key assumption in his model is that ownership of physical assets gives access to private information. But even though it is true that it increases the incentives to collect more information, managers of public companies could collude with their employees to protect the informational rents of the company when it enjoys a favorable state of nature, and therefore may choose not to disclose this private information to the government.

I propose instead the basic framework suggested by Laffont (1996), where there is a heterogeneous population of consumers who extract different surplus from the project. At the initial stage there is a democratic election that selects a government which acts to maximize the welfare of its electorate. The government regulates a natural monopoly by offering a subsidy to the firm. The efficiency of the firm is defined by the cost to implement the project that depends on two variables. The state of nature and the investment of the manager in cost reduction. Investment is non-verifiable but will be determined by the transfer received from the government. In contrast with Laffont (1996), I consider two alternative informational settings. First the existence of hidden information regarding the state of nature that has realized. The optimal transfer will be contingent on the state reported by the manager of the firm. Second, the existence of moral hazard. The investment of the manager influences the distribution function of the cost realization. The optimal transfer will be contingent on the observed realization of the cost.

When the economy begins, the firm is under public ownership. Departing from Laffont's analysis, I allow the government to privatize the firm by targeting at either a dispersed population of prospective owners (dispersed ownership) or by aiming at big institutional investors (concentrated ownership). Under concentrated ownership, each investor, accounting for a significant fraction of the firm's income rights, may decide to coordinate his actions with the other investors and lobby with the government in exchange for a favorable regulatory schedule. The aim of the chapter is to analyze which ownership structure minimizes the inefficiencies caused ex-ante by asymmetric information.

It is worth to emphasize that the same informational structure is assumed under both ownership structures. Underlying this assumption is the belief that the access to private information over the state of nature that has realized, is determined not so much by the ownership of the firm but rather by the transparency of the government or the regulatory body. The remainder of the chapter is organized as follows. The model is presented in Section 2, where imperfections to complete contracting between the government and the firm are based on hidden information. The section analyzes the efficiency a of natural monopoly under public ownership and allows the government to privatize the firm. It then analyzes the efficiency implications of dispersed and concentrated ownership. A parallel analysis is performed in Section 3 in a setting of moral hazard. Results prove to be robust to the informational specifications of the model. The section concludes with a discussion of the similarities between both approaches. Finally, Section 4 contains the concluding remarks and suggests a research agenda.

3.2 The model

The basic structure of the model is based on Laffont (1996). Consider a firm defined by the assets required to implement an indivisible project. This project is defined as a natural monopoly and will therefore be regulated by the government irrespective of the ownership structure of the firm. In the spirit of the incomplete contracts literature -Grossman and Hart (1986)-, we assume that it is not feasible to write down a complete contract whereby regulation is contingent on all possible states of nature. Instead the government will hold control rights in the provision of the regulatory scheme as the future unfolds. Regulation takes the form of a transfer of funds to the manager of the firm in order to cover the cost of implementing the project. The cost of the project, C, is determined by the prevailing state of nature β, and the effort exerted by the manager e. In particular, we assume the following simple linear form:

$$C = \beta - e$$

with $\beta \in \{\underline{\beta}, \overline{\beta}\}$. Let $\underline{\beta}$ denote the good state of nature with probability $v = \Pr(\beta = \underline{\beta})$ and $\overline{\beta}$ the bad state of nature with probability $(1 - v) = \Pr(\beta = \overline{\beta})$. Also, let $e \in R^+$ represent the level of effort spent by the manager in cost reduction. Managerial effort creates a disutility to the manager given by $\Psi(e)$ in monetary units, with $\Psi'(e) > 0$ and $\Psi''(e) > 0$. Although the cost level is public knowledge ex-post, the state of nature is privately observed by the manager and the choice of effort cannot be verified. Therefore, the government cannot infer whether a high cost realization is the result of a bad state of nature or the outcome of the manager's low level of effort.

The government would try to elicit high effort from the manager of the firm, by offering a transfer conditional on the cost which is observed ex-post. However, given the existence of private information over the state of the world that has realized, together with the fact that effort is costly and non verifiable, implies that the manager has always an incentive to report that a bad state of nature has occurred. To induce truth telling, the government shall offer incentives to the manager to reveal the truth when the good state realizes. By the revelation principle, we can restrict attention to a mechanism whereby transfers are made contingent on the state of nature announced by the manager. In equilibrium:

$$t(\beta) = \left\{\underline{t}\left(\underline{\beta}\right), \bar{t}\left(\overline{\beta}\right)\right\}$$

This mechanism induces truth-telling at the expense of awarding positive informational rents to the firm when the good state of nature is reported. Informational rents are increasing on the level of effort induced to the inefficient type. That is,

$$\Phi(\bar{e}) = \Psi(\bar{e}) - \Psi(\bar{e} - \Delta\beta)$$

Therefore the utility of the manager from implementing the project is given by:

$$U = \begin{array}{ll} \underline{U} = \Phi(\bar{e}) & v = \Pr\left(\underline{\beta}\right) \\ \overline{U} = 0 & 1 - v = \Pr\left(\overline{\beta}\right) \end{array}$$

That is, the utility of the inefficient type is always zero.[1] The transfer offered by the government just covers the cost to implement the project. However, it will be positive for the efficient type so that he has incentives to reveal the truth.

[1]Both the incentive compatibility constraint of the efficient type and the individual rationality constraint of the inefficient type bind in equilibrium:

$(IC)^*_{\underline{\beta}}$: $\underline{t} - \Psi(\underline{e}) = \bar{t} - \Psi(\bar{e} - \Delta\beta)$

$(IR)^*_{\overline{\beta}}$: $\bar{t} - \Psi(\bar{e}) = 0$

Then $\underline{U} = \Phi(\bar{e}) = \Psi(\bar{e}) - \Psi(\bar{e} - \Delta\beta)$

When the economy begins at date 0 there are two type of consumers, type 1 and type 2, defined with respect to the level of surplus that they extract from consuming the project. Type 1 extracts S_1 whereas type 2 extracts S_2 with $S_2 > S_1$. There is an exogenous fraction α of type 1 citizens (and therefore $(1-\alpha)$ of type 2 consumers). We assume that $\alpha > \frac{1}{2}$. Type 1 is in the majority and will select a government which represents his own interests.

Citizens derive a benefit from project consumption but suffer a disutility from paying taxes. Taxation is imposed by the government to finance the transfer granted to the firm in order to implement the project. We assume that the government can discriminate in taxation between type 1 and type 2 consumers. Let denote by t_1 and t_2 the tax received by the government from type 1 and type 2 respectively. There are several ways in which we can motivate this assumption. Consider for instance a world in which type 1 owns mainly labor whereas type 2 owns mainly capital. Discrimination will occur as long as the tax burden levied upon labor and capital differ. However, taxation is distortionary. One unit of funds collected via taxation has an associated cost of λ units. The net payoff of consumer of type i is determined by:

$$V_i = S_i - (1-\lambda)\, t_i$$

The company receives a transfer[2] from the government financed via taxation:

$$t = \alpha t_1 + (1-\alpha)\, t_2$$

The timing of events is as follows:

The economy begins at date 0 with the existence of a natural monopoly, a public project and the realization of a random variable $\alpha \in [0,1]$ that divides the population of citizens into two types, i.e. type 1 and type 2. We assume that type 1 is in majority so that $\alpha > \frac{1}{2}$.

The manager of the firm observes the state of nature β that determines, together with his effort in cost reduction, the cost to implement the project.

A government is selected by the population of consumers using a majority voting rule. Each consumer casts his vote in favor of the candidate who

[2]A straightforward example of the regulatory intervention of the government is to grant funds to the firm; but the interpretation can be enlarged to take into account other alterations of the economic environment of the regulated firm: revision of price cap, change of competition policy...(Faure-Grimaud, 1997).

maximizes his expected payoff, that is, who minimizes his anticipated tax burden.

The government pursues its own interest, namely the maximization of his probability of reelection. With this purpose in mind, it regulates the public project by offering a contingent transfer to the manager of the firm, $\{\underline{t}(\underline{\beta}), \bar{t}(\bar{\beta})\}$. This transfer is collected via differential taxation levied upon both the electorate and the opposing citizens. As $\alpha > \frac{1}{2}$, the elected government maximizes the welfare of type 1 consumers by expropriating type 2 consumers.

The manager reports the state of nature and chooses a level of effort to maximize his own utility.

Finally, the collection of taxes and the payment of subsidy take place.

First, we will analyze the effect of asymmetric information on the efficiency of the firm, when the government is self-interested. Here we depart from the analysis of Laffont (1996) by considering the possibility of tax discrimination. Also, we move a step backwards and allow the government to change the ownership structure of the firm. As a public project is always regulated by the government, a transfer of ownership will not compel the government to relinquish its control rights over the allocation of the subsidy. However, it may change its preferences over the optimal transfer of funds. If the government decides to give out the firm's income stream to private investors, it may choose between two alternative ownership structures, namely between concentrated and dispersed ownership. To achieve concentrated ownership, the government will target at institutional investors. As each investor receives a big fraction of the rents accruing to the firm, they will be able to overcome free riding problems to organize themselves as a lobby. This lobby may offer a monetary contribution to the government in exchange for a favorable regulatory outcome. Under dispersed ownership, we assume that the firm's stakeholdings are distributed uniformly among consumers. As each consumer accrues only a negligible fraction of the firm's rents, citizens are assumed to be unable to form a pressure group.

The purpose of the chapter is to analyze which ownership structure will be observed in equilibrium and which efficiency distortions will be generated by the presence of asymmetric information in the regulated firm. It is important to emphasize that private information prevails despite the ownership structure of the firm. Also we assume away any conflict of interest between the shareholders of the firm and the manager. That is, we consider that the rents generated by the existence of private information accrue to the shareholders of the firm via dividends. Before analyzing the decision on privatization, we analyze the efficiency of the firm under public ownership.

3.2.1 Public Ownership

The government will choose a system of transfers to maximize the social welfare of type 1 consumers, that is, their surplus extracted from consumption minus the cost of taxation. Also, the government, as the owner of the firm, will perceive the informational rents derived from the existence of private information. In fact, it cannot credibly commit not to appropriate such rents for its own interest, either for future consumption or to finance future electoral campaigns. When choosing the system of transfers, the government faces two sets of constraints. First, the incentive compatibility constraint of the manager to induce truth telling when the good state of nature realizes. Second, the participation constraint of type 2 of consumers. Their net surplus should be weakly positive in order to encourage them to participate in the political system.

The decision problem of the government boils down to the following maximization problem:

$$Max_{\{\overline{e},\underline{e}\}} \left\{\alpha S_1 - (1+\lambda)\,\alpha\left[v\underline{t}_1 + (1-v)\,\overline{t}_1\right] + v\underline{U}\right\}$$

$s.t.$

$$\underline{U} \geq \Phi(\overline{e})$$
$$S_2 - (1+\lambda)\,\underline{t}_2 \geq 0$$
$$S_2 - (1+\lambda)\,\overline{t}_2 \geq 0$$

where:

$$\alpha\underline{t}_1 + (1-\alpha)\,\underline{t}_2 = \underline{\beta} - \underline{e} + \Psi(\underline{e}) + \underline{U}$$

$$\alpha\overline{t}_1 + (1-\alpha)\,\overline{t}_2 = \overline{\beta} - \overline{e} + \Psi(\overline{e})$$

Note that the level of taxes levied upon type 2 consumers is the same irrespective of the state of nature and hence regardless of the cost to implementing the project. The government will simply expropriate the surplus enjoyed by type 2 consumers which is the same across states and, will set the tax level on type 1 consumers to cover the cost of the project. In particular:

$$t_2 = \underline{t}_2 = \overline{t}_2 = \frac{S_2}{1+\lambda}$$

The level of effort exerted by the manager of the firm is defined by:

$$\Psi'(\underline{e}^1) = 1 \Rightarrow \underline{e}^1 = \underline{e}^*$$
$$\Psi'(\overline{e}^1) = 1 - \tfrac{\lambda}{1+\lambda}\tfrac{v}{1-v}\Phi'(\overline{e}^1)$$
$$\Rightarrow \overline{e}^1 < \overline{e}^*$$

where the last inequality follows from $\Phi'(\overline{e}) > 0$ and $\Psi''(e) > 0$. In fact, the characterization of $\Phi'(e)$ as an increasing function is based on the convexity of $\Psi(e)$.

There is a suboptimal effort applied by the manager of the low type. This is due to the fact that an increase in the level of effort of the bad type rises the amount of informational rents accrued by the high type (See Laffont and Tirole, 1991). As taxes are costly to consumers in terms of taxation, the government faces the following trade-off. If it induces a higher effort provided the bad state of the world is reported and this happens to be the case, the efficiency of the firm will be enhanced. If instead, the good state of nature realizes, the government will have to pay out higher informational rents to the manager in order to induce him to reveal the truth. Depending on which state is more likely to arise, the optimal level of effort will be set to minimize the expected taxation levied on type 1 consumers. As the government accrues all the informational rents and can impose a differential taxation to type 2 consumers, the optimal transfer scheme offered by a self-interested government will be the same as if the government was benevolent and tried to maximize the welfare of the whole population. That is, the effort induced in the bad state of nature does not depend on the fraction of its electorate.

3.2.2 Private Ownership

The government may decide to privatize the firm aiming at a dispersed population of consumers. In such a case, it has two options. First, it may decide to aim at type 1 consumers. It may achieve this outcome by offering favorable conditions for the acquisition of shares. Informational rents would then accrue to its electorate. As the government maximizes the welfare of type 1 citizens to stay in power, it will offer the same regulatory scheme as in the case of a public ownership. Consequently, the level of efficiency of a regulated but privately held firm will be the same as the efficiency of a publicly owned firm. Alternatively, the government may target a dispersed population of type 2 consumers, by spreading ownership holdings across consumers. The benefit of this privatization pattern would be to allow the government to levy a higher burden of taxation upon type 2 consumers and hence decrease taxation levied upon its electorate. The objective function of the government would be the following:

$$Max_{\{\overline{e},\underline{e}\}} \left\{\alpha S_1 - (1+\lambda)\,\alpha \left[v\underline{t}_1 + (1-v)\,\overline{t}_1\right]\right\}$$

$s.t.$

$$\underline{U} \geq \Phi(\overline{e})$$

$$S_2 - (1+\lambda)\,\underline{t}_2 + \frac{\underline{U}}{1-\alpha} \geq 0$$

$$S_2 - (1+\lambda)\,\overline{t}_2 \geq 0$$

Again:

$$\alpha\underline{t}_1 + (1-\alpha)\,\underline{t}_2 = \underline{\beta} - \underline{e} + \Psi(\underline{e}) + \underline{U}$$

$$\alpha\overline{t}_1 + (1-\alpha)\,\overline{t}_2 = \overline{\beta} - \overline{e} + \Psi(\overline{e})$$

Now the tax burden suffered by type 2 consumers is higher when the good state of nature realizes. In particular:

$$\overline{t}_2 = \frac{S_2}{1+\lambda}$$

and,

$$\underline{t}_2 = \frac{S_2 + \frac{\Phi(\overline{e})}{1-\alpha}}{1+\lambda}$$

The first order conditions determine the optimal level of effort chosen by the manager:

$$\Psi'(\underline{e}^2) = 1 \Rightarrow \underline{e}^2 = \underline{e}^*$$

$$\Psi'(\overline{e}^2) = 1 - \frac{\lambda}{1+\lambda}\frac{v}{1-v}\Phi'(\overline{e}^2)$$

$$\Rightarrow \overline{e}^2 = \overline{e}^1 < \overline{e}^*$$

Note that the same regulatory outcome prevails under private ownership even if it is type 2 consumer that holds stakes in the newly privatized firm. This is due to the existence of tax discrimination. In principle, the government tries to minimize the extent of informational rents awarded to the firm as they fall outside its electorate and however are costly in terms of taxation. Yet, tax discrimination allows to impose the cost generated by informational rents on type 2 consumers, by increasing their tax burden when the good state of nature realizes. This in turn decreases the level of taxation imposed on type 1 consumers. The government, despite being self-interested offers the same regulatory outcome as if it was a benevolent government, that is, as if it maximized the total welfare of the population. The only difference lies on the distribution of taxes, being type 2 consumers responsible for the payment of a higher per-capita proportion of the cost, not only because their final surplus is reduced to zero, but also because they extract a higher surplus from consuming the project.

3.2.3 Concentrated Ownership

The government may decide to privatize the firm targeting at a stable core of institutional investors. Given that the surplus enjoyed by type 2 consumers is higher than the benefit derived by type 1, we assume that the optimal auction would assign the firm to a concentrated group of type 2 investors. We also consider that institutional investors decide to coordinate their actions and constitute themselves as a lobby. They will offer a contingent monetary contribution to the government to influence the government's regulatory policy.

Denote by $U(e, C)$ the utility of the lobby, where e denotes the level of effort induced by the regulation schedule and C denotes the contingent contribution offered to the manager. Likewise, denote by $G(e, C)$ the utility of the government. The lobby's payoff is decreasing in the contribution of its members where the government's payoff is increasing in the contribution received from the lobby.

To simplify the analysis, assume that both the lobby and the government have quasi-linear preferences in contributions. That is:

$$U(e, C) = V(e) - C$$

and,

$$G(e, C) = aW(e) + C$$

where $a \in [0, 1]$ parameterizes the weight attached to the welfare of the electorate vis-a-vis the collection of monetary contributions. For instance, if the electorate constitutes a narrow majority, i.e. $\alpha \simeq \frac{1}{2}$, the government may find it more compelling to receive contributions in order to finance future electoral campaigns and hence swing votes from indecisive voters.

In the spirit of Bernheim and Whinston (1986), the lobbying game can be modeled in a two-stage game. In the first stage, the lobby offers a contingent contribution schedule, anticipating the response of the governmental policy. In the second stage, the government chooses an effort vector optimally, given the contribution schedule offered by the lobby.

An equilibrium of this problem consists of a contribution $C^o(e)$ and a vector of effort e^o such that:

$$\begin{gathered} C^o \in \mathcal{C} \\ e^o = \arg\max G(e, C^o(e)) \\ G(e^o, C^o) = \max_e G(e, 0) \end{gathered}$$

There are multiple equilibria of this two-stage game. To restrict the set of equilibria, we apply the concept of Truthful Nash equilibrium as proposed by Bernheim and Whinston (1986). This concept can be interpreted as follows. Consider the regulatory scheme provided by the government as a public good. The organized group of investors would purchase an efficient quantity of the good at the marginal cost of influencing the existing level of provision by the government. Given the presence of just one organized group, it becomes pivotal in the public decision and hence lobbying can be regarded as a demand-revealing process whereby the contribution reflects the degree of influence over the quantity of the good offered by the government. What is required to pay is the difference between the gains to institutional investors in the form of informational rents and the losses to the electorate in the form of increased taxation. In general, as the transfer scheme is costly and lies in a continuum, the quantity that a lobby is willing to pay is its marginal valuation of the subsidy net of the marginal increase in taxes. In this particular case, as the government cannot discriminate in taxation between institutional investors and the remaining type 2 consumers, the marginal effect of increasing the subsidy on the amount of taxes is zero. As a consequence, not only the level of taxes is constant irrespective of the transfer scheme offered by the government but also it is the same regardless of the state of nature.

When we require the optimal contribution to form a locally truthful Nash equilibrium, it can be defined as follows:

$$\frac{\partial C^o(e^o)}{\partial e} = -\frac{\dfrac{\partial U(e^o, C^o(e^o))}{\partial e}}{\dfrac{\partial U(e^o, C^o(e^o))}{\partial C}}$$

In words, the marginal product of an increase of effort around the optimum should equal the ratio of marginal rates of substitution between the increase in utility due to an increase in effort and the decrease in utility due to a higher contribution.

Extending the concept to global truthfulness, the payment offered by the lobby equals the amount in the increase in welfare enjoyed by a change in the transfer scheme elicited from the government. In particular:

$$C^T(e^o, u^o) = \max(0, C(e, u^o)) \, forall e \in R.$$

where $C(e, u^o)$ is defined as $U(e, C(e, u^o)) = u^o$ for all $e \in R$.

By substituting the equilibrium contribution into the objective function of the government, the optimal level of effort induced to the manager of the firm will be defined by:

$e^o = \arg\max aW(e) + V(e)$

That is, the objective function of the government becomes a linear function of the utility of its electorate and the monetary contribution offered by the organized group of investors. Therefore, the government chooses a system of transfers that maximizes a weighted sum of the welfare of type 1 citizens and the fraction of type 2 investors that form the lobby.

The new maximization problem of the government becomes:

$$Max_{\overline{e},\underline{e}}\, a\left\{\alpha S_1 - (1+\lambda)\alpha\left[v\underline{t}_1 + (1-v)\overline{t}_1\right]\right\} +$$
$$+\left\{(1-\alpha)\delta\left(S_2 - (1+\lambda)\alpha\left[v\underline{t}_2 + (1-v)\overline{t}_2\right] + v\underline{U}\right)\right\}$$

$s.t.$

$$\underline{U} \geq \Phi(\overline{e})$$
$$S_2 - (1+\lambda)\underline{t}_2 \geq 0$$
$$S_2 - (1+\lambda)\overline{t}_2 \geq 0$$

It is important to emphasize that the taxation levied upon type 2 when the good state of nature realizes cannot account for the informational rents accruing to the firm as the government cannot discriminate between institutional investors and the remaining type 2 citizens. This assumption can be motivated by institutional constraints or by the existence of private information on the identity of the investors. This assumption imposes an upper bound on the maximum level of taxes that can be levied on type 2 consumers. This constraint may become binding for type 2 consumers that do not hold shares in the newly privatized firm but will be slack for institutional investors. By definition of concentrated ownership, institutional investors account for a small fraction δ of type 2 citizens.

Depending on the parameters of the model we can distinguish two cases, that are analyzed in turn in the following discussion.

Highly concentrated ownership

This case corresponds to a set of parameters satisfying the following relation: $\alpha a > (1-\alpha)\,\delta$

In this case, the government cares more about the welfare of its electorate than about the welfare of institutional investors which is internalized in its objective function through the lobbying game. Therefore, the participation constraints of type 2 consumers will be binding, which in turn implies constant level of taxation irrespective of the state of nature. Remember that the government participates from the informational rents awarded to the firm via the monetary contribution received from the lobby. The solution to the maximization problem of the government is as follows:

$$\Psi'\left(\underline{e}^3\right) = 1 \Rightarrow \underline{e}^3 = \underline{e}^*$$

$$\Psi'\left(\overline{e}^3\right) = 1 - \frac{a(1+\lambda)-1}{a(1+\lambda)}\frac{v}{1-v}\Phi'\left(\overline{e}^3\right)$$

Again the first-best effort is induced in the good state of nature. But distortions arise in the bad state of the world. Look at the second equation. The LHS denotes the cost suffered by the manager from a marginal increase in effort. The RHS denotes the marginal benefit of increasing effort in the bad state of nature (which translates into a smaller cost of implementing the project) minus the marginal cost of increasing effort, in terms of higher informational rents awarded in the good state of nature (which translates into higher taxation suffered by type 1 citizens). This cost rises with the value of a since this parameter shows how much the government cares about the welfare of its electorate vis-a-vis monetary contributions, and with the value of λ which captures the economic distortions generated by taxation. Yet the marginal cost of increasing efficiency is reduced by the increase in the contribution offered by the lobby.

Next, we compare the efficiency of a privatized firm characterized by dispersed and concentrated ownership. As long as $a < 1$, which is true by assumption, the marginal cost of increasing $\overline{e}$ is higher in the former case than in the latter. Given that the benefit of increasing effort is the same under both ownership structures, the firm will be more efficient under concentrated than under dispersed ownership. That is:^{o}

$a < 1 \Rightarrow \overline{e}^3 > \overline{e}^2$

The natural question that arises is whether there can be overinvestment in effort when the bad state of nature realizes. The answer is positive as long as:

$a < \dfrac{1}{(1+\lambda)} \Rightarrow \overline{e}^3 > \overline{e}^*$

In words, if the weight attached to the welfare of the electorate is lower than the cost generated by the transfer of funds to the firm in the form of rents raised through taxation, the regulatory schedule offered by the government will lead to overinvestment in cost reduction provided the bad state of nature realizes. This is because the informational rents, captured by the government, are highly appreciated to finance future elections.The optimal contribution offered by the lobby in equilibrium, $C^o\left(e^3, u^o\right)$, is defined implicitly by:

$$G\left(e^3, C^o\left(e^3, u^o\right)\right) = \max_e G\left(e, 0\right) = aW\left(e^1\right)$$

Substituting both terms of the equation:

$a\left\{\alpha S_1 - (1+\lambda)\left[vC\left(e^*\right) + (1-v)\,C\left(\overline{e}^3\right) + v\Phi\left(\overline{e}^3\right) - T_2\right]\right\} + C^o\left(e^3, u^o\right) =$

$a\left\{\alpha S_1 - (1+\lambda)\left[vC\left(e^*\right) + (1-v)\,C\left(\overline{e}^1\right) - T_2\right] - \lambda v\Phi\left(\overline{e}^1\right)\right\}$

where: $C\left(e^*\right) = \underline{\beta} - e^* + \Psi\left(e^*\right)$

$C\left(\overline{e}^i\right) = \overline{\beta} - \overline{e}^i + \Psi\left(\overline{e}^i\right)$ for $i \in \{1, 3\}$ and,

$T_2 = (1-\alpha)\dfrac{S_2}{1+\lambda}$ denotes the taxes levied upon type 2 citizens.

After some manipulation, the optimal contract in equilibrium is given by:

$$C^o\left(e^3, u^o\right) = a\left\{\begin{array}{c}\left[(1+\lambda)\, v\Phi\left(\overline{e}^3\right) - \lambda v\Phi\left(\overline{e}^1\right)\right] - \\ \left[(1+\lambda)\,(1-v)\left(C\left(\overline{e}^1\right) - C\left(\overline{e}^3\right)\right)\right]\end{array}\right\}$$

Look at the RHS of the equation. Notice that both brackets are positive. The first bracket captures the greater expected cost from higher informational rents under concentrated ownership whereas the second bracket represents its lower expected cost from higher efficiency.

Moderate concentrated ownership

In this case, the relation between the parameters of the model is the following: $\alpha a < (1-\alpha)\,\delta$

In this case, the government cares more about the welfare of institutional investors than over the welfare of its own electorate. This implies that the participation constraint derived from tax discrimination will be slack. The reason being that the government will try now to minimize the burden imposed on institutional investors via taxation in order to obtain higher contributions from the lobby. When choosing the regulatory scheme the government faces the following trade-off. On the one hand, higher informational rents increase the surplus of the lobby and hence the contribution that it is willing to offer. On the other hand, higher rents lead to higher taxation that decreases the net surplus of the lobby and hence its optimal contribution. In equilibrium, the efficiency of the firm is defined implicitly by:

$\Psi'\left(\underline{e}^4\right) = 1 \Rightarrow \underline{e} = \underline{e}^*$

$\Psi'\left(\overline{e}^4\right) = 1 - \frac{\delta(1+\lambda)-1}{\delta(1+\lambda)}\frac{v}{1-v}\Phi'\left(\overline{e}^4\right)$

where the marginal cost imposed from an increase in efficiency to the members of the lobby in terms of lower gross welfare increases with $\delta\,(1+\lambda)$, that is, with the fraction of institutional investors and the economic distortions induced by taxation.

Given that $\alpha a < (1-\alpha)\,\delta$ and that $\alpha > \frac{1}{2}$, it follows that $\delta > a$.

Therefore:

$$\frac{\delta(1+\lambda)-1}{\delta(1+\lambda)} > \frac{a(1+\lambda)-1}{a(1+\lambda)} \Rightarrow \overline{e}^4 < \overline{e}^3$$

To summarize, when monetary contributions are highly valued by the government, i.e. $a \in [0,1]$, the efficiency of a natural monopoly is greater under highly concentrated ownership. The intuition is as follows. Investors play a double role as taxpayers and shareholders. When they account for a small fraction of the total population, they internalize only partially the cost from higher taxation levied upon type 2 consumers. However, they enjoy all the informational rents awarded to the firm. As informational rents increase with efficiency, so does too the net payoff of the lobby. Given the characterization of the equilibrium contribution as a truthful schedule, this marginal increase in the lobby's net payoff will lead to an increase in the contribution offered to the government, which by assumption is more appreciated than the welfare of type 1 consumers. However, when investors account for a bigger fraction of type 2 consumers, the increase in the cost of taxation from higher efficiency becomes more important in the payoff function of the lobby. Therefore, they will be willing to rise their optimal contribution for a regulatory schedule leading to lower efficiency.

3.3 A Moral Hazard Approach

Let us review the informational imperfections that led to the inefficient behavior of a natural monopoly. The only impediment to perfect contracting between the government and the firm was the impossibility of the government to observe the information received by the manager of the firm concerning the state of nature. This information is learned by the manager after the contract has been signed and hence constitutes an illustration of hidden knowledge.

Also, it is interesting to remember the relation between the action of the government and the efficiency of the natural monopoly. The regulatory schedule offered by the government induces a specific effort in cost reduction. The functional form between effort and efficiency is linear. More specifically, an increment in effort leads to the same decrease in cost, and this irrespective of the state of nature. Finally, the state of nature realizes independently of the action of the manager.

In this section, we change the informational environment of the model to check the robustness of our results. Now we assume that the government can observe the state of nature. However it cannot verify the investment of the manager to increase the probability that the good state realizes. That is, we consider a moral hazard approach, where the inability of the government to observe the action taken by the manager is the only source of inefficiencies.

Moreover, we shall consider a non-linear relation between investment and efficiency. In particular, we assume that the expected marginal increase in efficiency from additional effort is decreasing in the level of effort. The basic structure of the model is the same presented in the previous section. The only difference lies on the cost structure of the project. Now the cost of implementing the project, β, which is stochastic at the contracting stage, can take on two values: $\beta = \underline{\beta}$ with probability $v(e)$ and $\beta = \overline{\beta}$ with probability $(1 - v(e))$ with $\overline{\beta} > \underline{\beta}$, where $e \in E$ denotes the effort spent by the manager in cost reduction. Finally, $v(e)$ is an increasing and concave function. The cost of the project is observed by the government ex-post but the choice of effort is non verifiable. Therefore, the government should provide incentives to the manager to elicit positive effort.

The firm receives a transfer from the government $t(\beta)$, where β represents now the cost of the project instead of the state of nature reported by the manager.

We shall replicate the analysis performed in Section 2 to determine which ownership structure minimizes the efficiency distortions created by asymmetric information.

3.3.1 Public Ownership

Let us start the analysis by considering the first-best case, where effort is chosen to maximize total expected surplus:

$Min_e v(e)\underline{\beta} + (1 - v(e))\overline{\beta} + e$

F.O.C.

$v'(e)\left(\overline{\beta} - \underline{\beta}\right) = 1$ and,

$$v'(e) = \frac{1}{\overline{\beta} - \underline{\beta}}$$

But the choice of effort is non verifiable. Therefore, in order to induce first-best, the government should provide appropriate incentives to the manager through an optimal system of transfers. In particular, it should satisfy both the participation constraint as well as the incentive compatibility constraint of the manager. Suppose that citizens are credit constrained so that their utility should be weakly positive in both states of nature. This is true in particular for the manager and hence:

$$\underline{U}(e^*), \overline{U}(e^*) \geq 0$$

where $\underline{U}$ and $\overline{U}$ denote his utility in the good and bad state of nature respectively. Also:

$$e^* = \arg\max_e \left\{ v(e)\left(\underline{t} - \underline{\beta} - e\right) + (1 - v(e))\left(\overline{t} - \overline{\beta} - e\right) \right\}$$

$$v'(e) = \frac{1}{\left(\underline{t} - \overline{t}\right)\left(\overline{\beta} - \underline{\beta}\right)}$$

But the government will set the efficiency of the firm to maximize its own objective function, namely the welfare of its electorate together with the rents accruing to the firm. The constrained optimization problem faced by the government is the following:

$$Max_e \left\{ \alpha S_1 - (1 + \lambda)\alpha\left[v(e)\underline{t}_1 + (1 - v(e))\overline{t}_1\right] \right\} + v(e)\underline{U}(e) + (1 - v(e))\overline{U}(e)$$

s.t.

$$\underline{U}(\widehat{e}), \overline{U}(\widehat{e}) \geq 0$$

$$\widehat{e} = \arg\max_e \left\{ v(e)\left(\underline{t} - \underline{\beta} - e\right) + (1 - v(e))\left(\overline{t} - \overline{\beta} - e\right) \right\}$$

$$S_2 - (1 + \lambda)\underline{t}_2 \geq 0$$

$$S_2 - (1 + \lambda)\overline{t}_2 \geq 0$$

where:

$$\underline{t} = \alpha\underline{t}_1 + (1 - \alpha)\underline{t}_2 = \underline{\beta} + e + \underline{U}(e)$$

$$\overline{t} = \alpha\overline{t}_1 + (1 - \alpha)\overline{t}_2 = \overline{\beta} + e + \overline{U}$$

The optimal system of transfers that solves this constrained optimization problem is given by:

$$\underline{t}(e) = \underline{\beta} + e + \underline{U}(e) \text{ and,}$$

$$\overline{t}(e) = \overline{\beta} + e$$

where $\underline{U}(e)$ is defined by:

$$\underline{U}(e) = -\frac{1}{v'(e)} + \left(\overline{\beta} - \underline{\beta}\right) \text{ for all } e \in E$$

We can rewrite the utility of the manager in the good state of nature as:

$\underline{U}(e) = \xi(e)$ where $\xi'(e) > 0$ given the assumption that $v'(e) < 0$ for all $e \in E$

Therefore, the effort choice induced by regulation is defined implicitly by:

$$(1+\lambda)\, v'(e^1)\left(\overline{\beta} - \underline{\beta}\right) = (1+\lambda) + \lambda v'(e^1)\,\xi(e^1) + v'(e^1)\,\xi'(e^1)$$

The LHS captures the marginal benefit to the government from an increase in efficiency, namely the greater probability that the good state of nature arises. The RHS represents its marginal cost, namely the increased cost of effort, the higher probability of awarding rents to the manager and the marginal increase in the amount of these rents as a result of higher efficiency. As the manager's payoff is internalized by the government, the cost of granting rents is only given by the economic distortions created by taxation. Solving for $v'(e^1)$:

$$v'(e^1) = \frac{1 + \frac{\lambda}{1+\lambda} v(e^1)\,\xi'(e^1)}{\left(\overline{\beta} - \underline{\beta}\right) - \frac{\lambda}{1+\lambda}\xi(e^1)}$$

As $v(e), \xi(e) > 0$ and $\xi'(e) > 0$ for all $e \in E$ then:

$$e^1 < e^*$$

There is a distortion in the effort induced to the manager with respect to first-best. Tax discrimination allows full expropriation of the surplus received by type 2 consumers. This means that any increase in taxation necessary to induce higher efficiency is fully levied upon the electorate of the government. Efficiency is costly since taxation is distortionary. Although the benefit enjoyed by the manager is internalized in the objective function of the government, still is lower than the corresponding cost of raising additional funds.

3.3.2 Private Ownership

We shall analyze separately both dispersed and concentrated ownership as they lead to different economic implications.

Suppose first that the government privatizes the firm by spreading ownership holdings among type 2 consumers. The new shareholders will now receive any income rights accruing to the firm. Given tax discrimination, higher rents will allow the government to transfer the higher cost of taxation from greater efficiency to type 2 consumers. Hence the constrained optimization problem of the government becomes:

$$Max_e \left\{ \alpha S_1 - (1+\lambda)\left[\alpha v(e)\underline{t}_1 + (1-v(e))\overline{t}_1 \right] \right\}$$

$s.t.:$

$$\xi(e) > 0$$

$$S_2 - (1+\lambda)\underline{t}_2 + \frac{\xi(e)}{1-\alpha} \geq 0$$

$$S_2 - (1+\lambda)\overline{t}_2 \geq 0$$

where:

$$\underline{t} = \alpha \underline{t}_1 + (1-\alpha)\underline{t}_2 = \underline{\beta} + e + \xi(e) \text{ and,}$$

$$\overline{t} = \alpha \overline{t}_1 + (1-\alpha)\overline{t}_2 = \overline{\beta} + e$$

Now the difference in taxation levied upon a type 2 consumer between the good and the bad state of the world is determined by the rents to which he is entitled as a shareholder of the firm. In particular,

$$\underline{t}_2 - \overline{t}_2 = \frac{\xi(e)}{1-\alpha}$$

The first order condition that implicitly defines the effort chosen by the manager in cost reduction is given by:

$$v'(e^2) = \frac{1 + \frac{\lambda}{1+\lambda} v(e^2)\xi'(e^2)}{(\overline{\beta} - \underline{\beta}) - \frac{\lambda}{1+\lambda}\xi(e^2)} \Rightarrow e^2 = e^1 < e^*$$

Now the government although does not internalize directly the utility accruing to the shareholders, it does internalize their payoff indirectly through tax discrimination.

3.3.3 Concentrated Ownership

Consider the case where the government sells off the natural monopoly to a group of institutional investors within the group of type 2 consumers. As in Section 2, investors form a lobby and offer a contingent monetary contribution in exchange for a favorable regulation. The government chooses a system of transfers optimally, given the contribution function offered by the lobby.

Given the preference functions of the lobby and the government presented in the previous section, namely $U(e, C) = V(e) - C$ and $G(e, C) = aW(e) + C$, where $a \in [0, 1]$, the truthful equilibrium of the game, $\{C^o(e), e^c\}$ is characterized by:

$$e^o = \arg\max_e a \left\{ \begin{array}{c} \alpha S_1 - (1+\lambda)\alpha\left[v(e)\underline{t}_1 + (1-v(e))\overline{t}_1\right] + \\ (1-\alpha)\delta\left(S_2 - (1+\lambda)\left[v(e)\underline{t}_2 + (1-v(e))\overline{t}_2\right]\right) \end{array} \right\} + v(e)\xi(e)$$

$s.t.:$

$\xi(e^o) > 0$

$S_2 - (1+\lambda)\underline{t}_2 + \dfrac{\xi(e^o)}{1-\alpha} \geq 0$

$S_2 - (1+\lambda)\overline{t}_2 \geq 0$

$G(e^3, C^o(e^3, u^o)) = \max_e G(e, 0) = aW(e^1)$

By the same argument presented in Section 2, the efficiency of the firm will depend on whether ownership is highly concentrated or not.

Highly concentrated ownership

As before, the relationship between the parameters of the model is the following: $\alpha a > (1-\alpha)\delta$

The equilibrium effort induced to the manager of the firm is defined implicitly by:

$$v'(e^3) = \frac{1 + \dfrac{a(1+\lambda) - 1}{a(1+\lambda)} v(e^3)\xi'(e^3)}{(\overline{\beta} - \underline{\beta}) - \dfrac{a(1+\lambda) - 1}{a(1+\lambda)}\xi(e^3)}$$

$$a < 1 \Rightarrow \frac{a(1+\lambda)-1}{a(1+\lambda)} < \frac{\lambda}{(1+\lambda)} \Rightarrow e^3 > e^2$$

The optimal contribution schedule defines the utility u^o captured by the lobby from bargaining with the government, so that the government is indifferent between privatizing the firm or keeping the firm under public ownership. Therefore:

$$C^o(e^3, u^o) = a\left[(1+\lambda)v(e^3)\xi(e^3) - \lambda v(e^1)\xi(e^1)\right] -$$
$$a\left[(1+\lambda)(\overline{\beta}-\underline{\beta})(v(e^3)-v(e^1))\right]$$

The expected rent is higher under concentrated ownership. In effect, not only the probability of awarding positive rents is higher, as $v(e^3) > v(e^1)$ but also the amount of the rent is greater as $\xi(e) > 0$. But the expected cost of the project is lower under concentrated ownership as the probability of a low cost realization is higher than the probability of a high cost realization.

Moderate concentrated ownership

This case is complementary to the one presented above, that is: $\alpha a < (1-\alpha)\delta$

The weight attached to the surplus of institutional investors in the objective function of the government is higher than the weight corresponding to the welfare of its electorate. Therefore, the participation constraint of type 2 citizens does not bind and the optimal level of effort solves the following equation:

$$v'(e^4) = \frac{1 + \frac{\delta(1+\lambda)-1}{\delta(1+\lambda)}v(e^4)\xi'(e^4)}{(\overline{\beta}-\underline{\beta}) - \frac{\delta(1+\lambda)-1}{\delta(1+\lambda)}\xi(e^4)}$$

The assumption that $\alpha a < (1-\alpha)\delta$ together with the fact that $\alpha > \frac{1}{2}$ implies that $e^4 < e^3$.

3.3.4 Discussion

Our results are robust to the characterization of the informational environment as a hidden information problem (where the manager holds private information concerning the state of nature) or as a moral hazard problem (where the action taken by the manager influences the distribution of the cost function).

The reason of this observation lies on the similarity between both specifications. In the hidden information problem, the marginal benefit of an increase in the manager's effort is linear in effort, whereas its marginal cost is an increasing function. This is due to the convexity of the cost function, which implies that the cost of informational rents to induce truth telling increases with the efficiency of the firm.

By contrast, in the moral hazard approach, the marginal cost of an increase in effort is linear whereas its marginal benefit decreases with the efficiency of the firm (as the probability of a good state is concave in effort). Therefore, the cost of incentives to elicit higher efficiency increases with the effort of the manager.

To summarize, in both informational settings the efficiency of the firm under public and dispersed private ownership is the same and lower than first-best. Also, the efficiency of the firm is higher under concentrated ownership when the lobby plays a truthful strategy. When monetary contributions are highly appreciated by the government (for instance, when the fraction of indecisive voters is significant), the lobbying game can lead to overinvestment in cost reduction.

3.4 Concluding Remarks

We are concerned with the efficiency of a regulated firm as a function of its ownership structure. Regulation implies that the ultimate control rights are held by the government irrespective of the firms' organizational form. However, ownership can still affect efficiency by influencing the preferences of the government towards regulation, as long as there exists some impediment to perfect contracting between the government and the firm. We consider the existence of private information concerning the action taken by the manager in cost reduction.

We focus the analysis on two ownership structures. Public ownership, where the rents accruing to the firm are captured by a self-interested government. And private ownership, where income rights are held by individual investors. If the government favors privatization, it may sell off the shares of the public firm to a dispersed population of consumers or alternatively to a reduced group of institutional investors. In the latter case leading to concentrated ownership, the government acknowledges that investors may constitute an interest group to bargain with the government for a favorable regulatory outcome.

We show two main results. First, the efficiency of a natural monopoly is greater under concentrated ownership as long as monetary contributions are sufficiently valued by the government. Second, the same efficiency arises under public and dispersed private ownership, given the possibility of tax discrimination. Also, the rents from the lobbying game are captured by investors so that the government is indifferent between both ownership structures. Our results hold in two different informational environment, namely in a hidden information model where the manager has private information over the state of nature that has realized and, in a moral hazard model where the action taken by the manager influences the distribution function of the random cost of the project.

We propose several extensions to the model presented in the chapter. First, given that the model values the monetary contribution received by the lobby to maximize its chances of reelection, it would be interesting to model the future political campaign between opposing candidates where contributions would be used to sway the voting behavior of indecisive voters.

Second, we could allow for the existence of competing lobbies. In effect, not only institutional investors but also the firm's employees may be willing to bargain with the government in exchange for a favorable regulatory policy. A priori, the surplus from the lobbying game would be captured by the government as it could credibly threaten to impose a different regulatory outcome to match the preferences of an alternative interest group.

Finally, any potential moral hazard problems between the manager of the firm and its shareholders have been assumed away. In a richer framework, a double agency problem would increase the cost or rising efficiency. If we assume that institutional investors can improve the effectiveness of corporate governance, we should expect higher efficiency induced under concentrated ownership, thus reinforcing the predictions of the model.

Bibliography

[1] Aghion, P., Blanchard, O (1996), On Insider Privatization, *European Economic Review*, 40: 759-766

[2] Aghion, P. and Bolton, P. (1998), Incomplete Social Contracts, *UCL Mimeo.*

[3] Alboek, S. and Schultz, C. (1997), One Cow, One Vote?, *Scandinavian Journal of Economics*, 99.4, 597-615.

[4] Arrow, K. J., (1963), Social Choice and Individual Values, 2nd ed. New York: Wiley.

[5] Barzel, Y. and Sass, T. (1990), The Allocation of Resources by Voting, *The Quarterly Journal of Economics*, 105.3, 745-771.

[6] Benham, L. and Keefer, P. (1991), Voting in Firms: The Role of Agenda Control, Size and Voter Homogeneity, *Economic Inquiry*, XXIX, 706-719.

[7] Bennedsen, M. (2000), Political Ownership, *Journal of Public Economics* 76 (3): 559-581

[8] Bernheim, B., Whinston, M. (1986), "Menu Auctions, Resource Allocation and Economic Influence", *Quarterly Journal of Economics* 101 (1): 1-31

[9] Besley, T.and Coate, S. (1998), Sources of Inefficiency in a Representative Democracy: A Dynamic Analysis, *American Economic Review*, 88, 346-75.

[10] Besley, T., Coate, S. (1996), An Economic Model of Representative Democracy, *Quarterly Journal of Economics* 112 (1): 85-114

[11] Bolton, P. and Xu, C. (2001), Ownership and Managerial Competition: Employee, Customer or Outside Ownership, *Sticerd D.P. TE/01/412.*

[12] Bonin, J., Jones, D. and Putterman, L, (1993), Theoretical and Empirical Studies of Producer Cooperatives: Will Ever the Twain Meet? *Journal*

of Economic Literature 31: 1290-1320.

[13] Boycko, M., Shleifer, A., Vishny, R. (1996), A Theory of Privatization, *The Economic Journal*, 106: 309-319

[14] Coase, R.(1960), The Problem of Social Cost, *Journal of Law and Economics* 1:1-44.

[14] Craig, B., and Pencavel J., (1992), The Behavior of Worker Cooperatives: The Plywood Companies of the Pacific Northwest, *American Economic Review* 82.5: 1083-1105.

[15] Davis, K. (1999) Incentive Compatible Governance in Cooperative Financial Institutions, *University of Melbourne Mimeo.*

[16] Dewatripont, M. and Roland, G. (1992), Economic Reform and Dynamic Political Constraints, *Review of Economic Studies*, 59, 703-730.

[17] Dixit, A., Grossman, G., Helpman, E. (1997), Common Agency and Coordination: General Theory and Application to Government Policy Making, *Journal of Political Economy 105 (4):*. 752-69

[18] Dixit, A.and Londregan, J. (1995), Redistributive Politics and Economic Efficiency, *American Political Science Review,* Vol. 89 (4), P. 856-866.

[19] Dow, G., (1993), Why Capital Hires Labor: a Bargaining Perspective, *The American Economic Review,* 83.1: 118-134.

[20] Farrell, J. and Scotchmer, S. (1988), Partnerships, *The Quarterly Journal of Economics*, 103.2, 279-297.

[21] Faure-Grimaud, A. (1997), The regulation of Predatory Firms, Journal of Economics and Management Strategy, 6 (4): 849-76

[22] Fernandez, R. and Rodrik, D. (1991), Resistance to Reform: Status Quo Bias in the Presence of Individual-Specific Uncertainty, *American Economic Review*, 81.5, 1146-1155.

[23] Frank, R. (1984), Are Workers Paid their Marginal Products? *The American Economic Review*, 74.4: 549-571.

[24] Gans, J. and Smart, M. (1996) Majority Voting with Single-Crossing Preferences, *Journal of Public Economics*, 59, 219-237.

[25] Grossman, S. and Hart, O. (1986), The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration, *Journal of Political Economy*, 94.4, 691-719.

[26] Grossman, S., and Helpman, E. (1994), Protection for Sale, *American Economic Review*, 84: 833-850

[27] Grossman, S., and Helpman, E. (1996), Electoral Competition and Special Interest Politics, *Review of Economic Studies*, 63: 265-286

[28] Groves, T. and Ledyard, J. (1977), Optimal Allocation of Public Goods: A Solution to the Free Rider Problem, *Econometrica, 45 (4): 783-809*

[29] Hansmann, H. (1996), The Ownership of Enterprise; *Harvard University Press*

[30] Hart, O. (1996), Firms, Contracts and Financial Structure. Oxford University Press.

[31] Hart, O. and Moore, J. (1999), On the Design of Hierarchies: Coordination versus Specialization, *Sticerd D.P.* TE/99/375.

[32] Hart, O. and Moore, J. (1998), The Governance of Exchanges: Members' Cooperatives vs. Outside Ownership, *Oxford Review of Economic Policy* 12.4 (Winter 1996): 53-69.

[33] Hart, O. and Moore, J. (1998), Cooperatives versus outside ownership, *NBER Discussion paper* 6421.

[34] Hart, O. and Moore, J. (1990), Property Rights and the Nature of the Firm, *Journal of Political Economy* 98.61: 1119-1158.

[34] Hart, O., Shleifer, A., and Vishny, R. (1997), The Proper Scope of Government: Theory and Application to Prisons, *Quarterly Journal of Economics* 112: 1127-1162

[35] Holmstrom, B. (1999), The Economics of Corporate Governance, *Third Louise and Goran Ehrnrooth Lectures, Swedish School of Economics,* Helsinki.

[36] Kremer, M. (1997), Why are Worker Cooperatives So Rare?, *NBER* 6118.

[37] Kremer, M. (1999), Worker Cooperatives as Economic Democracies, *MIT mimeo*

[38] Krusell, P. and Rios-Rull, J.V. (1996), Vested Interests in a Positive Theory of Stagnation and Growth, *Review of Economic Studies*, 63, 301-329.

[39] Laffont, J.J. and Tirole, J. (1991), Privatization and Incentives, *Journal of Law, Economics and Organization*, 7: 84-105

[40] Laffont, J.J. and Tirole, J. (1993), A Theory of Incentives in Procurement and Regulation, Cambridge (Mass.), MIT Press

[41] Laffont, J.J. (1996), Privatisation and Incitations, *Revue Economique*: 1239-1251

[41] Mailath G., Postlewaite, A. (1990), Asymmetric Information Bargaining Problems with Many Agents, *Review of Economic Studies,* 57 (3): 351-67.

[42] Mas-Colell, A., Whinston, M,. Green, J., (1995), Microeconomic Theory, Oxford University Press.

[42] Masulis, R. (1987), Changes in Ownership Structure: Conversions of Mutual Savings and Loans to Stock Charter, *Journal of Fianancial Economics*, 18: 29-59.

[43] May, K. (1952), A set of independent, necessary and sufficient conditions for simple majority decision. Econometrica 20: 680-68

[43] Mirrlees, J. (1971), An exploration in the theory of optimal income taxation, *Review of Economic Studies* 38: 175-208.

[43] Moore, J., (1992), Implementation, Contracts and Renegotiation in Environments with Complete Information, in *Advances in Economic Theory: Sixth World Congress,* vol. 1, edited by J.J. Laffont. Cambridge, U.K., Cambridge University Press.

[44] Mueller, D.C. (1997), Public Choice in Perspective, *A Handbook: Perspectives on Public Choice,* Cambridge University Press.

[45] Roberts, K. (1977), Voting over Income Tax Schedules, Journal of Public Economics 8, 329-340.

[46] Roberts, J. and Vand den Steen, E. (1999), Human Capital and Corporate Governance, *Standford Graduate School of Business Mimeo.*

[47] Roberts, K. (1999), Dynamic Voting in Clubs, *STICERD Discussion paper* TE/99/367.

[48] Sappington D., Stiglitz, J. (1987), Privatization, Information and Incentives, *Journal of Policy Analysis and Management*, 6: 567-582

[49] Schmidt, K. (1996), The Costs and Benefits of Privatization: An Incomplete Contracts Approach, *Journal of Law, Economics and Organization*, 12.1: 1-24

[50] Sen, A. (1986), Social Choice Theory, Ch. 22 in *Handbook of Mathematical Economics,* edited by K. Arrow and M. Intriligator, Amsterdam: North-Holland.

[51] Shapiro, C., and Willig, R. (1996), Economic Rationales for the Scope of Privatization, in Suleiman and Waterbury eds. The Political Economy of Public Sector Reform and Privatization. Boulder, Colo.: Westview Press

[52] Shleifer, A., and Vishny, R (1994), Politicians and Firms, *Quarterly Journal of Economics* 109: 995-1025

[53] Shleifer, A. (1998), State versus Private Ownership, *Journal of Economic Perspectives*, 12, 1998: 133-150

[54] Suleiman, E., Waterbury, J. (1990), The Political Economy of Public Sector Reform and Privatization, in Boulder and London: Westview Press.

[55] Vickers, J., Yarrow, G. (1990), Privatization: An Economic Analysis. Cambridge (Mass.), MIT Press

[56] Vickers, J., Yarrow, G. (1991), Economic Perspectives on Privatization, *Journal of Economic Perspectives*, 5.2: 111-132

[57] Williamson, O. (1985) The Economic Institutions of Capitalism: firms, markets, relational contracting. New York Free Press

[58] Wittman, D. (1989), Why Democracies Produce Efficient Results, *Journal of Political Economy*, 97.6, 1395-1424.