# Resistance, Redistribution and Investor-friendliness*

Sourav Bhattacharya† Tapas Kundu‡

February 2014

**Abstract**

Poor communities sometimes resist private investment and destroy economic surplus even if the government has the willingness and ability to redistribute. We interpret such acts of resistance as demands for redistribution: Destruction contains credible information about how the affected group values surplus, and such information is used by the government in implementing the optimal redistribution policy. The extent of destruction is increasing in the extent of political marginalization of the affected group. Resistance not only destroys economic surplus: it also mutes the investor's incentives to create surplus. The government uses a tax/subsidy on the investor to maximize weighted social surplus, and we show that the possibility of destruction may force the government to be too soft in its negotiations with the investor. We discuss several policy instruments that have the potential to improve welfare: These include compensation floor for the affected group, legal and/or financial protection for the investor and licensing fees for the investor.

*Keywords:* Resistance, Redistribution, Investor-friendliness, Signaling

*We thank the editor and two anonymous referees for comments and suggestions that helped improve the paper. We also thank participants at seminars at University of Pittsburgh, Frisch Center at University of Oslo, Indian Statistical Institute Kolkata, North American Summer Meeting of the Econometric Society at Boston 2009, 2010 UECE Meeting on Game Theory and Applications, Lisbon and Public Economic Theory Conference 2011 at Indiana University Bloomington, for valuable comments. This paper was previously circulated under the title "Resistance to Outside Investment: A Rational Model of Surplus Destruction." Any errors that remain in the paper are our sole responsibility.

†Department of Economics, University of Pittsburgh. Email:sourav@pitt.edu

‡School of Business and Economics, University of Tromsø. Email: tapas.kundu@uit.no. While carrying out (part of) this research, Tapas Kundu was associated with the centre of Equality, Social Organization, and Performance (ESOP) at the Department of Economics at the University of Oslo. ESOP is supported by the Research Council of Norway.

# 1 Introduction

Over the last few decades, local, provincial and national governments the world over have been increasingly relying on outside private investment to provide impetus for growth in employment and output.[1] Privatization has widely been promoted in developed and developing countries alike (Galal et al. 1994, World Bank 1995, Megginson et al. 1994) and governments have been actively pursued private capital by providing incentives and otherwise creating conditions favorable for investment (Oman 2000, Stern 2001).[2] While such policies are often favorably evaluated in terms of growth, efficiency and profitability, their distributional impact is questionable (McKenzie et al. 2003). On the one hand, private investment in industries demands large transfer of public resources from other sectors in the form of land acquisition and infrastructure building, causing displacement and loss of livelihood of a significant section of the population. On the other hand, the benefits from industrial growth are unevenly distributed to different sections of the society. With or without state intervention, the local communities often find themselves not compensated for such economic changes (Ghatak and Mookherjee 2011).

Recent development policy problems related to the issues of industrialization and urbanization, currently experienced in rapidly growing economies such as China, India or several Latin American countries, exhibit similar features. According to a report prepared for the World Commission on Dams, ten million people in China have been displaced to accommodate the hydroelectric projects in China since 1950s (Bartolomé et al. 2000).[3] India, during the post-liberalization period, experienced similar pattern in loss of livelihood among rural laborers and tribals because of acquisition of agricultural land and forest for the purpose of industrial development (Sarkar 2007).

Perhaps, not surprisingly, these economies at the same time had experienced massive public resistance to these industrial policies (Molano 1997, Bardhan 2006b, Beinen and Waterbury 1989, Rodrik 1999, Stiglitz 2002). Some of this resistance has taken the form of actual destruction of productive assets, disruption of production, or in some other way creating conditions that lower the productive capacity of the investor. The extent of the resistance is often greater than is usually acknowledged. The public security ministry in China officially reported 87000 cases of public order disturbances – in the form of protests, picketing and petitioning – in the year 2005 alone (Lam 2006). Cao et al. (2008) report an overwhelmingly large number of protests (17900 cases with 385000 participants in total) in the first nine months of 2006 in China due to the displacements caused by government's urban expansion policy. Various studies documented an alarmingly high number of cases of public resistance in the context of India (Sarkar 2007).[4] Uba (2005, 2008) documents the protests in connection with the government's initiative to bring private industrial investment in the post liberalization period. Between the years 1991 and 2003, there had been more than 178 protest actions. About 24% of these protests were strikes or demonstrations involving an average of two million participants. The privatization process in Latin America faced huge public opposition in the past two decades. The ruling parties were often forced to delay or abandon the investment policies in fear of losing political support (Hall et al. 2005).

What is puzzling about these protests is that local communities seem to be resisting precisely what is

[1] There are numerous studies, including Sheshinski and Lopez-Calva 2003, Bortolotti and Siniscalco 2004, Shirley and Walsh 2004, Cavaliere and Scabrosetti 2008 and Estrin et al. 2009, that provide a comprehensive review of this literature.

[2] The term privatisation has been used to cover an array of different policies. It involves not only the sale of state-owned enterprises (SOEs) or assets to private economic agents by the government, but also a more general process of attracting private funds in financial and various economic sectors including infrastructure, water, health and education. Megginson and Netter (2001) provides a comprehensive survey of the literature.

[3] Cao et al. (2008) suggest a more alarming figure of a yearly displacement of two and half million farmers due to the urban expansion programs in China.

[4] Several Indian states have experienced political tensions involving policies related to private investment. In 2011, the controversies related to the land acquisition policies in the state of West Bengal led to the overturn of the incumbent Communist Party of India, who had been ruling the state for the preceding thirty five years.

necessary to lift them out of the poverty trap. In a world with complete information, as long as there is a positive surplus created from investment, the government can always implement a suitable redistributive policy so that efficiency can be restored. Thus, destructive activities that ultimately reduce surplus seem counterproductive. We depart from the existing literature on private investment by addressing the incomplete and asymmetric information problems that closely characterize the political economy of redistribution in developing economies. This paper studies resistance as a rational response by purported beneficiaries of the investment when the government is willing and able to redistribute the surplus from investment, but is uninformed about the benefits of the investment accruing to different groups. The objective lies in analyzing the welfare consequences of such resistance from the point of view of a benevolent government. We further examine how resistance affects the government's contract with the private investor, and provide a positive theory of investor-friendliness.

Governments, both authoritarian and democratic, have pursued a wide range of approaches to mitigate public resistance, ranging from using force to ban demonstrations and protests to active negotiations with local communities. A prime example is the power plant project by Enron at Dabhol in the Indian state of Maharashtra in early 1990s. Local communities whose livelihoods were seriously damaged due to displacement and environmental degradation, initiated a campaign with demonstrations and protests in various forms including road blocks, hunger strikes, disruption of production and boycotting local elections. The state government used brutal forces to suppress the movement locally, but it led to a protest by human rights activists across the world (Amnesty International 1997), finally leading to Enron's departure from India. More recently, the land acquisition policies followed by the state governments to promote industrialization faced intense opposition and conflict with local communities in another Indian state of West Bengal, resulting in violence and loss of lives (Ray 2010). On the other hand, more peaceful negotiations on compensation with local communities have experienced mixed results. The delay in reaching an agreeable solution sometimes results in underinvestment by the investor or discontinuation of the project. But if an agreeable solution is reached, it is more likely to sustain in the long run. However, there been little attempt in understanding the comparative effects of these policies. In light of the growing resistance across industrializing countries, we face important questions regarding the government's optimal response to public dissent and the design of redistribution mechanisms. Based on our rational model of resistance, we are able to provide a comparative analysis of various policy instruments that have potential to improve welfare.

Our analysis rests on the following three premises.

1. There is asymmetric information about benefits from investment. Investment benefits different social groups (skilled and unskilled labor, industry and agriculture) differently. There is considerable uncertainty about the actual level of benefits (number of jobs, multiplier effect, etc.) to a certain group, referred to as the *affected group* and the government cannot directly elicit this information through the democratic process.

2. The affected group can signal its private information for preferential treatment. The signaling activities can take various forms, including demonstrations, protest, strikes or other violent means to disrupt production. Importantly, such signaling creates negative externality for the investor and other groups.

3. The government does not care directly about the profits of the external investor. The government can redistribute benefits between the affected group and the non-affected group to maximize a composite welfare function incorporating both groups' benefits.

The first premise captures two specific features of the privatization process in the developing economies. First, the realization of benefits to different social groups is not instantaneous. In many countries, privatization has been part of a larger economic reform process. For societies undergoing economic reform, it may be hard for the government as well as for the social groups to foresee the actual benefit that these investments would generate in the long run. Second, we assume existence of an information gap between policy makers and social groups at the interim stage. The information gap often plays a fundamental role in the political economy of redistribution in developing countries (Ray 2007, Ch. 14). In a centralized system, bureaucrats often lack information on local needs. Decentralization does not necessarily reduce the informational gap between policy maker and the community if local agents do not function appropriately (Bardhan 1996, Bardhan and Mookherjee 2006).

The second premise is motivated by the fact that the nature of anti-investment mobilization movements in developing countries often has externalities that accrue to the whole society.[5] Finally, the third premise is used as a device to understand how resistance can occur without any rent-seeking motivation on the part of the government. We do not intend this as an assertion about reality that there is never any covert nexus between the government and the external investor. On the contrary, our intention in making this assumption is to demonstrate that we may have resistance to investment even in absence of such a nexus. Violent protests may arise due to informational constraints in the society even with the most benevolent of governments.

In our model, there are four players: the government, an external investor and two social groups (of which one has a limited role). The government first offers a tax/subsidy to the investor, based on which the investor decides on the scale of the project. The valuation of the affected group is realized *after* the size of the project is decided, and the group signals its valuation through destructive action. The government implements a redistribution scheme between the two groups by using information contained in the signal. Therefore such destruction can be interpreted in equilibrium as a demand for redistribution of surplus.

The model yields the following insights. First, if a government is responsive to information but suffers from an informational constraint, resistance can be used as a signal to transmit valuable information to the policy maker. In this sense, we share features in common with a literature that interprets costly actions such as protest or delay or other forms of group mobilization to disrupt productive activities as a device to transmit private information (see, for example, Hart 1989 and Cramton and Tracy 1992 on strikes, Lohmann 1994 on political protest, Harstad 2007 on delay).

Second, the extent of resistance is critical in determining the credibility of resistance to transmit private information. In particular, it must solve an adverse selection problem - if the government offers a favorable redistribution scheme to the affected group after observing a low level of resistance, the affected group will have an incentive to show resistance even when its actual benefits from investment is high. We find that the extent of resistance in equilibrium is less if the government is favorably biased toward the affected group. The affected group expects a high post-redistribution surplus from investment when the government is favorably biased, reducing the marginal incentive to destroy surplus. The affected group thus internalizes the social cost of resistance more when government is biased in their favor. In other words, the more marginalized a group is in the political system, the more violently it will resist private investment. This result is broadly consistent with the general observation that in India, the more militant of anti-privatization movements occur in the districts which have a higher proportion of indigenous tribes.

In addition, the fact that the government values the relationship with the investor only in terms of possible gains to the groups internal to the society helps us endogenize the extent of investor friendliness of the government. Our model helps us to identify conditions under which the government subsidizes the

[5] Uba (2005, 2008) documents events that disrupt productive activities in a larger scale, including road blocks, rallies, nationwide strikes in the context of India. There can be various reasons behind it. Actions that create externality to the whole society are likely to generate high visibility. Additionally, if the policy maker lacks information about the benefit of the affected group, she may also be informationally constrained about the private cost that the group incurs to signal. On the other hand, if the policy maker is better informed about the investor's situation or some other group's situation, socially costly actions may have broader scope of transmitting private information.

investor at the cost of the society or taxes the investor and distributes the proceeds in the society. Under full information, the government subsidizes the investor when the investment has a larger marginal return to the society than to the investor, and taxes the investor otherwise. However, the threat of surplus destruction mutes the investor's incentives and government may be forced to offer more favorable terms to the investor at the cost of society. While it is often argued that resistance to private investment is a response to the government selling out to the investor, we argue that there is a reverse causality too: the possibility of resistance may weaken the government in its negotiations with the investor and force it to make concessions that would be unnecessary in absence of information constraints. However, it is also possible that the government can act too aggressively compared to the full information benchmark. The direction of distortion of the equilibrium tax/subsidy over the full information benchmark depends on a simple comparison of the benefits in the bad state, i.e. the state in which resistance occurs. The government is too soft (aggressive) if and only if the society's total benefits in the bad state is lower (higher) than that of the investor.

In order to assess the economic value of resistance, we compare results of our basic model with a regime where there is no signaling and the government commits to a suboptimal redistribution scheme in advance. We find that the government prefers the no-signaling regime when the probability of the *bad state* (a state in which the affected group's benefit is low) is high or the government's bias in favor of the affected group is sufficiently high. The intuition behind the first effect is straightforward: as resistance would occur only in the bad state, a high probability of the bad state occurring would reduce the attractiveness of the costly signaling channel. The second effect is driven by the fact that the redistribution problem is less acute when the government is strongly biased towards the affected group. We predict when banning resistance may or may not create a welfare improvement in terms of trading off its informative value against the cost of destruction.

In section 4, we provide a welfare comparison of allowing and banning protest. In reality, governments do not face such an all-or-nothing choice. While protests elicit socially valuable information, the government can control the scale of destruction by committing to various measures even before the protests occur. In section 5, we extend our model by including various welfare enhancing policy instruments. At this stage, it is important to note that there are two distinct economic problems in the paper: first, the investor creates externalities for the societies requiring the government to induce the "correct" level of investment and second, the informational gap in redistribution. Resistance is not only a costly source of socially useful information, it also links the two distinct problems by distorting the investor's incentives. The different policy instruments we study can be classified according to the problems they address.

In the benchmark model,. the government uses proportional taxes (or subsidies) to induce the socially optimal level of investment. If in addition, the government could charge the investor a licensing fee, it could extract all surplus from the investor and transfer it to the society. We study the optimal two-part tariff structure in section 6.2. Another policy instrument aimed at boosting investment is asset insurance for the investor. If the investor is compensated for surplus lost due to resistance, signaling does not distort the investor's incentives anymore.

Another class of policy instruments is aimed at striking a balance between redistributive justice and the minimizing the extent of resistance. If the government can commit to a minimum compensation for the affected group, then the extent of resistance required to credibly transmit information about valuations is lowered. We determine the optimal compensation floor by trading off suboptimal redistribution with reduced destruction and improved incentives for the investor. A judicious combination of a compensation floor and ceiling further reduces resistance while still extracting necessary information. Notice that asset insurance for the investor also reduces destructive resistance since the investor is paid by taxing the society, and the affected group internalizes this cost.

While most part of the paper concentrates on the redistribution problem by assuming that the investment project is always beneficial to the society, in an extension we study the case where the project is bad for the society in one state and good in the other state. Our model predicts that while there will be no resistance in the good state, there will be maximum resistance in the bad state. In our framework, this can be interpreted as the project being foiled because of public protests. This prediction squares with several observed cases where a project was forced out or called off because of public resistance. Failed privatization attempts of public utilities in Latin America readily come to mind as pertinent examples.

Our paper shares common features with several strands of work. The literature on wage bargaining between the firm management and the union demonstrates that strikes (leading to loss of surplus) can arise as a mechanism by which the firm can credibly transmit private information about its profitability to the union. This literature includes Fudenberg et al. (1985), Grossman and Perry (1986), Admati and Perry (1987), Cramton (1992), Hart (1989), Cramton and Tracy (1992) and a host of other papers that followed. While the literature has concentrated on different mechanisms (signaling, screening, war of attrition or a mix of these) that can explain the duration of strikes, the broad theme is the following: unions initiate strikes, and the management endures strikes in order to credibly signal a low valuation of the surplus. Harstad (2007) demonstrates a game where two parties bargain over the share of payment for a public good, where each party uses delay (which is costly to both parties) to signal its valuation of the good to the other party. While our paper also relies on destruction of economic surplus as a channel of signaling valuation, the mechanism considered is different in two important ways. First, in our case, the social groups bargain over redistribution in presence of an arbitrator (the government). Second, unlike in the strikes literature, it is the party with private information that initiates the destruction in order to signal information to the arbitrator.[6] Moreover, while the bargaining literature by and large starts with an exogenously given surplus, the amount of surplus to be bargained over is itself endogenous in our model, due to the presence of an important third party: the investor.

The model in our paper can be interpreted as one with two groups lobbying the government for redistributive transfer in presence of asymmetric information. In this respect, we share similarities with the literature on informational lobbying where interest groups use costly signals of their private information to establish credibility (see Austen-Smith and Wright 1992; Austen-Smith 1993, 1994, 1995; Lohmann 1995a, 1995b, 1998 and Laffont 1999). While most of these papers deal with informational efficiency, our focus is on comparing the informational benefits with the cost in terms of lost economic surplus. Esteban and Ray (2006) studies an informationally constrained government depending on lobbies for information necessary for optimally allocating resources. The paper shows that inefficient allocation may happen due to signal jamming by richer lobbies, and therefore higher inequality may lead to more inefficient allocation of resources. The authors conclude that inefficient resource allocation in developing countries may arise simply due to higher inequality rather than due to bureaucratic corruption. Our paper has a similar message: governments may be forced to offer softer deals to investors as a result of endemic informational problems, and not necessarily due to inherent corruption.

The paper is organized as follows. In Section 2, we introduce the basic analytical model. Section 3 presents the benchmark full information case and then analyzes the asymmetric information case with the possibility of signaling with resistance. Section 4 analyzes the asymmetric information problem in absence of signaling. In Section 5, we discuss various policy instruments that have potential to improve upon the welfare obtained in the asymmetric information case. Section 6 considers two extensions of our basic model.

[6] Susanne Lohmann (1993, 1994 and 1995a), studies costly political actions taken by informed activists as a form of credible communication to the leader. Unlike our paper, the focus of these papers is whether such actions taken by many activists can lead to aggregation of dispersed information in the society. Moreover, while resistance in our paper imposes costs on all parties involved, Lohmann studies a model where the costs are entirely private to the individual taking the signaling action.

Section 7 concludes with discussions on the implications of our results.

# 2 Analytical framework

## 2.1 Environment

### 2.1.1 Role of investment

Consider a development project that benefits the local economy and suppose that the government does not have the necessary resources (technical expertise, financial strength, human resources) for efficient implementation. The government, $G$, identifies an external investor, $I$, with such resources to implement the project.[7] $G$ offers an investment tax $\tau \in R$ to the investor on the size of investment.[8] A negative value of $\tau$ implies a subsidy to the investor. $I$ decides the size of the project $x \geq 0$, after observing $\tau$. Investment is costly and the investment cost is given by $\frac{x^2}{2k}$, where $k > 0$ measures productivity of investment.[9] From an investment of scale $x$, an investor gets a revenue of $qx$ with $q > 0$. The parameter $q$ can be interpreted as the price at which the investor is able to sell output generated by the project. A more rewarding way to think of $q$ is the following: suppose the investment has already been made, i.e. sunk. Now, $qx$ is the valuation of the project from the point of view of the investor, and thus $q$ is the valuation per unit of scale. The project creates economic externalities for the local community, which for our purposes is the society. The society comprises of two groups $A$ and $B$, who derive utility from the project. Groups may have different valuations of the project. Group $J$'s total valuation of the project is given by $v^J x, J \in \{A, B\}$, and valuation per unit scale is $v^J$.

### 2.1.2 Informational constraints

We assume uncertainty about the economic externality that the project generates. The uncertainty affects the government's redistributive concern. This can be modeled by introducing uncertainty over the values of $v^A$, or $v^B$, or both. To keep the model simple, we only consider one-sided uncertainty. While $v^A$ is assumed to be fixed, $v^B$ can be either *high* or *low*. Thus, in our model, group $B$ should be thought of as the "affected group". In the low state which occurs with probability $p$, group $B$ is affected adversely and $v_B$ takes the value $\underline{v}$. In the high state which occurs with probability $1 - p$, $v_B$ equals $\overline{v}$. We assume that $p \in (0, 1)$ and $\underline{v} < \overline{v}$. The distribution of $v^B$ is commonly known, but $v^B$ itself is realized after investment is made by the investor. The realized value of $v^B$, which we sometimes generically denote by $v$, is private information to group $B$.

### 2.1.3 Redistribution and signaling

In our framework, $G$ decides on two different kinds of redistributive transfer. Through the investment tax, as described above, a redistribution of surplus takes place between the investor and the society. If there is a positive investment tax (when $\tau > 0$), $G$ distributes the tax revenue among the citizens. Conversely, when offering a subsidy to $I$ (when $\tau < 0$), $G$ collects the subsidy from the society.

At the final stage, $G$ decides on a redistributive transfer between the two groups $A$ and $B$. The timing of the redistributive transfer between groups is particularly important in our framework. If the transfer

[7] In our basic framework, we assume that the government is the sole buyer of the investment. A geographically specific investment opportunity (e.g. mining) may be a relevant example here.

[8] We consider proportional investment tax to make the analysis simple and tractable. We check the robustness of our results with a richer tax policy in the form of two part tariffs in Section 6.2.

[9] Our results hold for any strictly increasing and convex cost function. The assumption of quadratic cost function is taken for simplicity and tractability of our results.

takes place after $v^B$ is realized, group $B$ has an incentive to signal its private information to affect the level of redistributive transfer. In particular, irrespective of the true valuation, B would like to pose as a low-valuation type to attract a higher transfer from the government. However, a high valuation type, by definition, values the surplus more than the low-valuation type. This creates an opportunity for the low valuation type to credibly signal its valuation by taking (publicly observable) action to destroy some surplus. Such destructive actions come in the form of protests, strikes or delaying the production process by other means. The government uses information inferred from such public action to implement an appropriate redistribution scheme. Such signaling, however, comes at a cost of surplus reduction which hurts all parties concerned. We assume that by taking an action of level $a$, $B$ effectively reduces the size of investment by $ax$. In this sense, the action is interpreted as the "share of output destroyed", and we assume that $a \in [0, 1]$. Notice that the action reduces the value of investment for the investor and for each of the two groups. Following an action of level $a$, group $J$'s payoff from the project becomes $v^J x(1-a)$.

Let $w^J$, $J = A, B$ denote group $J$'s surplus before the between-groups transfer takes place. We can write $w^A(a) = v^A x(1-a) + s^A \tau x$ and $w^B(v, a) = vx(1-a) + s^B \tau x$, where $s^J$ is the share of group $J$ of the tax revenue or subsidy payment and $v \in \{\underline{v}, \overline{v}\}$ is the value taken by $v^B$. We write $s^B = s$ and $s^A = 1 - s$. Note that both $s$ and $t$ are instruments of redistribution between groups. For each level of tax share $s \in (0, 1)$ chosen before the signaling stage, the government can choose some intergroup transfer $t$ at the redistribution stage that achieves the same outcome for each group. Therefore, the results in the benchmark model (sections 3 and 4) do not depend on the value of $s$. We therefore assume that $s \in (0, 1)$ is fixed at some level and that $t \in \mathbb{R}$, the redistributive transfer from group $A$ to group $B$, is the only instrument that $G$ chooses. The post-transfer surplus of groups $A$ and $B$ are given by

$$w^A - t = v^A x(1-a) + s\tau x - t, \text{ and} \tag{1}$$
$$w^B + t = v^B x(1-a) + (1-s)\,\tau x + t. \tag{2}$$

The following condition is assumed throughout our analysis.

**Assumption 1** $v^A + \underline{v} > 0$.

Assumption 1 guarantees that the total surplus generated by the project is large enough to ensure positive surplus for the groups in every state. By making this assumption, we move away from the 'adverse selection' problem of choosing bad projects, and focus only on the informational problem related to the redistribution of surplus. In Section 6.1, we discuss the case when this assumption is relaxed, and we address the selection problem.

## 2.2 Payoffs

A group's payoff is given by its post-transfer surplus (1), (2). In our framework, group $A$ is not considered as a strategic player, and does not take any action to influence its payoff. Group $B$ chooses the level of action to signal its valuation of the project. The investor's payoff is given by $qx\,(1-a) - \frac{x^2}{2k} - \tau x$.[10]

In our framework, we do not model the government as a rent-seeker. Instead, it plays the role of a planner with two concerns - *a)* inducing private investment that is necessary for development, and *b)* redistribution of surplus among different groups within society. Its motivation for redistribution implicitly stems from a

[10] In the basic framework, we assume that the investment tax/subsidy is contingent on the total size of the project. The government does not provide any insurance to the investor against the losses due to costly action. We later show in an extension that if the government can compensate the investor for its losses by raising money from the society, the results do not change qualitatively, but there is some welfare improvement in equilibrium.

concern over unequal distribution of surplus. To capture the redistribution motivation, we therefore introduce a measure of inequality. The cost of inequality to $G$ is given by

$$L(t) = \left[\lambda\left(w^A - t\right) - (1-\lambda)\left(w^B + t\right)\right]^2. \tag{3}$$

In the above expression, $\lambda$ measures $G$'s bias towards group $B$ when measuring the difference in post-transfer surplus.[11] For $\lambda = 1/2$, this measure of inequality is simply the square difference between two groups' post-transfer wealth. As $\lambda$ increases (decreases) from 1/2, high post-transfer wealth of $A$ (relative to $B$) is considered to be costly to $G$, thus creating a bias toward group $B$'s wealth in determining the level of inequality. The exact opposite effect works as $\lambda$ decreases from 1/2.

For a given level of inequality, $G$ prefers high total surplus of the society. Therefore, its payoff function can be given as

$$W = \left[w^A + w^B\right] - \left[\lambda\left(w^A - t\right) - (1-\lambda)\left(w^B + t\right)\right]^2 \equiv S - L(t) \tag{4}$$

The first component in (4), $w^A + w^B$, is the total surplus $S$ of the society, and the second component reflects the loss from inequality $L(t)$. Both $S$ and $L$ depend on the action $a$ and the affected group's valuation $v$, but the redistributive transfer $t$ affects only the inequality loss. While the transfer $t$ is used by the government to minimize the weighted inequality, the tax $\tau$ is used by the government to maximize the surplus. In what follows, we shall sometimes explicitly denote the dependence of the variables on $a, v, t$ and write $w^A(a)$, $w^B(v,a)$, $S(v,a)$, $L(v,a,t)$ and $W(v,a,t)$.

There is an alternative expression for the objective function that is equivalent in terms of the optimal choice of the government and of the other parties. If the government has Cobb-Douglas preferences over the group utilities, i.e. if the objective function is $\left(w^A - t\right)^{1-\lambda}\left(w^B + t\right)^{\lambda}$, then we are really solving the same optimization problem for the government. Thus, the government in our model is a weighted social welfare maximizer. While the Cobb-Douglas objective function is perhaps easier to interpret, it has the problem that the expression is undefined for negative values of the utilities. Since $w^A$ and $w^B$ are themselves endogenous, there is no easy way of avoiding this problem. We therefore work with the inequality weighted objective function.

## 2.3 Sequence of events

The sequence of events in the basic model is described below:

1. Policy stage: $G$ decides the investment tax/subsidy $\tau$.

2. Investment stage: $I$ decides the size of investment $x$.

3. Signaling stage: $v^B$ is realized but only $B$ can observe $v^B$. $B$ takes an action $a \in [0,1]$ to signal its valuation $v^B$ to $G$.

4. Redistribution stage: $G$ decides a transfer $t \in \mathbb{R}$ from $A$ to $B$.

To identify the impact of signaling, we discuss an alternative sequence of events in Section 4. In particular, we assume $G$ determines the transfer before $v^B$ is realized, and commits not to renegotiate the amount. Therefore, $B$ finds no incentive to signal through costly action after $v^B$ is realized. The scenario effectively has three stages of actions - policy stage, investment stage and redistribution stage. Finally, after the redistribution stage, nature determines $v^B$ and payoffs are realized.

[11] The bias toward one of the groups may result from several factors such as lobbying power, number of swing voters etc. We are particularly interested in analyzing the distortionary effect of this bias on private investment.

# 3 Equilibrium analysis

We proceed to solve the model by considering three different informational regimes. First, in section 3.2, we consider the *full information benchmark* case where the valuation of group B is known to the government. In this case, the government can optimally allocate the surplus created by the investment at no cost, and moreover, there is no distortionary effect on investment. Next, in section 3.3, we proceed to the *costly signaling* regime, in which the group with private information can signal its valuation through action that is costly to the society. Note that in a separating equilibrium signaling fully reveals information. Therefore, $G$ can still redistribute the surplus optimally, but the level of investment gets affected due to costly destructive action. A comparison between full-information and costly-signaling regimes measures the distortionary effect of the signaling channel on investment. We will begin with describing players' strategies and the equilibrium concept for our analysis.[12]

## 3.1 Strategies, belief and equilibrium concept

The strategy of the investor $I$ is the size of investment $x(\tau) \in \mathbb{R}$, given an investment tax $\tau$. The marginal valuation of the project to Group $B$, i.e. $v^B \in \{\underline{v}, \overline{v}\}$ is private information only to $B$. $B$'s strategy is $a(\tau, x, v^B) \in [0,1]$, the level of action taken after observing $\tau$, $x$ and $v^B$. $G$ chooses two different taxes. First, it decides on an investment tax that will be imposed on the investor. Finally, after observing the action taken by $B$, $G$ decides on a redistributive transfer $t$ from $A$ to $B$. Therefore, $G$'s strategy is given by a tuple $(\tau, t)$ such that $\tau \in \mathbb{R}$ is the investment tax and $t(\tau, x, a)$ is the redistributive transfer. Let $\mu(\tau, x, a) \in [0,1]$ denote $G$'s belief that group $B$ has low valuation for the project, i.e. $v^B = \underline{v}$, after observing a feasible choice tuple $(\tau, x, a)$. We will look for the set of *Perfect Bayesian Equilibria* (PBE) that involves a strategy profile and a belief system such that the strategy profile is sequentially rational and beliefs are derived by Bayes' rule when possible. The set of signaling equilibria is large because of broad flexibility permitted by PBE in specifying out-of-equilibrium beliefs. To get more tractability of our results, we restrict our attention only to the separating equilibria satisfying the *Intuitive Criterion* (Cho and Kreps 1987).

## 3.2 Full information

As the benchmark, we consider a situation in which the government can gain information about groups' valuation at no cost. It is important to note that the realized value of $v^B$ will still be unknown at the policy stage and the investment stage, but will only be known at the redistribution stage. The total surplus available to the government for redistribution within groups is then $S(v^B, 0) = (v^A + v^B + \tau)x$, given the investment tax $\tau$ and the size of investment $x$. At the redistribution stage, $G$ chooses $t \in R$ to maximize $W(v^B, 0, t)$, which is equivalent of minimizing $\left[\lambda\left(w^A(0) - t\right) - (1-\lambda)\left(w^B\left(v^B, 0\right) + t\right)\right]^2$. The optimal group transfer is given by

$$t^o = \lambda w^A(0) - (1-\lambda) w^B\left(v^B, 0\right).$$

Essentially, the weighted loss from inequality is set to zero at this transfer (i.e., $L(t^o) = 0$) and the post transfer payoff to $G$ is simply $S(v^B, 0)$. It is easy to check that the payoffs of groups $A$ and $B$ are given by $(1-\lambda) S(v^B, 0)$ and $\lambda S(v^B, 0)$ respectively.

Next, we turn to the investment stage and the policy stage. The government decides the tax on the investor by balancing the following tradeoff: an increase in the tax will depress investment and therefore reduce surplus, but on the other hand, it will lead to a larger transfer from the investor to the government

[12] We find that in this model, no pooling equilibrium survives the intuitive criterion.

given a scale of investment. The tax is therefore determined by balancing the marginal valuation of investment $x$ by the government with that of the investor.

To solve for optimal tax and investment, we use a result which will prove very useful throughout the rest of our analysis. Suppose that at the policy stage, (i.e. before the valuations are made public), the government's payoff and the investor's net profit as a function of the investment $x$ is $Vx + \tau x$ and $Qx - \frac{x^2}{2k} - \tau x$ respectively. We can think of $V$ as the government's marginal valuation of investment at the policy stage. Similarly, we think of $Q$ as the investor's effective marginal return from investment once the cost of the project is sunk. Alternatively, $Q$ can be thought of the imputed price that the investor obtains per unit of produced output. While in the different informational regimes, $V$ and $Q$ will have different values, these can be treated as constants at the policy/investment stage of a given regime as long as they are independent of the investment level $x$.

**Lemma 1** *Suppose the investor's pre-tax profit from investment $x$ is $Qx - \frac{x^2}{2k}$ and the government"s pre-tax payoff is $Vx$. Then, for any given tax rate $\tau$, the optimal level of investment chosen by the investor is $k(Q-\tau)$. In the policy stage, government's optimal choice of tax rate is $\frac{1}{2}(Q-V)$ and the maximized payoff is $\frac{k}{4}(Q+V)^2$. Further the investment is taxed if and only if $V < Q$.*

**Proof.** Given a tax rate $\tau$, the optimal size of investment is given by $x(\tau) = \arg\max_x \left(Qx - \frac{x^2}{2k} - \tau x\right) = k\,(Q-\tau)$. At the policy stage, the government's payoff for any tax rate $\tau$ is $Vx(\tau) + \tau x(\tau)$. Therefore, the government's optimal tax rate is $\tau^* = \arg\max_x \,(V+\tau)\,x(\tau) = \frac{1}{2}(Q-V)$. Simple calculations show that the payoff of the government is $k\,(V+\tau^*)\,(Q-\tau^*) = \frac{k}{4}(Q+V)^2$. The investment is taxed if and only if $\tau^* > 0$, or equivalently, if and only if $V < Q$. ■

Based on this result, two comments are in order. First, notice that the government taxes the investor if the society's marginal valuation of output $V$ is lower than the investor's marginal return $Q$, and subsidizes the investor otherwise. The tax rate is decided *as if* it results from an underlying bargaining scenario. If after completion of the project, $G$ has a relatively higher stake (i.e., when $V > Q$), it takes a soft position in dealing with the investor and offers subsidy. On the other hand, if $I$ has a relatively high stake after completion (i.e., when $V < Q$), the converse effect holds. This line of interpretation turns out to be useful throughout our analysis. Comparing relative stakes of two parties after completion of the project in different scenarios, it is easy to interpret how and why $G$ becomes more or less aggressive in dealing with the investor.

Second, while we have assumed that the government is not directly interested in the investor's profits, the government's payoff increases both in the investor's marginal return of output $Q$ and productivity (inverse of $k$). If the investor has a larger incentive to invest, then the project size will be larger, leading to a larger total surplus for the society. Therefore, a government always benefits if the investor finds it beneficial to invest more.

Lemma 1 helps us determine the optimal tax and the resulting size of investment in the full information case. When the state is known, the government's payoff from investment $x$ is $\left(v^A + v^B + \tau\right)x$. However, the state is not yet revealed at the policy stage. Thus, for purpose of deciding the tax on the investor, the government's payoff is $\left(v^A + Ev^B + \tau\right)x$ where $Ev^B \equiv (1-p)\,\overline{v} + p\underline{v}$. In terms of Lemma 1, when information is costlessly available, we have $V = v^A + Ev^B + \tau$. On the other hand, since there is no destruction, $Q = q$. As a straightforward application of the result, the following Proposition outlines the equilibrium actions and payoffs in absence of the informational problem.

**Proposition 1** *Consider a situation in which groups' marginal valuations are public information. The equilibrium intergroup transfer is set to make the weighted inequality loss to be zero. The equilibrium investment* *is* $x^o = k\,(q - \tau^o)$ *and the equilibrium tax rate is* $\tau^o = \frac{q - v^A - Ev^B}{2}$*. The investment is taxed if and only if* $v^A + Ev^B < q$*. In equilibrium, G receives a payoff of* $W^0 = \frac{k}{4}\left(q + v^A + Ev^B\right)^2$*.*

The proposition suggests that if there is access to information about group valuations, the government can always set the intergroup transfer optimally so that the loss from inequality $L(t)$ is zero. In addition, $G$ will tax ($\tau > 0$) the investor if the society's expected total valuation $v^A + Ev^B$ of investment is less than the investor's marginal return $q$ and subsidize ($\tau < 0$) the investor otherwise. The apparent simplicity of the second result depends on the assumptions of quadratic costs and fixed marginal valuations. These results will serve as the benchmark for the rest of the paper.

## 3.3 Private information and signaling

In this section, we analyze the problem when $B$'s valuation of the project is private information and $B$ can signal by taking a costly public action. We solve the game by backward induction. The following lemma characterizes the unique separating equilibrium satisfying the intuitive criterion of this game under private information.[13]

**Lemma 2** *Suppose* $x > 0$ *and Assumption 1 holds. Then there exists a unique separating equilibrium in the signaling subgame that satisfies the Cho-Kreps intuitive criterion. In this equilibrium, group B takes a costly action only when it realizes a low valuation from the project. The equilibrium level of action is given by* $a^e = \frac{(1-\lambda)(\overline{v} - \underline{v})}{((v^A + \overline{v}) - (1-\lambda)(v^A + \underline{v}))}$*. Further, at the unique separating equilibrium, the equilibrium intergroup transfers in both states are set to make the weighted inequality loss to be zero.*

**Proof.** In appendix A. ■

Based on this result, two comments are in order. First, in any separating equilibrium, the amount of resistance will perfectly reveal the private information. Therefore, similar to the full information case, $G$ can choose an optimal intergroup transfer that set the inequality loss, $L(t)$, to be zero. Second, we find that in any separating equilibrium, group $B$ takes a costly action if and only if it has low valuation. Thus, destructive action is a credible signal for low valuation. The proof to Lemma 2 shows that there is an interval of actions such that any level in that interval can be supported in a separating equilibrium. Among all these separating equilibria, we restrict our attention to the equilibria that satisfy the intuitive criterion. It turns out that the only equilibrium which survives the restriction, as described in Lemma 2, is also the *Pareto efficient* one. From now on, we will treat this equilibrium as our predicted outcome of the signaling subgame. In this equilibrium, the high valuation type is indifferent between taking the action and not doing so.

We can now solve for the optimal size of investment and the equilibrium investment tax rate. For a given investment tax $\tau$, the optimal investment maximizes investor's payoff, which is $(q(1 - pa^e) - \tau)\,x - \frac{x^2}{2k}$. Therefore, once the investment is sunk, the pre-tax marginal return for the investor is $Q = q(1 - pa^e)$, since a proportion $a^e$ of the produced output is lost due to resistance with probability $p$. And, at the policy stage, $G$ decides the optimal investment tax that maximizes its expected payoff, which is given by $\left(v^A + Ev^B - pa^e\left(v^A + \underline{v}\right)\right) x^e(\tau) + \tau x^e(\tau)$. A direct application of Lemma 1 allows us to solve for the equilibrium investment size and the tax rate, which are described in the following proposition.

**Proposition 2** *Assume that group B's valuations of the project is private information and it can signal through costly public action. At the unique separating equilibrium satisfying intuitive criterion, the equilibrium investment is* $x^e = k(q(1 - pa^e) - \tau^e)$ *and the equilibrium tax rate is* $\tau^e = \frac{pa^e\left(v^A + \underline{v} - q\right) - \left(v^A + Ev^B - q\right)}{2}$*. The*

[13] While pooling equilibria exist in the signaling subgame, none of the pooling equilibria satisfies the intuitive criterion. An analysis of the pooling equilibria is available with the authors.

*investment is taxed if and only if* $\left(v^A + Ev^B - q\right) < pa^e\left(v^A + \underline{v} - q\right)$*. In equilibrium, G receives an expected payoff of* $W^e = \frac{k}{4}\left[\left(v^A + Ev^B + q\right) - pa^e\left(v^A + \underline{v} + q\right)\right]^2$.

From the above proposition, we see that $G$ will tax investment ($\tau^e > 0$) if and only if

$$\left(v^A + Ev^B - q\right) < pa^e\left(v^A + \underline{v} - q\right). \tag{5}$$

As before, we can interpret this condition by comparing society's expected marginal valuation with the investor's marginal return of produced output. If $G$ has a relatively high stake after completion (i.e., when $v^A + Ev^B - pa^e\left(v^A + \underline{v}\right) > q(1 - pa^e)$), it takes a soft position in dealing with the investor and offers subsidy. In the converse scenario, $G$ will tax investment. It is easy to see that $G$ offers a subsidy whenever $v^A + \underline{v} > q$. In such a case, the government's stake in both states ($v^B = \underline{v}$ *or* $\overline{v}$) is comparatively high, and therefore it offers subsidy to provide an incentive to the investor to increase size of investment. On the other hand, when $v^A + \underline{v} < q$, $G$ offers subsidy if the probability of bad state $p$ is high or if the extent of destruction $a^e$ is high. It is worth mentioning here that the parameter set in which the government offers subsidy expands compared to the full information scenario. To examine how the possibility of resistance affects the government's investor-friendliness, the next section formally compares the equilibrium tax $\tau^e$ with the full information benchmark $\tau^0$.

#### 3.3.1 Resistance and Investor-friendliness

We say that the government is too investor-friendly, or too soft, if the tax rate in a given regime is lower than the benchmark full-information tax rate for the same parameter values, and say that the government is too aggressive if the tax rate in a given regime is higher than the benchmark. The following proposition examines when resistance makes the government too aggressive or too soft in its negotiations with the investor in the above sense.

**Proposition 3** *Compare the case when valuations are public information with the case when group B's valuation of the project is private information and it can signal through costly public action. The government will be less aggressive (i.e.,* $\tau^e < \tau^o$*) in choosing the tax rate in the second case if and only if* $v^A + \underline{v} < q$*. Moreover, the difference between the tax offers in the two regimes* $|\tau^e - \tau^o|$ *is increasing in* $p$*, the probability of the bad state and in* $a^e$*, the share of output destroyed.*

**Proof.** We can rewrite $\tau^e$ as a function $\tau^o$ as follows: $\tau^e = \tau^o + \frac{1}{2}pa^e\left(v^A + \underline{v} - q\right)$.Therefore, $\tau^e < \tau^o$ if and only if $v^A + \underline{v} < q$. The second part follows trivially. ■

The possibility of destructive signaling introduces a distortion over the full information benchmark, given by the difference between $\tau^e$ and $\tau^o$. Increasing the tax rate has two effects: raising revenue per unit of investment on the one hand and depressing total investment on the other. If $v^A + \underline{v} > q$, the society's marginal loss from resistance is relatively high, and society values output increase that much less. As a consequence, the cost of output loss due to increased tax rate is lower in the margin, and the government raises tax above $\tau^o$. On the other hand, if the society values output relatively less in the bad state, i.e. $v^A + \underline{v} < q$, then the government is softer, i.e. more investor friendly, than it would be under full information. The second part of the proposition says that higher the resistance, the stronger is the distortion.

The import of proposition 3 is that if the society's valuation in the bad state is not very high, resistance forces the government to be too investor friendly. While the common rhetoric suggests that such resistance arises in response to the government being too investor-friendly, the point of the paper is to show that a reverse causality exists. The next section shows that higher resistance may happen due to increased marginalization (decrease in $\lambda$) of the affected group. Thus, the political structure of the society as encapsulated by $\lambda$ may have a significant impact on the deal offered to a foreign investor and consequently, on the scale of investment.

Next, we formally study how the extent of resistance depends on the parameters of the model.

### 3.3.2 Destruction of output

Certain conclusions are obvious from the very set-up. We do not observe resistance to all investment, it occurs only when an affected group considers the valuation of investment to be low, and uses destructive means to demand more compensation. Second, since $a^e$ is independent of the scale of investment, the total destruction $a^e x$ is strictly increasing in the scale of investment. Thus, large projects face large resistance. Also, since high subsidies are associated with large scale projects (yielding high social return), one can see that more destruction of total output will be seen to occur when the volume of subsidies is high, seemingly explaining the high correlation between increased resistance and highly subsidized projects of governments.

The following proposition tells us how the share of output destroyed, $a^e$, depends on the nature of investment project and the political structure of the society.[14]

**Proposition 4** *As $\lambda$, which is G's bias in favor of the affected group increases from 0 to 1, the optimal action $a^e$ by the group decreases monotonically from 1 to 0. Ceteris paribus, $a^e$ is strictly decreasing in $v^A$ and $\underline{v}$, strictly increasing in $\overline{v}$ and is independent of p.*

The first part of proposition 4 shows that the more politically marginalized the affected group is, the more destructive action it undertakes. On the other hand, if $G$ is favorably biased toward the affected group, it expects a high transfer in each state. This creates an incentive not to destroy too much of surplus, since such destruction eventually hurts the total amount of post-transfer wealth. The optimal action $a^e$ decreases in $v^A$ and $\underline{v}$ because an increase in these parameters increases the marginal valuation of output in each state, creating an incentive to destroy less. The intuition for the effect of $\overline{v}$ is a little more subtle. Notice that $a^e$ is determined by equating the gain in transfer from action and the high type's cost of taking action. While an increase in $\overline{v}$ leads to a larger transfer, it also increases the cost of misrepresentation to the high type. In fact, a marginal increase in $\overline{v}$ increases transfer by $(1-\lambda)x$ while it increases cost by $a^e x$. Since $a^e < 1-\lambda$, the extent of action increases with $\overline{v}$.

In order to better assess the economic effect of resistance on welfare, investment and investor-friendliness, we now study an alternative regime - one where resistance does not take place.

## 4 An alternative regime - no signaling

In the previous section, the government uses information about valuations to implement the optimal redistribution scheme, but such information comes at a social cost. Additionally, the possibility of such a cost being imposed on the investor leads to a distortion in the government's deal with the investor. To balance the extent of the benefit of optimal redistribution against these two costs, we need to compare the government's payoff in the previous section with another benchmark - an alternative regime where there is no signaling (and therefore no cost), and the government has to implement a redistribution scheme without the precise knowledge of the group valuations.

[14] The proof follows from the first order differentiation of $a^e$, defined in Lemma 2, with respect to various parameters. The algebra is straightforward, we therefore skip the proof of this proposition.

In this section, we assume that the government commits not to use information about valuations even if it is made available. Such commitment takes away the incentive for signaling activity by social groups. In reality, an announced ban on signaling will have the same effect.

The game is the same as it is in section 3.3, except that we force the value of $a$ to be 0. Equivalently, there is no signaling stage. In the redistribution stage, the government uses the transfer that maximizes the expected welfare. Therefore, the tax offered to the investor is given by

$$\begin{aligned} t^{ns} &= \arg\max_{t\in R} pW(\underline{v},0,t)+(1-p)W(\overline{v},0,t) \\ &= \arg\max_{t\in R} pL(\underline{v},0,t)+(1-p)L(\overline{v},0,t)=\lambda w^A(0)-(1-\lambda)Ew^B(v^B,0) \end{aligned}$$

where $Ew^B(v^B,0)=pw^B(\underline{v},0)+(1-p)w^B(\overline{v},0)$. It is easy to see that $G$ incurs inequality losses in both states, and these losses are given by

$$\begin{aligned} L(\overline{v},0,t^{ns}) &= \left[p(1-\lambda)(\overline{v}-\underline{v})x\right]^2 \\ L(\underline{v},0,t^{ns}) &= \left[(1-p)(1-\lambda)(\overline{v}-\underline{v})x\right]^2 \end{aligned} \tag{6}$$

The following proposition describes the equilibrium outcome under no signaling.

**Proposition 5** *Assume that group B's valuation of the project is private information, but it cannot convey the information to the government. Then in the unique SPNE of the game, G incurs positive inequality loss in both states, given by (6). The size of investment and the investment tax are given by* $x^{ns}=k\left(q-\tau^{ns}\right)$ *and* $\tau^{ns}=\frac{[q-(v^A+Ev^B)]+2qkF}{2+2kF}$ *respectively where* $F=p(1-p)(1-\lambda)^2(\overline{v}-\underline{v})^2$. *In equilibrium, G receives an expected payoff of* $W^{ns}=\frac{k}{4}\frac{(q+v^A+Ev^B)^2}{1+kF}$.

The proof involves simple algebra and is given in the appendix. The following corollary establishes that the government will tax investment if and only if the total expected marginal return to the society is greater than a threshold strictly greater than the marginal return to the investor.

**Corollary 1** *Assume that group B's valuations of the project is private information, but it cannot convey the information to the government. Then, the government will tax the investor if and only if*

$$v^A+Ev^B<q(1+2kF)$$

*where* $F=p(1-p)(1-\lambda)^2(\overline{v}-\underline{v})^2>0$.

In other words, when $v^A+Ev^B\in(q,q[1+2kF])$, the government taxes the investor under no-signaling while it would have subsidized the investor under full information. Moreover, simple algebra shows us that $\tau^{ns}>\tau^o$. Both under the benchmark case and no-signaling case, there is no output loss due to resistance, but in the latter case, the surplus is suboptimally distributed across groups. Thus, the marginal value of increased output is lower in the latter case than the benchmark. Therefore, the government is unambiguously more aggressive with the investor than the benchmark case when signaling is banned.

The next section formally compares the equilibrium values of the different variables under the two regimes.

## 4.1 Comparison across regimes

There are two distinct motivations for studying the comparison between the two regimes. First, as mentioned before, it allows us to assess the economic effect of resistance as a costly information channel. Second, the government's welfare ranking over the two regimes tells us the circumstances under which a government is better off committing to strictly enforce a ban on protest activities. However, the commitment power of a government is often determined institutionally. In particular, such a ban on protest activities may be a feature of autocratic regimes, and democratic governments may find it hard to employ such coercive measures even if they are potentially welfare improving. Thus, a comparison between the two regimes can also be read as a comparison between two different political institutions: Autocracy and democracy.

#### 4.1.1 Welfare

First, we compare the government's payoff under signaling with that under no-signaling to see when destructive resistance as a signaling channel is overall beneficial to the society.

**Proposition 6** *Fix* $\{v^A, \underline{v}, \overline{v}, q\}$ *and let* $p$ *and* $\lambda$ *vary as parameters. Now compare the government's welfare in the no-signaling regime with that in the regime where the government allows signaling. For any* $\lambda$*, there is a unique cut-off* $p(\lambda) < 1$ *such that the government strictly prefers the no-signaling regime if* $p > p(\lambda)$*, strictly prefers the signaling regime if* $p < p(\lambda)$*, and is indifferent between the two regimes if* $p = p(\lambda)$*. There exists some (possibly empty) interval* $[\underline{\lambda}, \overline{\lambda}]$ *such that whenever* $\lambda \notin [\underline{\lambda}, \overline{\lambda}]$*, we have* $p(\lambda) = 0$*, i.e. no-signaling is preferred for all* $p \in (0, 1)$*. We always have* $\overline{\lambda} < 1$*, i.e.* $p(\lambda) = 0$ *for large enough* $\lambda$*. On the other hand, given* $\{v^A, \overline{v}\}$*, if* $\underline{v}$ *is sufficiently small, then* $\underline{\lambda} = 0$*.*

**Proof.** In appendix A. ■

The above proposition broadly suggests that the signaling regime is better than the no-signaling regime if the bad outcome is rare.[15] Further, when the bad outcome is severe, signaling regime is better when the affected group is highly marginalized. Figures 1 and 2 give pictorial representation of the proposition for (relatively) low and high values of $\underline{v}$ respectively. The shaded area represents the combination of $\lambda$ and $p$ for which no signaling equilibrium gives higher payoff. We explain the partial intuition for these results in the next two paragraphs.

To see how the government's welfare in the two regimes depends on the probability $p$ of the bad state happening, fix $\lambda$ and the valuation parameters. When $p = 0$, the informational problem does not exist, and both regimes lead to the same payoff. In the no-signaling regime, the loss due to suboptimal redistribution is the highest when the uncertainty is high, i.e. when $p$ is neither too high, nor too low. On the other hand, the government's expected payoff in the signaling equilibrium decreases monotonically with $p$ since the likelihood of destruction increases. Therefore, whenever the probability of the bad state (and hence destruction) is high enough, the ability to prevent such destruction by committing to a suboptimal redistribution scheme makes the government better off.

How does the government's preference over groups, $\lambda$, affect its welfare in each regime? Here our assumption that there is no uncertainty over group $A$'s valuation makes a difference. Under signaling, the *difference* between the transfers to the affected group in the two states is $(1 - \lambda)(\overline{v} - \underline{v})x$, which is decreasing in $\lambda$. In this sense, the information obtained through signaling is more valuable when $\lambda$ is low. In this situation, the real trade off between the two regimes kicks in – the government prefers signaling when the cost of information in terms of expected destruction is low and no-signaling when the said cost is high. According to proposition 4, the destruction $a^e$ is high when the affected group is more marginalized. Therefore, the

[15] Our result contrasts with the result obtained in Spencian educational signaling where banning signaling would work better when the probability of low type is low enough. The broad reason is simply that in our model, it is the low type that signals its valuation whereas in the Spencian model, it is the high type that benefits from signaling. We thank a referee for pointing this out to us.

government is better off in the signaling regime for low enough $p$ when $\lambda$ is in a moderate interval, and destruction is not very high. When $\lambda$ is sufficiently low, the *share* of output destroyed is very high, and the no-signaling equilibrium is better if the total surplus is high enough, as the amount of output lost due to destructive resistance is significant.

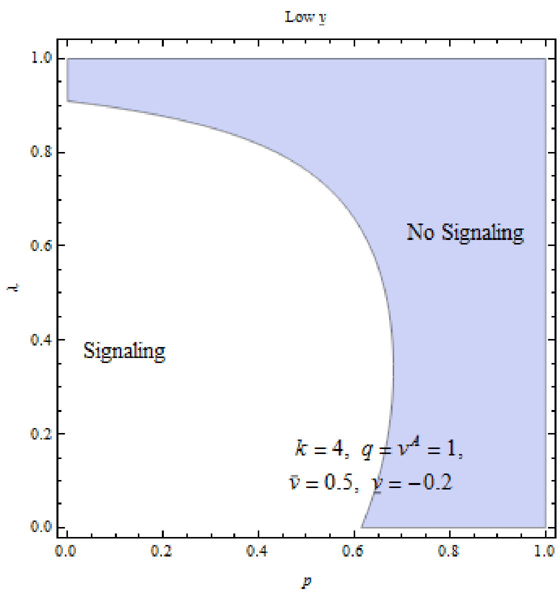


Figure 1

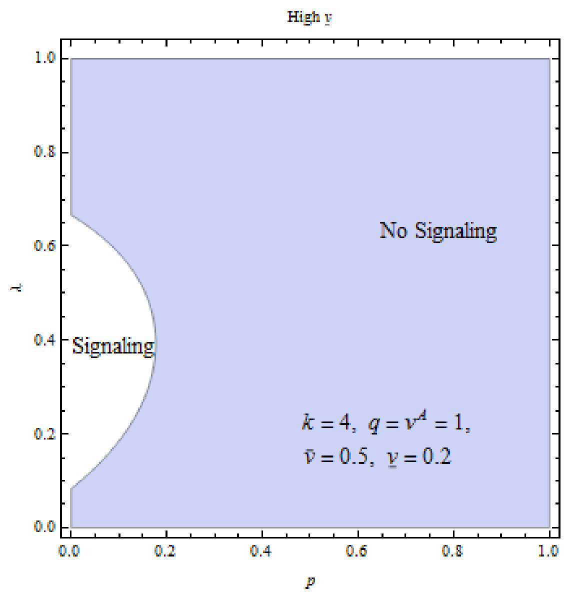


Figure 2

Where do these findings stand in terms of comparison between autocracy and democracy? Before interpreting our results, we must note that the two institutions can differ on several important dimensions. First, as mentioned before, employing coercive measures to mitigate resistance can be difficult within the institutional capacity of a democratic system. Second, enforcing a ban on resistance demands a commitment to limit the use of information, and such commitment may be easily available in an autocracy. Besides, the centralized political process in autocracies often implies that the affected groups tend to be more marginalized compared to democracies where they have a stonger voice. The model therefore predicts that while autocratic institutions find it easier to ban resistance, they can possibly be better off by allowing signaling since the information obtained through signaling is more valuable for redistributive purposes with low $\lambda$. On the contrary, in democracies, a large likelihood of destruction can introduce large distortion and reduces the welfare under signaling regime. In both the institutions, the effective use of information is typically more valuable when the marginalization of the affected group makes the problem of redistribution more acute.

### 4.1.2 Taxes and investment

Next, we compare the tax rate in the no-signaling regime with that under signaling. We know that $\tau^{ns} > \tau^{o}$. Also, from proposition 3, we have that $\tau^{e} < \tau^{o}$ whenever $v^A + \underline{v} < q$. Therefore, if $v^A + \underline{v} < q$, the government is less aggressive in the signaling regime. When $v^A + \underline{v} > q$, i.e. when the investment has (ex ante) relatively high social externality even in the bad state, and therefore output destruction is costlier to the government, the comparison between $\tau^{ns}$ and $\tau^{e}$ remains ambiguous: In the signaling case, increase in output is devalued by destructive resistance, and in the no-signaling case, value of increased output is reduced by suboptimal redistribution. If the former effect is larger (smaller) than the latter, the government is more (less) aggressive under the signaling regime than under the no-signaling regime.

In a similar vein, the comparison between the extent of investment in the two regimes also gives ambiguous results. We have

$$x^e - x^{ns} = k\left[\tau^{ns} - \tau^e - qpa^e\right]$$

Thus, if the government is softer (or not much more aggressive) under no-signaling than under signaling, the possibility of destruction leads to a higher investment in the former regime. Indeed, one can show that $x^e < x^{ns}$ for a large range of parameter values (with large $p$, $q$ and $a^e$) even when the government can deal with the investor aggressively.

In an imperfect sense, comparison between these two regimes reflects the differences in the development experiences faced by China and India. In particular, our results in section 4.1.1 suggest that the practice of strictures on protests may be actually welfare-reducing in China. On the other hand, the discussion in the previous paragraph suggests an explanation why the centralized regime in China is more successful in attracting private investment than a democratic regime like India, without adversely affecting the Chinese government's negotiation power with the investors.

# 5 Policy Instruments

In this section, we study two different policy options available to the government that have potential to improve social surplus beyond the level obtained in the signaling equilibrium studied in section 3.3. These are (i) financial insurance for the investor, and (ii) a minimum guaranteed compensation for the affected group. The first instrument mitigates the affected group's incentive to destroy surplus and also reduces the investor's disincentive arising from destruction. The second instrument allows the government to obtain information about valuations at a low public cost, and optimally trades off the gains arising from reduced destruction with suboptimal redistribution. Notice however that while there are several policy options available to the government that are potentially welfare improving, each such policy instrument requires a certain degree of pre-commitment; and therefore, the social welfare depends crucially on the commitment power of the government.

## 5.1 Investment with financial insurance

In the no-signaling regime, the government legally protects the investor from resistance, and is forced to redistribute suboptimally. In this section, we consider the provision of financial protection (instead of legal) to the investor. Suppose that the government provides an insurance to the investor ensuring full compensation of the amount it lost due to resistance.[16] Such an insurance increases welfare in two ways: First, it removes the disincentive for the investor and second, by making destruction more costly to the society, it reduces the extent of destruction. However, destruction has the same informational content as before and the government can still implement the optimal redistribution policy. Moreover, since there is no distortion of the investor's incentives due to destruction, the government is never forced to be too soft in negotiation with the investor. In fact, the government is always too aggressive compared to the full information benchmark since the possibility of destruction reduces the marginal value of output.

Formally, the game is the same as in section 3.3 except that in case $B$ takes an action $a$ that destroys investor's revenue by $qax$, $G$ compensates $I$ by the same amount. That amount is raised from the society and group $J$ bears a share $r^J$ of the amount with $r^A + r^B = 1$. We call this game as *the game with full*

[16] However, such compensation in reality may not always be feasible in practical terms. First, there may be accounting problems in estimating damages, and related issues of moral hazard or adverse selection. Second, making such compensation may be politically difficult. This is the sense in which the instrument calls for commitment.

*insurance*. Therefore, each group's pre-transfer payoff is $w^J(v,a) = v^J x(1-a) + s^J \tau x - r^J qax, \ J = A, B$ where $s^A = 1-s$, $s^B = s$, and the aggregate social surplus is

$$S(v,a) = (v^A + v)x(1-a) + \tau x - qax \tag{7}$$

The government, as usual, maximizes $S(v,a) - L(v,a,t)$.

We again use the Intuitive criterion to refine the equilibria. However, unlike in Lemma 2, we cannot identify uniquely the level of action satisfying the Cho-Kreps criterion in the signaling game. Nevertheless, the following proposition tells us that in any such equilibrium of the game with full insurance for the investor, the level of action $a^*$ will be strictly less than $a^e$, the action in the signaling game without insurance.

**Proposition 7** *Consider the game with full insurance. Assume that $x > 0$ and Assumption 1 holds. In any separating equilibrium of the game with full compensation that satisfies the Cho-Kreps intuitive criterion, the action $a^*$ of the low valuation type is strictly lower than $a^e$, the corresponding action in the game with no compensation.*

**Proof.** In appendix A ■

In what follows, we make statements that are true about any separating equilibrium satisfying the intuitive criterion. Given the solution to the signaling subgame, we can derive the optimal investment and tax policy by maximizing the investor's and the government's expected payoff, which are respectively given by $(q-\tau)\,x - \frac{x^2}{2k}$ and $v^A + Ev^B - pa^*(v^A + \underline{v} + q)$. Applications of Lemma 7 and Lemma 1 now characterize the equilibrium outcome. It is easy to see now that in the game with full insurance, the equilibrium investment $x^*$, tax $\tau^*$ and welfare $W^*$ will be given by the same expressions as in proposition 2, only with $a^e$ replaced by a lower level of destruction $a^*$.

Next, we turn to the welfare comparison under the three regimes: Signaling without insurance, signaling with financial insurance to the investor and no-signaling. It makes a clear policy implication: Some form of protection for the investor (either legal or financial) is not only better for the investor, it is better for the society too, since it helps increase surplus.

**Proposition 8** *Suppose that the payoff of the government under the unique equilibrium satisfying the intuitive criterion in the signaling regime without compensation is $W^e$, the payoff in* some *equilibrium satisfying the intuitive criterion in the signaling regime with full compensation is $W^*$ and the payoff of the government in the no-signaling regime is $W^{ns}$. Then the government always prefers signaling with compensation to signaling without compensation, i.e. $W^* > W^e$ for all parameter values. Moreover, for any $\lambda$ there is a unique cut-off $p^*(\lambda) < 1$ such that the $W^* < W^{ns}$ if $p > p^*(\lambda)$, $W^* > W^{ns}$ if $p < p^*(\lambda)$, and $W^* = W^{ns}$ if $p = p^*(\lambda)$. In other words, the government prefers signaling with compensation to no-signaling if and only if the probability of destruction is small enough.*

The proof of this proposition is exactly similar to that of proposition 6. Comparing expressions, it is easy to see that since $a^* < a^e$, the welfare of the government is *always higher with insurance than without.* Insurance not only corrects the distortion of the investor's incentives, it also ensures that the government obtains information at a lower social cost. Therefore, there is an unambiguous increase of welfare, i.e. $W^* > W^e$.

How does $W^*$ compare to $W^{ns}$? In other words, given a choice, would the government prefer to ban destruction and legally protect the investor or provide an insurance to financially protect the investor? Since $W^*$ and $W^e$ have exactly the same expressions except for different values of destruction, it turns out that we have a result that is very similar to proposition 6. In particular, there is a cut-off $p^*(\lambda)$ such that no-signaling is better than signaling with compensation if and only if $p \geq p^*(\lambda)$.[17] Moreover, whenever signaling is better than the no-signaling regime, the government should prefer signaling with financial insurance to both. Therefore, we can conclude that the government should always consider some form of protection for the investor: financial protection if the probability of severe outcome is low enough and legal protection if the said probability is high.

## 5.2 Compensation floor for the affected group

If the government could commit to paying a minimum compensation to the affected group irrespective of whether the valuation turned out to be high or low, then there can be a welfare improvement over the signaling equilibrium. To see why, consider the no signaling equilibrium. By having the same level of inter-group transfer in both states, the government takes away the incentive to undertake any costly signaling activity. However, an adverse effect of such a policy is that the government incurs the inequality loss in both states. In comparison, a compensation floor trades off the negative effect of resistance with the inequality loss by reducing the difference between transfer in the two states.[18] We are interested to find the optimal compensation floor and the associated redistributive policy in this set up.

The precise mechanism by which a compensation floor yields a welfare improvement is as follows. Suppose that in the signaling equilibrium, the transfers to group $B$ are $t(\underline{v}, a^e)$ and $t(\overline{v}, 0)$ in the low and high state respectively, and assume that $0 < t(\overline{v}, 0) < t(\underline{v}, a^e)$. Notice that these transfers implement the optimal redistribution in each state. Suppose now that the compensation floor $T$ is set at $t(\overline{v}, 0) < T < t(\underline{v}, a^e)$. If the state is revealed to be bad, the government can still implement the optimal transfer. But if the state is revealed to be good, the government has to pay the minimum committed amount $T$. The difference in transfer between the two states is reduced by an amount $T - t(\overline{v}, 0)$. This makes lying less attractive for the high valuation type and reduces the level of destruction of surplus required for credible information revelation. Therefore, the information about valuation is available at a lower loss of surplus and consequently, a lower distortion of the investor's incentives. However, the gain is traded off against the suboptimal redistribution in the high state.

Formally speaking, suppose that at the start of the game, the government announces a minimum transfer $T$ to group $B$ as a function of $x$, $a$ and $\tau$. In order to keep things both tractable and to give economic meaning to the set-up, we need to assume that $(a)$ $\overline{v} > 0$, $(b)$ $\lambda > \frac{\underline{v}}{\underline{v}+v^A}$ and $(c)$ $s = \lambda$. Assumption $(a)$ ensures that in any separating equilibrium, the transfer in the bad state is higher than that in the low state, and therefore, any amount beyond the floor is paid only when the valuation is low. Assumption $(b)$ implies that the transfer in each state is positive, i.e., group $B$ is always a net recipient. Assumption $(c)$ is needed to ensure that tax share considerations do not enter into the calculation of the optimal action. Given these assumptions, we look for the optimal floor $T^*(x, a, \tau)$ that maximizes the government's equilibrium welfare.

First, notice that since we can always obtain the equilibrium outcome without the floor (i.e. the outcome in proposition 2 ) by setting $T$ low enough. Therefore, the optimal $T^*$ always obtains a weak welfare improvement over the case where the government cannot commit to a particular redistribution scheme. The following proposition now tells us that the optimal floor has a particularly simple form. If the investment opportunity is sufficiently attractive for the investor, the optimal floor promises to group $B$ a constant amount $C^*$ in addition to the optimal transfer in the good state.

[17] The proof is exactly same as that of claim 1 in proposition 6, since the said proof does not depend on the value of $a^*$.

[18] We are thankful to one of the referees for pointing this intuition to us.

**Proposition 9** *Assume that $q$ is sufficiently large, and assumptions (a), (b) and (c) are satisfied in addition to assumption 1. Suppose the government commits to a minimum transfer $T(x, a, \tau)$ to group $B$ at the beginning of the game. Among all such transfers, the government's welfare in the equilibrium satisfying Cho-Kreps criterion is maximized by setting $T^* = \lambda S(\overline{v}, 0) + C^*$, where $C^* = \frac{p}{2(1-p)}\left[\frac{v^A+\underline{v}}{(v^A+\overline{v})-(1-\lambda)(v^A+\underline{v})}\right]$. In equilibrium, group $B$ takes a costly action $a^f$ only when it realizes a low valuation from the project, and the extent of such action is less than that without the compensation floor, i.e. $a^f < a^e$. The government implements an efficient redistribution scheme when the valuation is low and pays group $B$ the floor amount when the valuation is high.*

**Proof.** In appendix A. ■

In absence of a compensation floor, the difference between the optimal redistributive transfers in the two states, i.e. $(1-\lambda)(\overline{v}-\underline{v})x$. By committing to overpay group $B$ by an amount $C^*$ in the high valuation state, the government reduces the difference to $(1-\lambda)(\overline{v}-\underline{v})x - C^*$ in the signaling game: this reduces the extent of surplus destruction required by the low valuation type to credibly transmit information. Notice that the extent of "overpayment" $C^*$ in the high state must be strictly less than $(1-\lambda)(\overline{v}-\underline{v})x$. Otherwise, the government has to pay $T^*$ in both states and we will have no information revealed in equilibrium. This is the reason why we require that $q$ be large enough: a large $q$ ensures that $x$ is sufficiently large without affecting $C^*$. We would obtain the same result if we assumed that $\overline{v}-\underline{v}$ is sufficiently large.

## 5.3 Redistribution with compensation floor and ceiling

While a prudently chosen compensation floor can deliver a higher welfare than the separating equilibrium without such a floor, it is not necessarily better than the welfare in the equilibrium with no-signaling studied in section 4. In case of a compensation floor, the government commits only to overpay above the optimal transfer. In order to induce a pooling outcome with a compensation floor, the government has to overpay in both states (and set $T > t(\underline{v}, 0)$). However, we have seen in section 4 that the optimal transfer scheme $t^{ns}$ among those that induce the pooling outcome requires an overpayment in the high state and an underpayment in the low state. Therefore, the government can do better than using a compensation floor if it can commit to limit its ability to optimally redistribute in both states (rather than just in the high state, as is the case with the compensation floor). A redistribution policy with a commitment to a minimum transfer $\underline{T}$ and a maximum transfer $\overline{T}$ to the affected group works exactly the same way.

By setting $\underline{T} = \overline{T} = t^{ns}$, the government can induce the best pooling outcome as obtained in section 4. By setting $\underline{T} = T^*$ and $\overline{T}$ very high, the outcome with the best compensation floor can be induced. Therefore, if the pair $(\underline{T}, \overline{T})$ is chosen optimally, it is possible to (weakly) improve over the welfare obtained either with no commitment or a commitment to not use any information. Here we do not describe the full characterization of the optimal redistribution policy with floor and ceiling, as it is beyond the scope of the paper. However, it is easy to show that the affected group will be undercompensated in the low valuation state and overcompensated in the high valuation state. Moreover, action will be taken only in the low valuation state and the extent of action will be lower than $a^e$.

Therefore, a policy of committing to a ceiling and a floor to compensation will do better than either banning resistance or having just a compensation floor (or just a ceiling). In this context, several comments are in order. First, as is clear from the above discussion, the extent of welfare improvement over the equilibrium depends on the commitment power of a government. Such commitment power may often depend on the social, political and historical environment. In other words, not all such policy instruments may be available to a certain government. Second, it must be noted that even with an optimally chosen ceiling and a floor, the welfare is lower than in the full information benchmark studied in section 3.2. In other words, the cost of obtaining information through resistance (and consequent distortion of investor's incentives) does not go away. Third, there are other ways for the government increase social surplus. For example, if the government can extract surplus from the investor using a two-part tariff, then the social welfare can be higher. We touch upon this in the next section.

# 6 Extensions

In this section, we study two extensions of our basic model. First, we study a modification of assumption 1 (that ensures that a project is always beneficial ex-post) and study the case where at the low valuation state, the project has negative social valuation. Second, we consider how our results would change if the government could extract surplus from the investor using a two-part tariff rather than being restricted to proportional taxes.

## 6.1 The selection problem

So far, we have assumed that $v^A + v^B > 0$ in both states, and therefore the government's problem is one of optimal redistribution of the surplus created by the investor. In this section, we modify assumption 1, and consider a different problem: that of project selection. We call the problem one of project selection if $v^A + \overline{v} > 0$ while $v^A + \underline{v} < 0$. In other words, in the low state, the society's marginal valuation of surplus is negative. The following result then suggests that in the unique Cho-Kreps equilibrium of the signaling game, all the surplus is destroyed by the affected group in the low state.

**Proposition 10** *Suppose $x > 0$ and consider the selection problem. Then there exists a unique separating equilibrium in the signaling subgame that satisfies the Cho-Kreps intuitive criterion. In this equilibrium, groups B takes a costly action only when it realizes a low valuation from the project. The equilibrium level of action is given by $a^e = 1$.*

**Proof.** In appendix A. ■

In the context of our model, the fact that all surplus is destroyed should be taken to mean that the project is called off because of public resistance. The above proposition suggests that if a project creates negative value for the society, it is forced out by the affected group and if it creates positive value, there is no resistance. This observation allows us to square with the observed reality that sometimes the public resistance is so extreme that the investor has to make a complete retreat. As discussed before, this has been the case with the Dabhol Power Project by Enron in the state of Maharashtra in India, the Tata Nano project at Singur in the state of West Bengal in India and several other cases of failed privatization attempts with public utilities in Latin America, of which the Cochabamba water wars in Bolivia have often received special mention in the literature.

Such an outcome can be inefficient from the point of view of surplus creation. The society fails to take advantage of the fact that if the investor finds the investment attractive enough, then a large tax revenue may compensate for the negative marginal valuation in the low state (i.e., even if $v^A + \underline{v} < 0$, we may have $q + v^A + \underline{v} > 0$).

To understand why there is complete destruction of surplus in a bad state whenever $v^A + \underline{v} < 0$, we need to consider carefully the timing of the game. In the benchmark model, the tax rate $\tau$ is contracted upon and the project size $x$ is determined before the valuations are realized. Therefore, at the signaling stage, the total tax revenue $\tau x$ is already taken as given. This tax revenue is shared in the ratio $\lambda : 1 - \lambda$ between the two groups irrespective of the level of action and of the realized valuation of the affected group.

In any separating equilibrium, the utility for the affected group in the low valuation state in a separating equilibrium is $w^B(a|\underline{v}) = \lambda(v^A + \underline{v})x(1-a) + \lambda\tau x$.

The Cho-Kreps criterion selects the "best" separating equilibrium in the signaling subgame from the point of view of the affected group. When the social marginal valuation of the investor's output is positive ($v^A + \underline{v} > 0$), $w^B(a|\underline{v})$ decreases in the action $a$, the Cho-Kreps criterion selects the equilibrium with minimal level of action necessary for separation. On the other hand, in the project selection problem, $w^B(a|\underline{v})$ is increasing in $a$ since action destroys negative surplus, and thus, the Cho-Kreps outcome in any signaling subgame is $a = 1$. In such situations, banning of resistance or financial insurance for the investor have the potential to improve welfare by generating tax revenues.

## 6.2 Two part tariff

While we consider proportional taxation in the main body of the paper, it is probably more natural to assume that the government can indeed charge the investor a license fee for doing business in addition to the tax per unit of investment (or output). Therefore, consider the following tax structure: $\tau_0 + \tau_1 x$, where $\tau_0$ is the "entry free" and $\tau_1$ is the per unit tax. These are both objects of choice by the government. As standard theory suggests, the two part tariff is optimally set in order to capture all of the investor's profits. As a result, we will always have $\tau_1 < 0$ and $\tau_0 > 0$. Moreover, the government will set a per unit subsidy ($-\tau_1$) exactly equal to its expected marginal valuation. While it is difficult to define investor-friendliness in the standard way here, in order to compare with the results in the main body of the paper, we say that the government taxes the investor if the total transfer to the society $\tau_0 + \tau_1 x > 0$; and subsidizes if $\tau_0 + \tau_1 x < 0$. While the final payoff of the investor is always zero, the interpretation of an overall tax or overall subsidy is the following: suppose $x^0$ is the cut-off level of investment above (below) which the investor would have made a negative (positive) profit in absence of any taxes. Then, an overall tax in a two-part tariff would mean that the investor is producing less than $x^0$ and an overall subsidy would mean that the investor produces greater than $x^0$. If the marginal valuation of the society for surplus is high enough, the government subsidizes the investor enough to produce at a scale that would amount to a loss for the investor. Since the investor is (exactly) compensated for this loss, it indeed produces an amount greater than $x^0$.

In appendix B, we solve the model with two-part tariff for the three cases: (i) full information benchmark, (ii) signaling equilibrium with private information, and (iii) no-signaling equilibrium and compare. It is no surprise that since the government can now capture the investor's entire surplus, its payoff increases in every case. On the other hand, all the existing comparison results of the model with proportional taxes go through in the qualitative sense once we adopt the abovementioned definition of overall tax/subsidy. In particular, the respective conditions for taxation vs. subsidization remains completely unchanged for the full-information case and the signaling equilibrium.

Unlike proportional taxation, the two part tariff allows the government to use two different instruments to meet the two objectives of rent extraction and providing incentives to the investor. In this sense, the case of two part tariff shares certain similarities with the case of financial insurance in which insurance acts as a mean of incentive provision. However, the comparison between the two cases is ambiguous. Financial insurance improves the payoff over signaling equilibrium by reducing the amount of resistance. Two part tariff, on the other hand, ensures efficient investment, but for a high level of resistance. The welfare comparison between the two cases depends on the relative levels of resistance needed for information revelation.

# 7 Discussion

## 7.1 Implications of the model

We posit that destructive protest may have informational value for the government especially in a less developed society where the bottom-up channels of information may not work very well. Interpreting resistance as demands for redistribution, we find that marginalized sections of the society respond more aggressively with resistance. Such a result is consistent with the observation that more aggressive forms of anti-privatization movements in India occurred in the districts with higher proportion of indigenous tribes. An important implication of this finding therefore is that the affected communities should be involved more in the policy making process to use the investment opportunities efficiently. An interesting example is the public-private partnership practised in the planning and construction of the Cochin International Airport in Indian state of Kerala. More than 1300 acres of land were acquired from 2300 landowners and led to displacement of a significant number of households (Raghuram and Varkkey 2001). While public resistance had been observed regularly at the early stages of development, the local government set up negotiation committees with active participation from local communities and political representatives. The government was successful in coming up with a sustainable compensation and rehabilitation plan for the displaced households, and also managed to implement the work process without further resistance.

From the policy angle, another important question is how the government should respond to public dissent when the informational problem is acute. The model predicts that it is indeed strategically optimal from welfare consideration to allow resistance when resistance is ex ante less likely or the value of information is highly important from the redistribution concern (this happens if the affected group is moderately marginalized). However, the government does not face a binary choice between banning protest or allowing it - by committing to certain measures, it can contain the scale of destruction and still elicit the necessary information. We provide a detailed analysis of some such policy instruments. We show that a two-part tariff (i.e., a license fee-cum-tax) ensures optimal investment for any given level of resistance, and some combination of a judiciously chosen minimum and maximum transfer for the affected group is the best policy for redistributing a given amount of surplus.

Specifically, a policy of committing to a sufficiently high minimum transfer to the affected group has important implications in the context of current land acquisition debate in India. The existing land acquisition policy in India had been heavily criticized on the ground of insufficient compensation and resettlement prospects for the displaced population (Ghatak and Ghosh 2011). The recent recommendation in the form of Land Acquisition and Rehabilitation and Resettlement bill (LARR 2011), on the contrary, suggests over-compensating the affected group. While the new bill has been criticized on various aspects including arbitrary determination of compensation and distorted incentives for investing in land quality, we predict a different positive impact of over-compensation which is not discussed so far in the existing literature.[19] Specifically, over-compensation through inter-group transfer can mitigate resistance incentives, and thereby creates an indirect positive effect on government's ability to deal with the investor. In addition, we calculate a formula for the optimal compensation floor which can guide the determination of compensation for the affected groups.

Moreover, in order to develop a theory of the government's investor friendliness, we model the government as a weighted social welfare maximizer and not as a rent-seeker. The informational constraint on the government introduces a distortion to the full-information benchmark. The possibility of destruction mutes

[19] As an alternative proposal for "just compensation", Ghatak and Ghosh 2011 propose a land auction where landholders can choose to be paid in land or cash. Such an auction can implement the efficient allocation. Efficiency arises costlessly in their model since there are multiple affected parties who are at least partially substitutable. In our model, there is a single affected party. See Ghatak and Mookherjee 2011 and Roy Chowdhury 2010 for other critiques of LARR 2011.

the investor's incentives, and forces the government to be softer in its negotiations provided that the bad outcome is sufficiently severe. The message of this result is that inefficiencies in decision-making can arise simply from informational constraints on a government rather than from rent-seeking motivation. Therefore, softness in the government's dealing with external investors in less developed economies should not necessarily be taken as evidence of bureaucratic dishonesty or corruption. In fact, we point out that the inefficiency may actually go in the other direction: if the government finds it preferable to ban resistance, then suboptimal redistribution reduces the marginal value of surplus and makes the government too aggressive compared to the full information benchmark.

### 7.2 Future research

There are other interesting questions that are closely linked with the issue of resistance to private investment. For example, we assume that resistance has a public cost and creates externality to the whole society. Theoretically, affected individuals can potentially signal the private information with actions that involves private cost.[20] It would be interesting to have a systematic analysis on when and why the groups may find it optimal to signal through activities with high public cost.

We have considered that a government can redistribute the surplus freely. This is probably an extreme assumption, as redistributing surplus comes not in terms of lumpsum payments but setting up changes in the structure of the local economy which may involve deadweight losses. The actual effects will depend on how such losses are distributed across groups, and it would be valuable to study such effects in detail.

We recognize that in dealing with an investor, governments may face severe external constraints in the form of competing governments. There is a large literature on tax competition in Public Finance that shows that local governments might end up with a race to the bottom in trying to attract a monopoly investor (see Rauscher 1995 and Haufler and Wooton 1999 for two related instances). It is easy to show in our model that when two governments compete for a single investor, they will engage in a subsidy war where both lose, and all the gains accrue to the investor. Such a war may lead to economic inefficiencies as the investor might find it profitable to locate in a less action-prone destination (high $\lambda$) rather than a more productive destination (low $k$). This observation also indicates that the political structure of a society (e.g. extent of marginalization of relevant groups) matter for determining the investment destination. It is a challenge for governments in less developed economies to solve this problem by coordinating with each other. A possible solution would be for the more productive region to get the investment and arrange some side payments with the other society. We look into such alternative solutions in our further research.

# References

Admati A. and M. Perry. 1987. "Strategic Delay in Bargaining" *Review of Economic Studies*, 54: 345-363.

Amnesty International. 1997. "'The "Enron Project' in Maharasthra—Protests Suppressed in the Name of Development." London: AI. available at http://web.amnesty.org/library/pdf/ASA200311997ENGLISH/$File/ASA2003197.pdf

Austen-Smith, D. 1993. "Information and Influence: Lobbying for Agendas and Votes". *American Journal of Political Science.* 37(3): 799-833.

Austen-Smith, D. 1994. "Strategic Transmission of Costly Information". *Econometrica.* 62(4): 955-963

[20] Uba (2008) mentions events of hunger strikes – an activity with private cost – as a device to gain public and politicians' attention in the context of anti-privatization mobilization in India. However, the data on such events has been limited.

Austen-Smith, D. 1995. “Campaign Contributions and Access”. *American Political Science Review*. 89(3): 566-582

Austen-Smith, D and J. R. Wright. 1992 “Competitive Lobbying for a Legislator’s Vote”, *Social Choice and Welfare,* 9: 229-25

Bardhan, P. 1996. “Efficiency, Equity and Poverty Alleviation: Policy Issues in Less Developed Countries.” *Economic Journal*. 106(September): 1344-1356.

Bardhan, P. 2006a. “Globalization Hits Road Bumps in India.” *Yale Global Online*, October 2006.

Bardhan, P. 2006b. “Does globalization help or hurt the world’s poor?” *Scientific American*. 294: 84-91.

Bardhan, P. and D. Mookherjee. 2006. “Decentralisation and Accountability in Infrastructure Delivery in Developing Countries.” *Economic Journal*, 116 (January): 101–127.

Bartolomé, L. J., C. de Wet, H. Mander and V. Nagraj. 2000. *Displacement, resettlement, rehabilitation, reparation, and development*. Cape Town, South Africa: World Commission on Dams.

Beinen, Henry , and Waterbury, John. (1989). The political economy of privatization in developing countries. *World Development*. 17(May): 617-632.

Bortolotti, B. and Siniscalco, D. 2004. *The Challenges of Privatization. An International Analysis.* Oxford: Oxford University Press.

Cao, G., C. Feng and R. Tao. 2008. “Local ‘land finance’ in China’s urban expansion: Challenges and solutions.” *China & World Economy*, 16(2), 19-30.

Cavaliere, A. and S. Scabrosetti. 2008. “Privatization and efficiency: From principals and agents to political economy.” *Journal of Economic Surveys*. 22: 685-710.

Cho, I-K. & D. M. Kreps. 1987. “Signaling games and stable equilibria.” *Quarterly Journal of Economics.* 102: 179-221.

Cramton, P. 1992. “Strategic Delay in Bargaining with Two-Sided Uncertainty,” *Review of Economic Studies*, 59: 205-25.

Cramton, P. and J. Tracy. 1992. “Strikes and Holdouts in Wage Bargaining:Theory and Data.” *American Economic Review*. 82: 100-121.

Esteban, J. and D. Ray. 2006 “Inequality, Lobbying and Resource Allocation” *American Economic Review.* 96: 257-279.

Estrin, S., J. Hanousek, E. Kocenda, and J. Svejnar. 2007. “Effects of Privatization and Ownership in Transition Economies.” *Journal of Economic Literature*. 47(3): 699–728.

Fudenberg, D., D. Levine and J. Tirole. 1985. “Infinite Horizon Models with One-Sided Incomplete Information” in Alvin Roth (ed.), Game Theoretic Models of Bargaining, Cambridge University Press.

Galal, A., L. Jones, P. Tandon and I. Vogelsang. 1994. *Welfare Consequences of Selling Public Enterprises*. Oxford: Oxford University Press.

Ghatak, M. and P. Ghosh. 2011. “The Land Acquisition Bill: A Critique and a Proposal”, *Economic and Political Weekly*, 46(41), 65-72.

Ghatak, M. and D. Mookherjee. 2011. “Land Acquisition for Industrialization and Compensation of Displaced Farmers”, *Journal of Development Economics,* forthcoming

Grossman, S. J. and M. Perry. 1986. “Sequential Bargaining under Asymmetric Information”, *Journal of Economic Theory,* 39: 120-154.

Hall, D., E. Lobina and R. De La Motte. 2005. “Public resistance to privatisation in water and energy.” *Development in Practice*, 15(3-4), 286-301.

Hart, O. 1989. “Bargaining and Strikes.” *Quarterly Journal of Economics*. 104: 25-43.

Harstad, B. 2007. “Harmonization and Side Payments in Political Cooperation.” *American Economic Review*. 97(3): 871-889.

Haufler, A. and I. Wooton. 1999. “Country Size and Tax Competition for Foreign Direct Investment”. *Journal of Public Economics* 71: 121-139

Laffont, J.J,. “Political Economy, Information and Incentives”, *European Economic Review*, 43: 649-669.

Lum, T. 2006. "Social unrest in China." Congressional Research Service (CRS) Reports and Issue Briefs, 19.

Lohmann, S. 1993. “A signaling Model of Informative and Manipulative Political Action” *The American Political Science Review* 87: 319-333.

Lohmann, S. 1994. “Information Aggregation Through Costly Political Action.” *American Economic Review*. 84: 518-530.

Lohmann, S. 1995a. “A Signaling Model of Competitive Political Pressures.” *Economics and Politics*. 5: 181-206.

Lohmann, S. 1995b. “Information, Access and Contributions: A Signaling Model of Lobbying.” *Public Choice*. 85: 267-284.

Lohmann, S. 1998. “An Information Rationale for the Power of Special Interests” *The American Political Science Review* 92: 809-827.

McKenzie, D., D. Mookherjee, G. Castañeda and J. Saavedra. 2003. “The Distributive Impact of Privatization in Latin America: Evidence from Four Countries. [with Comments]” *Economia*, 161-233.

Megginson, W. L., R. C. Nash and M. Van Randenborgh. 1994. “The Financial and Operating Performance of Newly Privatized Firms: An International Empirical Analysis.” *Journal of Finance*, 49: 403-452.

Megginson, W. L., and J. M. Netter. 2001. “From State to Market: A Survey of Empirical Studies on Privatization.” *Journal of Economic Literature*, 39: 321-389.

Molano, W. 1997. *The logic of privatization: the case of telecommunications in the Southern Cone of Latin America*. Greenwood Press.

Oman, C. P. 2000. *Policy Competition for Foreign Direct Investment: A study of Competition among Governments to Attract FDI.* OECD Development Center, Paris: OECD.

Persson, T. and G. Tabellini. 2000. *Political Economics: Explaining Economic Policy.* Cambridge: The MIT Press.

Raghuram, G. and B. Varkkey. 2001. "Public Private Partnership in Airport Development-Governance and Risk Management Implications from Cochin International Airport Ltd." WP2001-10-05, Indian Institute of Management Ahmedabad, Research and Publication Department.

Rauscher, M. 1995. "Environmental Regulation and the Location of Polluting Industries" *International Public Finance* 2: 229-244

Ray, D. 2007. *A Game Theoretic Perspective on Coalition Formation*. Oxford: Oxford University Press.

Ray, D. 2010. "Uneven Growth: A Framework for Research in Development Economics." *Journal of Economic Perspectives*. 24(3): 45-60.

Rodrik, D. 1999. "The New Global Economy and Developing Countries: Making Openness Work." Policy Essay No. 24. Overseas Development Council. Washington D.C.

Roy Chowdhury, P. 2010. "Land acquisition: Political intervention, voice and fragmentation." Indian Statistical Institute Discussion Paper 10-05, New Delhi, India.

Sarkar, A. 2007. "Development and Displacement: Land Acquisition in West Bengal", *Economic and Political Weekly*, 42(16), 1435-42.

Sheshinski, E. and Lopez-Calva, L.F. (2003) Privatization and its benefits: theory and evidence. *CESifo Economic Studies.* 49: 429–459.

Shirley, M.M. and Walsh, P. 2004. *Public versus Private Ownership: The Current State of the Debate*. Washington, DC: The World Bank.

Stern, Nicholas 2001. *A Strategy for Development*. Washington: World Bank.

Stiglitz, J. 2002. *Globalization and Its Discontents*. W.W. Norton & Company.

Uba, K. 2005. "Political Protest and Policy Change: The Direct Impacts of Indian Anti-privatization Mobilizations." *Mobilization: An International Journal*. 10(3): 383-396.

Uba, K. 2008. "Labor union resistance to economic liberalization in India: what can national and state level patterns of protests against privatization tell us?" *Asian Survey*. 48(5): 860–884.

World Bank. 1995. *Bureaucrats in Business: The Economics and Politics of Government Ownership*. Washington DC: Oxford University Press for the World Bank.

# Appendix A

**Proof of Lemma 2.** First we derive the optimal transfer for any belief $\mu \in [0, 1]$.

**Claim L2a**: Suppose $x > 0$. For beliefs $\mu \in [0, 1]$,

$$t(\mu, a) = \lambda w^A(a) - (1 - \lambda)\left[\mu w^B(\underline{v}, a) + (1 - \mu) w^B(\overline{v}, a)\right]$$

The transfer to group B is strictly increasing in $\mu$ if $a < 1$ and constant if $a = 1$.

Proof of Claim L2a: Denote the maximand $\mu W(\underline{v}, a, t') + (1-\mu)W(\overline{v}, a, t')$ by $E_\mu W(a, t')$. Now,

$$
\begin{aligned}
\frac{dE_\mu W(a,t)}{dt} &= \frac{d}{dt}[\mu S(\underline{v}, a) + (1-\mu)S(\overline{v}, a)] \\
&\quad -\frac{d}{dt}\mu[\lambda(w^A - t) - (1-\lambda)(w^B(\underline{v}) + t)]^2 - \frac{d}{dt}(1-\mu)[\lambda(w^A - t) - (1-\lambda)(w^B(\overline{v}) + t)]^2 \\
&= 2[\lambda(w^A - t) - (1-\lambda)\{\mu w^B(\underline{v}) + (1-\mu)w^B(\overline{v}) + t\}]
\end{aligned}
$$

Therefore, $\frac{d^2 E_\mu W(a,t)}{dt^2} = -2$, and the maximum occurs where $\lambda(w^A - t) - (1-\lambda)\{\mu w^B(\underline{v}) + (1-\mu)(w^B(\overline{v}) + t)\} = 0$, implying $t(\mu, a) = \lambda w^A(a) - (1-\lambda)[\mu w^B(\underline{v}, a) + (1-\mu)w^B(\overline{v}, a)]$. Since $w^B(\overline{v}, a) - w^B(\underline{v}, a) = (\overline{v} - \underline{v})x(1-a)$, is easy to see that given $a$, the transfer $t(\mu, a)$ is strictly increasing in $\mu$ if $x > 0$ and $a < 1$. If $x = 0$ or $a = 1$, $t(\mu, a) = 0$ for all $\mu$. Thus Claim L2a is proved. We now proceed to derive all separating equilibria of the signaling game.

**Claim L2b**: Suppose $x > 0$ and Assumption 1 holds. Then, the set of separating equilibria of the signaling subgame is given by actions $\underline{a} \in [a_L, \min\{a_H, 1\}]$ and $\overline{a} = 0$, where

$$
a_L = \frac{(1-\lambda)(\overline{v} - \underline{v})}{((v^A + \overline{v}) - (1-\lambda)(v^A + \underline{v}))}, \text{ and } a_H = \frac{(1-\lambda)(\overline{v} - \underline{v})}{\lambda(v^A + \underline{v})}.
$$

Proof of Claim L2b: The proof proceeds in two steps. First, we establish that in any separating equilibrium, the high-valuation type sets $\overline{a} = 0$. Then, we establish the range of $\underline{a}$ in equilibrium. In this proof, sometimes we abuse notation by writing $t(0, a)$ as $t(\overline{v}, a)$ and $t(1, a)$ as $t(\underline{v}, a)$.

In any separating equilibrium, we have $\mu(\overline{a}) = 0$ and $\mu(\underline{a}) = 1$. Suppose that $\overline{a} > 0$. In a separating equilibrium, the transfer to the high type is $t(\overline{v}, \overline{a})$ and the resultant utility of the high type is $\lambda[(\overline{v} + v^A)(1 - \overline{a}) + \tau]x$. On the other hand, the payoff obtained from deviating to $a = 0$ is $\overline{v}x + t(\mu(0), 0) + s\tau x$. Now, from Claim 1, since $\mu(0) \geq 0$, we must have $t(\mu(0), 0) \geq t(\overline{v}, 0)$. Therefore,

$$
\overline{v}x + t(\mu(0), 0) + s\tau x \geq \overline{v}x + t(\overline{v}, 0) + s\tau x = \lambda[(\overline{v} + v^A) + \tau]x > \lambda[(\overline{v} + v^A)(1 - \overline{a}) + \tau]x
$$

We can then say that the deviation payoff is strictly higher than the equilibrium payoff if $\overline{a} > 0$ since $\overline{v} + v^A > 0$ by assumption 1, and $x > 0$. This establishes that $\overline{a} = 0$ in any separating equilibrium. Next, we turn to the determination of $\underline{a}$.

A necessary condition that the optimal level of actions $(\underline{a}, 0)$ would have to satisfy is that neither type would gain by misrepresenting its own type. Let $w^B(a, t|v)$ denote group $B$'s payoff given its true marginal valuation $v$, a redistributive transfer $t$, and an action $a$. The no-lying constraint for the high type is

$$
w^B(0, t(\overline{v}, 0)|\overline{v}) \geq w^B(\underline{a}, t(\underline{v}, \underline{a})|\overline{v}) \tag{8}
$$

And the no-lying constraint for the low type is

$$
w^B(\underline{a}, t(\underline{v}, \underline{a})|\underline{v}) \geq w^B(0, t(\overline{v}, 0)|\underline{v}) \tag{9}
$$

By rearranging terms, we see that inequalities (8) and (9) can be summarized as

$$
\overline{v}\underline{a}x \geq \Delta t(\underline{a}) \geq \underline{v}\underline{a}x, \text{ where } \Delta t(\underline{a}) = t(\underline{v}, \underline{a}) - t(\overline{v}, 0)
$$

The gain in transfer $\Delta t(\underline{a})$ from representing oneself as of having low valuation by taking an action of level

$\underline{a}$ is given by

$$\Delta t\left(\underline{a}\right)=x\left[\left(1-\lambda\right)\left(\overline{v}-\underline{v}\right)+\underline{a}\left(\left(1-\lambda\right)\underline{v}-\lambda v^{A}\right)\right].$$

After rearranging terms, we see that in any separating equilibrium,

$$\frac{\left(1-\lambda\right)\left(\overline{v}-\underline{v}\right)}{\left(\left(v^{A}+\overline{v}\right)-\left(1-\lambda\right)\left(v^{A}+\underline{v}\right)\right)}\leq\underline{a}\leq\frac{\left(1-\lambda\right)\left(\overline{v}-\underline{v}\right)}{\lambda(v^{A}+\underline{v})}. \tag{10}$$

where the upper bound comes from condition (9) and the lower bound from condition (8). Condition (10) is only necessary for there to be a separating equilibrium. It can be checked that any $\underline{a}\in[a_L,a_H]$ will be an equilibrium, given beliefs

$$\mu(a)=\begin{cases}0 \text{ if } a\in[0,\underline{a})\cup(\underline{a},1]\\ 1 \text{ if } a=\underline{a}\end{cases}$$

A separating equilibrium exists only if $[a_L,\min\{a_H,1\}]$ is a non-empty interval. By inspection, it is easy to see that if $\overline{v}+v^A>0$, $a_L\in(0,1)$. Also, after a little algebra, we see that

$$a_H-a_L=\frac{\left(1-\lambda\right)\left(\overline{v}-\underline{v}\right)^2}{[(v^{A}+\overline{v})-\left(1-\lambda\right)\left(v^{A}+\underline{v}\right)]\lambda(v^{A}+\underline{v})}, \tag{11}$$

and thus $a_H>a_L$ if and only if $(v^A+\underline{v})\geq 0$, which holds true given Assumption 1. Thus Claim L2b is

proved.

We are now going to show there is a unique separating equilibrium that survives the intuitive criterion. To see this, consider any separating equilibrium with $\underline{a}>a_L$, and $\overline{a}=0$. That there exists such an $\underline{a}$ is guaranteed by that fact that since $\overline{v}-\underline{v}>0$, we will never have 0 in the right hand side of equation 11. Consider some action $a'\in(a_L,\underline{a})$. For any belief $\mu\in[0,1]$,

$$\begin{aligned}
w^B(a',t(\mu,a')|\overline{v}) &= \overline{v}x(1-a')+t(\mu,a')+s\tau x\leq\overline{v}x(1-a')+t(\underline{v},a')+s\tau x\\
&= \overline{v}x(1-a')+[\lambda\{v^Ax(1-a')+(1-s)\tau x\}-(1-\lambda)\{\underline{v}x(1-a')+s\tau x\}]+s\tau x\\
&= \lambda\tau x+\{\lambda v^A+\overline{v}-(1-\lambda)\underline{v}\}x(1-a')\\
&< \lambda\tau x+\{\lambda v^A+\overline{v}-(1-\lambda)\underline{v}\}x(1-a_L)\\
&= \lambda\tau x+\{\lambda v^A+\overline{v}-(1-\lambda)\underline{v}\}x\left(1-\frac{\left(1-\lambda\right)\left(\overline{v}-\underline{v}\right)}{\lambda v^A+\overline{v}-(1-\lambda)\underline{v}}\right)\\
&= \lambda\tau x+\lambda(v^A+\overline{v})x=\lambda(v^A+\overline{v}+\tau)x=w^B(0,t(\overline{v},0)|\overline{v}).
\end{aligned}$$

Therefore, for all possible beliefs $\mu$ arising from action $a'$, the high type would get a lower utility from playing $a'$ that it does in equilibrium. Thus, $a'$ is equilibrium dominated for the high type, and hence we must have $\mu(a')=1$. If $\mu(a')=1$, then the payoff of the low type from playing action $a'$ is

$$w^B(a',t(\underline{v},a')|\underline{v})=\lambda((\underline{v}+v^A)(1-a')+\tau)x>\lambda((\underline{v}+v^A)(1-\underline{a})+\tau)x=w^B(\underline{a},t(\underline{v},\underline{a})|\underline{v}).$$

Therefore, the low type has a deviation yielding a higher payoff than the equilibrium payoff. Thus, the separating equilibrium with $\underline{a}>a_L$, and $\overline{a}=0$ does not survive the intuitive criterion. ■

**Proof of Proposition 5.**

It is easy to see that the investor's optimal investment for a given tax rate is $x^{ns}(\tau)=k(q-\tau)$. The optimal investment tax maximizes $G$'s payoff, which is

$$\begin{aligned} & pW(\underline{v},0,t^{ns})+(1-p)W(\overline{v},0,t^{ns}) \quad (12)\\ = \; & (v^A+Ev^B)x^{ns}(\tau)+\tau x^{ns}(\tau)-[pL(\underline{v},0,t^{ns})+(1-p)L(\overline{v},0,t^{ns})] \\ = \; & (v^A+Ev^B)x^{ns}(\tau)+\tau x^{ns}(\tau)-F[x^{ns}(\tau)]^2 \end{aligned}$$

where $F=p(1-p)(1-\lambda)^2(\overline{v}-\underline{v})^2$. Solving, we get $\tau^{ns}=\frac{[q-(v^A+Ev^B)]+2qkF}{2+2kF}$. Replacing $\tau^{ns}$ and $x^{ns}$ in (12), we can derive $G$'s equilibrium payoff. ■

**Proof of proposition 6.** Fix $\overline{v},\underline{v}$ and $\lambda$, and consider $W^e$ and $\not{W}^{ns}$ as functions of $p$. Now, it is easy to see that

$$\frac{\not{W}^{ns}(p)}{W^e(p)}=\left[\frac{N(p)}{S(p)}\right]^2$$

where

$$N(p) = \frac{v^A+Ev_B+q}{\sqrt{1+kF(p)}},\; F(p)=p(1-p)(1-\lambda)^2(\overline{v}-\underline{v})^2 \quad (13)$$

$$S(p) = (v^A+Ev_B+q)-pa^e(v^A+\underline{v}+q),\; a^e=\frac{(1-\lambda)(\overline{v}-\underline{v})}{(v^A+\overline{v})-(1-\lambda)(v^A+\underline{v})} \quad (14)$$

Since $(v^A+Ev_B+q)-pa^e(v^A+\underline{v}+q)>0$, we can say that $\not{W}^{ns}(p)\lesseqgtr W^e(p)$ if and only if $N(p)\lesseqgtr S(p)$.

First, notice that $N(0)=S(0)=v^A+\overline{v}+q$. Also, $N(1)=(v^A+\underline{v}+q)>S(1)=(1-a^e)(v^A+\underline{v}+q)$ since $a^e\in(0,1)$. Next, note that

$$\frac{dS(p)}{dp}=(\underline{v}-\overline{v})-a^e(v^A+\underline{v}+q)<0 \quad (15)$$

and by (14), $S(p)$ is a downward sloping straight line. On the other hand,

$$\begin{aligned}\frac{dN(p)}{dp} &= \frac{1}{1+kF(p)}\left\{(\underline{v}-\overline{v})\sqrt{1+kF(p)}-(v^A+Ev_B+q)\frac{k(1-\lambda)^2(\overline{v}-\underline{v})^2}{2\sqrt{1+kF(p)}}(1-2p)\right\}\\ &= \frac{(\underline{v}-\overline{v})}{\sqrt{1+kF(p)}}-(v^A+Ev_B+q)\frac{k(1-\lambda)^2(\overline{v}-\underline{v})^2}{(1+kF(p))^{\frac{3}{2}}}\left(\frac{1}{2}-p\right) \quad (16)\end{aligned}$$

Notice that

$$\frac{dN(p)}{dp}|_{p=0}=(\underline{v}-\overline{v})-\frac{1}{2}k(v^A+\overline{v}+q)(1-\lambda)^2(\overline{v}-\underline{v})^2 \quad (17)$$

Next, we claim that *for any $p^*\in(0,1)$ for which $N(p)=S(p)$, we must have $\frac{dN(p)}{dp}>\frac{dS(p)}{dp}$*. To prove, let us assume that, if possible, the above claim does not hold true. Then there is some $p^*\in(0,1)$ satisfying $N(p)=S(p)$, and $\frac{dN(p)}{dp}\leq\frac{dS(p)}{dp}$. Therefore, by (16) and (17), for $p^*$, we must have

$$\begin{aligned}\frac{(\underline{v}-\overline{v})}{\sqrt{1+kF(p)}}-(v^A+Ev_B+q)\frac{k(1-\lambda)^2(\overline{v}-\underline{v})^2}{(1+kF(p))^{\frac{3}{2}}}(\frac{1}{2}-p) &\leq (\underline{v}-\overline{v})-a^e(v^A+\underline{v}+q),\text{ or}\\ (v^A+Ev_B+q)\frac{k(1-\lambda)^2(\overline{v}-\underline{v})^2}{(1+kF(p))^{\frac{3}{2}}}(\frac{1}{2}-p)-a^e(v^A+\underline{v}+q) &\geq \frac{(\underline{v}-\overline{v})}{\sqrt{1+kF(p)}}-(\underline{v}-\overline{v})\end{aligned}$$

Since $p^*>0$, $\sqrt{1+kF(p)}>1$, and since $(\underline{v}-\overline{v})<0$, the right hand side is strictly positive. Therefore, we must have

$$(v^A + Ev_B + q)\frac{k(1-\lambda)^2(\overline{v}-\underline{v})^2}{(1+kF(p))^{\frac{3}{2}}}\left(\frac{1}{2}-p\right) > a^e(v^A + \underline{v} + q) \tag{18}$$

From (13) and (14), since $N(p) = S(p)$ at $p^*$, we have $v^A + Ev_B + q = pa^e(v^A + \underline{v} + q)/(1 - \frac{1}{\sqrt{1+kF(p)}})$. We can therefore rewrite (18) as

$$a^e(v^A + \underline{v} + q)\frac{k(1-\lambda)^2(\overline{v}-\underline{v})^2\left(\frac{1}{2}-p\right)p}{\left(1-\frac{1}{\sqrt{1+kF(p)}}\right)(1+kF(p))^{\frac{3}{2}}} > a^e(v^A + \underline{v} + q),$$

which is true if and only if

$$\begin{aligned}
\left(1-\frac{1}{\sqrt{1+kF(p)}}\right)(1+kF(p))^{\frac{3}{2}} &< k(1-\lambda)^2(\overline{v}-\underline{v})^2\left(\frac{1}{2}-p\right)p \\
\Leftrightarrow (1+kF(p))^{\frac{3}{2}} - (1+kF(p)) &< k(1-\lambda)^2(\overline{v}-\underline{v})^2\left(\frac{1}{2}-p\right)p, \text{ or} \\
\Leftrightarrow \left[1+k(1-\lambda)^2(\overline{v}-\underline{v})^2(1-p)p\right]^{3/2} &< k(1-\lambda)^2(\overline{v}-\underline{v})^2\left(\frac{1}{2}-p\right)p + 1 + k(1-\lambda)^2(\overline{v}-\underline{v})^2(1-p)p \\
&= 1 + k(1-\lambda)^2(\overline{v}-\underline{v})^2 p\left(\frac{3}{2}-2p\right)
\end{aligned} \tag{19}$$

Now, from the Taylor series expansion of the left hand side,

$$\begin{aligned}
\left[1+k(1-\lambda)^2(\overline{v}-\underline{v})^2(1-p)p\right]^{3/2} &> 1 + \frac{3}{2}k(1-\lambda)^2(\overline{v}-\underline{v})^2(1-p)p \\
&= 1 + k(1-\lambda)^2(\overline{v}-\underline{v})^2 p\left(\frac{3}{2}-\frac{3}{2}p\right) \\
&> 1 + k(1-\lambda)^2(\overline{v}-\underline{v})^2 p\left(\frac{3}{2}-2p\right)
\end{aligned} \tag{20}$$

since $p^* > 0$. Inequality (20) is a contradiction to inequality (19). Since inequality (19) is false, condition (18) is not satisfied. This proves our claim that that for any $p^* \in (0,1)$ for which $N(p) = S(p)$, we must have $\frac{dN(p)}{dp} > \frac{dS(p)}{dp}$. An immediate implication is that whenever $N(p^*) = S(p^*)$ other than $p^* = 0$, $N(p)$ should cut $S(p)$ from below. This implies that there is at most one solution to $N(p) = S(p)$ for $p \in (0,1]$. To see that, suppose there were more than one solutions to $N(p) = S(p)$. By claim 1, in case of each solution, $N(p)$ should cut $S(p)$ from below. But since both $N(p)$ and $S(p)$ are continuous, by the intermediate value theorem, between any two such distinct solutions, there must be some $p'$ such that $N(p') = S(p')$ where $N(p)$ cuts $S(p)$ from above. This is a contradiction to claim 1. From claim 1, it follows that there is at most one solution to $N(p) = S(p)$ for $p \in (0,1]$. Also, if there exists such a solution $p^*$, for $p < p^*$, $N(p) < S(p)$ and for $p > p^*$, $N(p) > S(p)$. Moreover, since $N(1) > S(1)$, we must have $p^* < 1$.

Since $N(0) = S(0)$, there is an interior solution $p^*$ to the equation $N(p) = S(p)$ if and only if there is some $\epsilon > 0$ such that $N(p) < S(p)$ for the interval $(0, \epsilon)$. Such an $\epsilon$ exists if and only if $\frac{dN(p)}{dp} < \frac{dS(p)}{dp}$ at $p = 0$. Comparing (15) and (17), the condition is

$$a^e(v^A + \underline{v} + q) < \frac{1}{2}k(v^A + \overline{v} + q)(1-\lambda)^2(\overline{v}-\underline{v})^2 \tag{21}$$

Condition (21) can be broken down further as

$$(1-\lambda)\left[(v^A+\overline{v})-(1-\lambda)(v^A+\underline{v})\right] > \frac{(v^A+\underline{v}+q)}{(v^A+\overline{v}+q)}\frac{2}{k(\overline{v}-\underline{v})} \tag{22}$$

Taking $(1-\lambda)=x$, $v^A+\underline{v}=a$ and $v^A+\overline{v}=b$, we can rewrite condition (22) as $f(x)\equiv ax^2-bx+\frac{2}{k(b-a)}\frac{a+q}{b+q}<0$. Now, $f(0)>0$ and $f''(x)=a>0$. Thus, we have at most an interval of $x$ such that $f(x)<0$. If that range is $[x_1,x_2]$, then $\overline{\lambda}=\max\{1-x_1,0\}$ and $\underline{\lambda}=\max\{1-x_2,0\}$. Since $f(0)>0$, we have $x_1>0$, implying $\overline{\lambda}<1$. Also, $f(1)=-(b-a)+\frac{2}{k(b-a)}\frac{a+q}{b+q}$. Making $a$ small enough, we can have $f(1)<0$, which implies that $\underline{\lambda}=0$. ■

**Proof of Lemma 7.** The proof of this lemma proceeds in several steps. While deriving the optimal transfer for a given belief, we see that the Claim L2a, made in the proof of Lemma 2 holds. Thus, the transfer $t(\mu,a)$ is strictly increasing in $\mu$ except if $a=1$ or $x=0$, in which case, $t(\mu,a)$ is constant in $\mu$. Now, suppose that in a separating equilibrium, the high valuation type takes action $\overline{a}$ and the low valuation type takes action $\underline{a}$.

To check that $\overline{a}=0$, suppose otherwise. In a separating equilibrium, the transfer to the high type is $t(\overline{v},\overline{a})$ and the resultant utility of the high type is $\lambda[(\overline{v}+v^A)(1-\overline{a})+\tau-q\overline{a}]x$. On the other hand, the payoff obtained from deviating to $a=0$ is $\overline{v}x+t(\mu(0),0)+s\tau x$. Therefore,

$$\overline{v}x+t(\mu(0),0)+s\tau x\geq\overline{v}x+t(\overline{v},0)+s\tau x=\lambda[(\overline{v}+v^A)+\tau]x>\lambda[(\overline{v}+v^A)(1-\overline{a})+\tau-q\overline{a}]x$$

We can then say that the deviation payoff is strictly higher than the equilibrium payoff if $\overline{a}>0$ since $\overline{v}+v^A>0$ by assumption 1, and $x>0$. This establishes that $\overline{a}=0$ in any separating equilibrium.

Next, we turn to the determination of $\underline{a}$. As in the proof of Lemma 2, the range of $\underline{a}$ satisfies

$$\overline{v}\underline{a}x\geq\Delta t\left(a\right)\geq\underline{v}\underline{a}x,\ \text{where}\ \Delta t\left(\underline{a}\right)=t(\underline{v},\underline{a})-t(\overline{v},0)$$

Now, we have for the transfers

$$\begin{aligned}
t(\underline{v},\underline{a}) &= \lambda[v^Ax(1-a)+s^A\tau x-r^Aqax]-(1-\lambda)[\underline{v}x(1-a)+s^B\tau x-r^Bqax]\\
t(\overline{v},0) &= \lambda[v^Ax+s^A\tau x]-(1-\lambda)[\overline{v}x+s^B\tau x]
\end{aligned}$$

Hence, the gain in transfer $\Delta t\left(\underline{a}\right)$ from representing oneself as of having low valuation by taking an action of level $\underline{a}$ is given by

$$\Delta t(\underline{a})=t(\underline{v},\underline{a})-t(\overline{v},0)=x[(1-\lambda)(\overline{v}-\underline{v})+a\{\underline{v}(1-\lambda)-\lambda v^A\}]+qax\{(1-\lambda)r^B-\lambda r^A\}$$

The range of $\underline{a}$ given by

$$\begin{aligned}
[(1-\lambda)(\overline{v}-\underline{v})+a\{\underline{v}(1-\lambda)-\lambda v^A\}]+a\{(1-\lambda)r^B-\lambda r^A\} &\leq \overline{v}a+r^Baq\\
a'_L=\frac{(1-\lambda)(\overline{v}-\underline{v})}{(v^A+\overline{v})-(1-\lambda)(v^A+\underline{v})+\lambda q} &\leq a
\end{aligned}$$

and that

$$\begin{aligned}
(1-\lambda)(\overline{v}-\underline{v})+a\{\underline{v}(1-\lambda)-\lambda v^A\}]+a\{(1-\lambda)r^B-\lambda r^A\} &\geq \underline{v}a+r^Baq\\
a'_H=\frac{(1-\lambda)\left(\overline{v}-\underline{v}\right)}{\lambda(v^A+\underline{v})+\lambda q} &\geq a
\end{aligned}$$

It can be easily checked that $a'_L < \min\{a'_H, 1\}$ and thus, a separating equilibrium always exists. Notice that $a'_L < a_L = a^e$.

Now, we turn to refining the set of equilibria using the Cho-Kreps criterion and showing that any equilibrium satisfying the criterion has the property that the action of the low valuation type $a^*$ satisfies $a^* < a^e$.In particular, we show that no $\underline{a}$ with $\underline{a} > \max\left\{a'_L, \frac{a_L}{1+\lambda q}\right\}$ satisfies the Cho-Kreps criterion.

Consider any separating equilibrium with $\underline{a} > \max\left\{a'_L, \frac{a_L}{1+\lambda q}\right\}$, and $\overline{a} = 0$. Consider some action $a' \in \left(\max\left\{a'_L, \frac{a_L}{1+\lambda q}\right\}, \underline{a}\right)$. For any belief $\mu \in [0,1]$,

$$\begin{aligned}
w^B(a', t(\mu, a')|\overline{v}) &= \overline{v}x(1-a') + t(\mu, a') + s\tau x - r^B qa'x \leq \overline{v}x(1-a') + t(\underline{v}, a') + s\tau x - r^B qa'x \\
&= \overline{v}x(1-a') + +s\tau x - r^B qa'x \\
&\quad +[\lambda\{v^A x(1-a') + (1-s)\tau x - r^A qa'x\} - (1-\lambda)\{\underline{v}x(1-a') + s\tau x - r^B qa'x\}] \\
&= \lambda\tau x + \{\lambda v^A + \overline{v} - (1-\lambda)\underline{v}\}x(1-a') - (\lambda r^A - (1-\lambda)r^B + r^B)qa'x \\
&= \lambda\tau x + [\lambda v^A + \overline{v} - (1-\lambda)\underline{v}][1 - a'(1+\lambda q)]x \\
&< \lambda\tau x + [\lambda v^A + \overline{v} - (1-\lambda)\underline{v}][1 - a_L]x \\
&= \lambda\tau x + [\lambda v^A + \overline{v} - (1-\lambda)\underline{v}]\left[1 - \frac{(1-\lambda)(\overline{v} - \underline{v})}{\lambda v^A + \overline{v} - (1-\lambda)\underline{v}}\right]x \\
&= \lambda\tau x + \lambda(v^A + \overline{v})x = \lambda(v^A + \overline{v} + \tau)x = w^B(0, t(\overline{v}, 0)|\overline{v}).
\end{aligned}$$

Therefore, for all possible beliefs $\mu$ arising from action $a'$, the high type would get a lower utility from playing $a'$ that it does in equilibrium. Thus, $a'$ is equilibrium dominated for the high type, and hence we must have $\mu(a') = 1$. If $\mu(a') = 1$, then the payoff of the low type from playing action $a'$ is

$$w^B(a', t(\underline{v}, a')|\underline{v}) = \lambda((\underline{v} + v^A)(1-a') - a'q + \tau)x > \lambda((\underline{v} + v^A)(1-\underline{a}) - \underline{a}q + \tau)x = w^B(\underline{a}, t(\underline{v}, \underline{a})|\underline{v}).$$

Therefore, the low type has a deviation yielding a higher payoff than the equilibrium payoff. Thus, the separating equilibrium with $\underline{a} > \max\left\{a'_L, \frac{a_L}{1+\lambda q}\right\}$, and $\overline{a} = 0$ does not survive the intuitive criterion. ■

**Proof of Proposition 9.** Suppose the government commits to a compensation floor of $T > 0$. In order to find optimal floor, we first find the outcome for a given $T$ and then calculate the optimal floor. Suppose $x > 0$. For beliefs $\mu \in [0,1]$, the transfer to group $B$ is given by

$$t_f(\mu, a) = \begin{cases} t(\mu, a) & if \quad t(\mu, a) > T \\ T & if \quad t(\mu, a) \leq T \end{cases}, \text{ where}$$
$$t(\mu, a) = \lambda w^A(a) - (1-\lambda)\left[\mu w^B(\underline{v}, a) + (1-\mu)w^B(\overline{v}, a)\right]$$

**Claim P9a**: $t_f(\mu, a)$ is weakly increasing in $\mu$ and strictly so if $t(\mu, a) > T$ and $a < 1$.

Proof of Claim P9a: Suppose there was no floor to transfer. Now, it is easy to see that the expected welfare to $G$ is concave in $t$, and maximized at $t(\mu, a)$. If the floor binds, i.e.$t(\mu, a) \leq T$ then the constrained maximum occurs at $T$. The rest of the proof follows proof of Claim L2a, made in the proof Lemma 2 above.

**Claim P9b**: In any separating equilibrium, $\overline{a} = 0$.

Proof of Claim P9b: If $T \leq t(\overline{a}, x)$, then the proof holds by Claim L2b, made in the proof Lemma 2 above. Suppose now that $T > t(\overline{a}, x)$. Suppose that $\overline{a} > 0$. In a separating equilibrium, transfer to the high type is $T$. And, the resultant utility of the high type is $[\overline{v}(1-\overline{a})x + s\tau x + T$. On the other hand, the payoff obtained from deviating to $a = 0$ is $\overline{v}x + t_f(\mu(0), 0) + s\tau x$. Now, from Claim P9a, since $\mu(0) \geq 0$, we must have $t_f(\mu(0), 0) \geq T$. Therefore, comparing payoffs

$$[\overline{v}x + t(\mu(0), 0) + s\tau x] - [\overline{v}x(1 - \overline{a}) + T + s\tau x] = \overline{v}x\overline{a} + t(\mu(0), 0) - T \geq \overline{v}x\overline{a} > 0$$

This establishes that $\overline{a} = 0$ in any separating equilibrium.

**Claim P9c**: Given a signaling game with a compensation floor, in the welfare maximizing separating equilibrium, we must have

$$a^f = \frac{[\lambda v^A - (1-\lambda)\underline{v}] - \frac{T}{x}}{(v^A + \overline{v}) - (1-\lambda)(v^A + \underline{v})} \text{ and } a^f > 0.$$

Proof of Claim P9c: Suppose in the signaling game with $x > 0$, equilibrium transfer to the low type is $t(\underline{a})$ and that to the high type is $T$. For separation, we need $\underline{a} > 0$ and $\overline{v}\underline{a}x \geq t(\underline{a}) - T \geq \underline{v}\underline{a}x$. As,

$$t(\underline{a}) = \lambda[v^A(1-\underline{a}) + (1-s)\tau]x - (1-\lambda)\left[\underline{v}(1-\underline{a}) + s\tau\right]x = [\lambda v^A - (1-\lambda)\,\underline{v}](1-\underline{a})x$$

we must have

$$\frac{[\lambda v^A - (1-\lambda)\underline{v}] - \frac{T}{x}}{(v^A + \overline{v}) - (1-\lambda)(v^A + \underline{v})} \leq \underline{a} \leq \frac{[\lambda v^A - (1-\lambda)\underline{v}] - \frac{T}{x}}{\lambda(v^A + \underline{v})}$$

To see that $\frac{[\lambda v^A - (1-\lambda)\underline{v}] - \frac{T}{x}}{(v^A + \overline{v}) - (1-\lambda)(v^A + \underline{v})} < \frac{[\lambda v^A - (1-\lambda)\underline{v}] - \frac{T}{x}}{\lambda(v^A + \underline{v})}$, notice that $(i)$ since we have separation, we must have separation, we must have $t(\underline{a}) > T$, implying that $[\lambda v^A - (1-\lambda)\,\underline{v}](1-\underline{a}) > \frac{T}{x}$ which implies that the numerator is positive, and $(ii)$ $(v^A + \overline{v}) - (1-\lambda)(v^A + \underline{v}) > \lambda(v^A + \underline{v})$ since $\overline{v} > \underline{v}$. Moreover, the assumption that $\lambda > \frac{\underline{v}}{v^A + \underline{v}}$ implies that for some positive $T$, there exists a separating equilibrium with $\underline{a} > 0$.Therefore the "best" separating equilibrium of the signaling game requires $a^f = \frac{[\lambda v^A - (1-\lambda)\underline{v}] - \frac{T}{x}}{(v^A + \overline{v}) - (1-\lambda)(v^A + \underline{v})}$ and $a^f > 0$ (which we verify at the end).

Notice that the extent of action is a decreasing function of the compensation floor. However, if $T$ is larger than $[\lambda v^A - (1-\lambda)\underline{v}]x$, we no longer have a separating equilibrium, (i.e. $a^f = \overline{a} = 0$). Notice also that when $T = t(\overline{a}|x)$, we have $a^f = a^e$. Therefore, $a^f \leq a^e$. We now write

$$a^f = \frac{[\lambda v^A - (1-\lambda)\underline{v}] - \frac{T}{x}}{(v^A + \overline{v}) - (1-\lambda)(v^A + \underline{v})} = \alpha - \beta\frac{T}{x}$$

where $\alpha = \frac{\lambda v^A - (1-\lambda)\underline{v}}{(v^A + \overline{v}) - (1-\lambda)(v^A + \underline{v})}$ and $\beta = \frac{1}{(v^A + \overline{v}) - (1-\lambda)(v^A + \underline{v})}$.

Next consider the investor's problem. It is easy to see that the optimal investment, for a given level of action $a$ and investment tax $\tau$, is $k[q(1 - p\alpha) - \tau]$. And, the government chooses $\tau$ and $T$ to maximize

$$\begin{aligned} W^f(T,\tau) &= \left[(1-p)(v^A + \overline{v}) + p(v^A + \underline{v})\left(1 - \alpha + \beta\frac{T}{x}\right)\right]x^f(\tau) + \tau x^f(\tau) - (1-p)L(\overline{v}, 0, \tau|T) \\ \text{where } L(\overline{v}, 0, \tau|T) &= \left[\lambda\left(w^A(0) - T\right) - (1-\lambda)\left(w^B(0) + T\right)\right]^2 = \left[\left(\lambda v^A - (1-\lambda)\overline{v}\right)x^f(\tau) - T\right]^2 \end{aligned}$$

Therefore,

$$\begin{aligned} W^f(T,\tau) &= \left[(1-p)(v^A+\overline{v})+p(v^A+\underline{v})\left(1-\alpha+\beta\frac{T}{x^f(\tau)}\right)\right]x^f(\tau)+\tau x^f(\tau) \\ &\quad -(1-p)\left[\left(\lambda v^A-(1-\lambda)\overline{v}\right)x^f(\tau)-T\right]^2 \\ &= \left[(1-p)(v^A+\overline{v})+p(v^A+\underline{v})(1-\alpha)\right]x^f(\tau)+\tau x^f(\tau)+p(v^A+\underline{v})\beta T \\ &\quad -(1-p)\left[\left(\lambda v^A-(1-\lambda)\overline{v}\right)x^f(\tau)-T\right]^2 \\ &= Vx^f(\tau)+\tau x^f(\tau)+p(v^A+\underline{v})\beta T-(1-p)\left[\left(\lambda v^A-(1-\lambda)\overline{v}\right)x^f(\tau)-T\right]^2 \end{aligned}$$

Taking derivative with respect to $T$, we get $\frac{\partial W^f(T,\tau)}{\partial T}=p(v^A+\underline{v})\beta+2(1-p)\left[\left(\lambda v^A-(1-\lambda)\overline{v}\right)x^f(\tau)-T\right]$ and $\frac{\partial^2 W^f(T,\tau)}{\partial T^2}=-2T>0$. Hence, we obtain

$$T^*-\left(\lambda v^A-(1-\lambda)\overline{v}\right)x^f(\tau)=C^*$$

where $C^*=\frac{p}{2(1-p)}\left[\frac{v^A+\underline{v}}{(v^A+\overline{v})-(1-\lambda)(v^A+\underline{v})}\right]$ and we can therefore conclude that, irrespective of the scale of investment, the optimal compensation floor implements a constant level of "extra compensation" in addition to the amount that is optimal in the high state given the scale of investment (provided $a^f>0$). To check whether $a^f>0$, we need $[\lambda v^A-(1-\lambda)\underline{v}]x^f(\tau)>T^*$, or equivalently (after some simple algebra), $x^f(\tau)>\frac{C^*}{(1-\lambda)(\overline{v}-\underline{v})}$. Notice now that while $\tau$ is endogenous, $x^f(\tau)$ can be increased unboundedly by increasing $q$. Therefore, if $q$ is large enough, our "interior solution" holds, and the optimal compensation floor indeed provides an extra compensation of $C^*$. ■

**Proof of Proposition 10.** The optimal transfer strategy in this case is similar to that discussed in Lemma 2.

**Claim P10a**: Suppose $x>0$. For beliefs $\mu\in[0,1]$,

$$t(\mu,a)=\lambda w^A(a)-(1-\lambda)\left[\mu w^B(\underline{v},a)+(1-\mu)w^B(\overline{v},a)\right]$$

The transfer to group B is strictly increasing in $\mu$ if $a<1$ and constant if $a=1$.

The proof is exactly similar to the proof of Claim L2a, and hence skipped.

**Claim P10b**: Suppose $x>0$. Then the set of separating equilibria of the signaling subgame is given by actions $\overline{a}=0$ and $\underline{a}\in[a_L,1]$, where $a_L=\frac{(1-\lambda)(\overline{v}-\underline{v})}{((v^A+\overline{v})-(1-\lambda)(v^A+\underline{v}))}$.

Proof of P10b: The proof is similar to the proof of Claim L2b, discussed in the proof of Lemma 2, except that equation (9), which earlier led to $\underline{a}\leq a_H$, now yields that $\underline{a}\geq a_H$. The term $a_H$ has the same expression as before, but is now negative (which is what is responsible for the reversal of the inequality). In other words, the no lying constraint of the low type does not bind.

**Claim P10c**: Suppose $x>0$. Then the unique separating equilibrium of the signaling subgame that satisfies the Cho-Kreps criterion is $\overline{a}=0$ and $\underline{a}=1$.

Proof of Claim P10c: First, note that $a_L<1$. Now, consider any separating equilibrium with $\underline{a}<1$. Consider some action $a'\in(\underline{a},1)$The rest of the proof of lemma 4 goes through with surprising exactness. Notice that, for the last step, there is a crucial inequality

$$\lambda\left((\underline{v}+v^A)(1-a')+\tau\right)x>\lambda\left((\underline{v}+v^A)(1-\underline{a})+\tau\right)x$$

While this held in lemma 4 since $\underline{v}+v^A>0$ and $a'<\underline{a}$, in the present case it holds because $\underline{v}+v^A<0$ and $a'>\underline{a}$. ■

# Appendix B

## Two-part investment tariff

Consider a two-part tariff of the form $\tau_0 + \tau_1 x$, where $x$ is the size of investment. For given $\tau_0, \tau_1$ and a size of investment $x$, if the total tax transfer $(\tau_0 + \tau_1 x)$ from the investor to the society is positive, we say that the investment is taxed; otherwise subsidized. Subsequently, we study investor-friendliness under different regimes by comparing the total transfer from the investor to the society. For a given size of investment $x$, we say that investment is subsidized (taxed) if $\tau_0 + \tau_1 x \leq (\geq) 0$. We assume that the investor's reservation utility is zero. The socially efficient level of investment that maximizes the expected social value of investment, $\left(v^A + Ev^B + q\right) x - \frac{x^2}{2k}$, is given by $x^e = k\left(v^A + Ev^B + q\right)$.

The following lemma is useful in characterizing the equilibrium outcome under different regimes. It describes the investor's optimal investment and the government's optimal investment tax policy for a broader class of payoff functions.

**Lemma B1** *Suppose the investor's pre-tax profit from investment is $Qx - \frac{x^2}{2k}$ and the government's pre-tax payoff is $Vx$. Then, for any two-part tariff $(\tau_0, \tau_1)$, the optimal level of investment chosen by the investor is $x^* = k(Q - \tau_1^*)$. In the policy stage, the government's optimal choice of tariff is*

$$\tau_0^* = \frac{k}{2}(Q+V)^2, \text{ and } \tau_1^* = -V.$$

*The government's maximal payoff is $\frac{k}{2}(Q+V)^2$. Further, the total transfer from the investor to the society is $\frac{k}{2}\left(Q^2 - V^2\right)$, and consequently the investment is taxed if and only if $V < Q$.*

**Proof.** Given a two-part tariff $(\tau_0, \tau_1)$ the optimal size of investment $x(\tau_0, \tau_1)$ maximizes $\left(Qx - \frac{x^2}{2k} - \tau_1 x - \tau_0\right)$, and thus given by $k(Q - \tau_1)$. At the policy stage, the government's payoff is $Vx(\tau_0, \tau_1) + \tau_1 x(\tau_0, \tau_1) + \tau_0$. It is easy to see that the investor at the optimal contract, cannot receive a utility strictly above her reservation utility. Otherwise, the government can increase its payoff by increasing $\tau_0$, but keeping the investor still above her reservation utility. We can therefore set $\tau_1 x + \tau_0 = Qx - \frac{x^2}{2k}$, and the government's payoff as $Vx(\tau_0, \tau_1) + Qx(\tau_0, \tau_1) - \frac{x(\tau_0, \tau_1)^2}{2k} - u^0$. Solving the first order conditions, we find that the payoff maximizing $\tau_0$ and $\tau_1$ are given by $\tau_1^* = -V$, $\tau_0^* = \frac{k}{2}(Q+V)^2$. At the optimal, the government's payoff is $Vx(\tau_0^*, \tau_1^*) + Qx(\tau_0^*, \tau_1^*) - \frac{x(\tau_0^*, \tau_1^*)^2}{2k} = \frac{k}{2}(Q+V)^2$. The total transfer from the investor to the society is $\tau_0^* + \tau_1^* x(\tau_0^*, \tau_1^*) = \frac{k}{2}\left(Q^2 - V^2\right)$. ■

### The benchmark case: Full information

Consider the case when groups' marginal valuation from investment is public information. The government's expected pre-tax payoff is $\left(v^A + Ev^B\right) x$ where $Ev^B \equiv (1-p)\,\overline{v} + p\underline{v}$ and the investor's pre-tax return from investment is $qx - \frac{x^2}{2k}$. A direct application of Lemma B1 gives the equilibrium investment and tax policy as follows.

**Proposition B1** *Consider a situation in which groups' marginal valuations are public information. The equilibrium level of investment and the optimal tariff policy are as follows: $x^o = k(q - \tau_1^o)$, $\tau_1^o = -v^A - Ev^B$ and $\tau_0^o = \frac{k}{2}\left(q + v^A + Ev^B\right)^2$. Further, the government's expected payoff is $W^o = \frac{k}{2}\left(q + v^A + Ev^B\right)^2$, and the investment is taxed if and only if $v^A + Ev^B < q$.*

Comparing the above result with the corresponding proposition in case of proportional taxation, we see that the investment is efficient with two part tariff, and the government's payoff under two-part tariff is higher than that under proportional taxation. However, the government's investor friendliness result is not affected if we allow two-part tariff.

## Private information and signaling

Consider the case when group $B$'s marginal valuation of the project is private information and $B$ can signal by taking a costly public information. It is important to note that when we solve the optimal inter-group transfer and the equilibrium level of resistance, we consider the total investment tax transfer and the size of investment as given. Therefore the equilibrium resistance required to reveal information does not depend on the precise functional form of the tax function, but rather the total amount of transfer, which depends on $\tau_0, \tau_1$ and $x$. The equilibrium inter-group transfer and the resistance will therefore be exactly the same as they had been in case of proportional taxation.

**Lemma B2** *Suppose $x > 0$ and Assumption 1 holds. Then there exists a unique separating equilibrium in the signaling subgame that satisfies the Cho-Kreps intuitive criterion. In this equilibrium, group B takes a costly action only when it realizes a low valuation from the project. The equilibrium level of action is given by $a^e = \frac{(1-\lambda)(\overline{v}-\underline{v})}{((v^A+\overline{v})-(1-\lambda)(v^A+\underline{v}))}$. Further, at the unique separating equilibrium, the equilibrium intergroup transfers in both states are set to make the weighted inequality loss to be zero..*

To solve for the optimal investment and investment tariff policy, note that the investor's expected payoff is given by $q(1-pa^e)x - \frac{x^2}{2k} - \tau_1 x - \tau_0$, and the government's expected payoff is given by

$$\left(v^A + Ev^B - pa^e\left(v^A + \underline{v}\right)\right)x + \tau_1 x + \tau_0.$$

Applying Lemma B1, we can solve for the equilibrium investment and tariff, which are described in the following proposition.

**Proposition B2** *Assume that group B's valuations of the project is private information and it can signal through costly public action. At the unique separating equilibrium satisfying intuitive criterion, the equilibrium investment is $x^e = k\left(q(1-pa^e) - \tau_1^o\right)$ and the equilibrium two part tariff is given by $\tau_1^e = -\left(v^A + Ev^B - pa^e\left(v^A + \underline{v}\right)\right)$ and $\tau_0^e = \frac{k}{2}\left(v^A + Ev^B + q - pa^e\left(v^A + \underline{v} + q\right)\right)^2$. The investment is taxed if and only if $\left(v^A + Ev^B - q\right) < pa^e\left(v^A + \underline{v} - q\right)$. In equilibrium, G receives an expected payoff of $W^e = \frac{k}{2}\left[\left(v^A + Ev^B + q\right) - pa^e\left(v^A + \underline{v} + q\right)\right]^2$.*

Comparing the above result with Proposition B1, we see that government's payoff decreases as we introduce informational asymmetry. The total size of investment also decreases from $x^o = k\left(q + v^A + Ev^B\right)$ to $x^e = k\left(q + v^A + Ev^B - pa^e\left(v^A + \underline{v} + q\right)\right)$. When we compare our results with the corresponding results under proportional taxation, we see that the government's payoff is higher when it offers a two-part tariff. The condition that determines whether or not investment is taxed, however remains unchanged.

## The alternative regime: No signaling

Next, consider the case when there is no signaling (and therefore no cost), and the government has to implement a redistribution scheme without the precise knowledge of the group valuations. At the redistribution stage, the government implements an inter-group transfer that maximizes the expected welfare, and commits not to renegotiate it. As we derive it in the proportional taxation, the tax offered to the investor is given by

$$
\begin{aligned}
t^{ns} &= \arg\max_{t \in R} pW(\underline{v}, 0, t) + (1-p)W(\overline{v}, 0, t) \\
&= \arg\max_{t \in R} pL(\underline{v}, 0, t) + (1-p)L(\overline{v}, 0, t) = \lambda w^A(0) - (1-\lambda)Ew^B(v^B, 0)
\end{aligned}
$$

where $Ew^B(v^B, 0) = pw^B(\underline{v}, 0) + (1-p)w^B(\overline{v}, 0)$. $G$ incurs inequality loss in both states and the losses are given by

$$
\begin{aligned}
L(\overline{v}, 0, t^{ns}) &= [p(1-\lambda)(\overline{v} - \underline{v})x]^2 \\
L(\underline{v}, 0, t^{ns}) &= [(1-p)(1-\lambda)(\overline{v} - \underline{v})x]^2
\end{aligned}
\tag{23}
$$

The optimal investment tax $\tau^{ns}$ maximizes

$$
\begin{aligned}
& (v^A + Ev^B)x^{ns}(\tau) + \tau x^{ns}(\tau) - [pL(\underline{v}, 0, t^{ns}) + (1-p)L(\overline{v}, 0, t^{ns})] \\
= \; & (v^A + Ev^B)x^{ns}(\tau) + \tau x^{ns}(\tau) - F[x^{ns}(\tau)]^2
\end{aligned}
\tag{24}
$$

where $F = p(1-p)(1-\lambda)^2(\overline{v} - \underline{v})^2$. The following proposition describes the equilibrium under no signaling.

**Proposition B3** *Assume that group B's valuations of the project is private information, but it cannot convey the information to the government. Then in the unique SPNE of the game, G incurs positive inequality loss in both states, given by (23). The size of investment and the investment tariffs are given by* $x^{ns} = k\,(q - \tau_1^{ns})$ *and* $(\tau_0^{ns}, \tau_1^{ns}) = (qx^{ns} - \frac{(x^{ns})^2}{2k} - \tau_1^{ns}x^{ns}, \frac{2qkF - (v^A + Ev^B)}{1+2kF})$ *where* $F = p(1-p)(1-\lambda)^2(\overline{v} - \underline{v})^2$. *In equilibrium, G receives an expected payoff of* $W^{ns} = \frac{k}{2}\frac{(q+v^A+Ev^B)^2}{1+2kF}$.

**Proof.** The optimal size of investment is given by $x^{ns}(\tau_0, \tau_1) = \arg\max_x \left(qx - \frac{x^2}{2k} - \tau_1 x - \tau_0\right)$, which is $k\,(q - \tau_1)$. The optimal investment tax $\tau^{ns}$ maximizes (24). $G$ is however, constrained by the fact that the investor at the optimal contract, cannot receive a utility strictly above her reservation utility, which we assume to be zero. This implies that $\tau_1 x + \tau_0 = qx - \frac{x^2}{2k}$, and the government's payoff as $(v^A + Ev^B + q)x^{ns}(\tau_0, \tau_1) - \frac{x^{ns}(\tau_0,\tau_1)^2}{2k} - F[x^{ns}(\tau_0, \tau_1)]^2$. Solving the first order conditions, we find that the payoff maximizing $\tau_0$ and $\tau_1$ are given by $\tau_1^{ns} = \frac{2qkF - (v^A + Ev^B)}{1+2kF}$. Consequently,

$$
\tau_0^{ns} = qx^{ns} - \frac{(x^{ns})^2}{2k} - \tau_1^{ns}x^{ns} \text{ and } x^{ns} = k\,(q - \tau_1^{ns}).
$$

Putting the optimal values of two part tariff and investment in (24), we get that the government's equilibrium payoff is $\frac{k}{2}\frac{(q+v^A+Ev^B)^2}{1+2kF}$. ■

Comparing the above with the corresponding results under proportional taxation, we see that the government's payoff is higher when it offers a two-part tariff. We are now able to find out the economic value of resistance by comparing $G$'s payoff under signaling with that under no signaling, given that $G$ offers a two part investment tariff. The ratio of the two payoffs is given by

$$
\frac{W^{ns}(p)}{W^e(p)} = \left[\frac{v^A + Ev_B + q}{\sqrt{1+2kF(p)}((v^A + Ev_B + q) - pa^e(v^A + \underline{v} + q))}\right]^2.
$$

The equivalent expression under proportional investment tax has been

$$\frac{W^{ns}(p)}{W^{e}(p)} = \left[\frac{v^A + Ev_B + q}{\sqrt{1 + kF(p)}((v^A + Ev_B + q) - pa^e(v^A + \underline{v} + q))}\right]^2.$$

As the above two expressions, as functions of $p$ and $\lambda$, behave exactly the same way, the proposition 5 (which holds true for all positive values of $k$) remains valid under two part tariff.