Essays on financial instability and political economy of regulation

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This dissertation comprises of three papers that explore the theme of financial instability and political economy of regulation. The first chapter studies how in the presence of moral hazard faced by banks, balance sheet opacity may induce mistakes by other market participants and consequently amplify a credit boom. The second chapter examines the role of voter preferences in shaping regulation aimed at curbing over-borrowing and alleviating future busts. The third chapter analyses how the structure of competition between interest groups affects politician's choice of the form of political governance and its consequences for policy.

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Contents

Introduction

The Great Financial Crisis of 2007-2008 uncovered gaps in our understanding of financial stability, reshaping the research agenda of macroeconomics and finance. One of the key questions that emerged is what drives the build up of risk during the boom-phase of the financial cycle. The subsequent literature recognized the potential role of mistakes by investors and households (Gennaioli et al., 2012), moral hazard faced by financial intermediaries (Acharya and Viswanathan, 2011), and externalities associated with borrowing (Lorenzoni, 2008). Insufficient regulation, which can emerge as a consequence of political considerations, can be an important enabler for some of these mechanisms (Rajan, 2011).

This dissertation comprises of papers that explore these themes. The first chapter studies how in the presence of moral hazard faced by banks balance sheet opacity may induce mistakes by other market participants and amplify a boom. The second chapter examines the role of voter preferences in shaping regulation aimed at curbing over-borrowing and alleviating future busts. The third chapter analyses how the structure of competition between interest groups affects politician's choice of the form of political governance and the consequences for policy.

The first chapter is joint work with Enrico Perotti. We develop a theoretical model, which uncovers how bank's risk-shifting incentives and opacity of their balance sheets can obstruct the assessment of the aggregate economic conditions by rational market participants. In our setting large banks with superior information about aggregate productivity can engage in excessive risk taking, inflating asset prices. As their balance sheets are opaque, other market participants do not observe banks' incentives and so may be unable to correctly interpret the signal on asset prices. The resulting error in inference amplifies the high aggregate investment when global banks risk-shift and can lead to low investment by the less-informed market participants otherwise. If these uninformed agents are also levered, the uncertainty that arises due to confused inference may induce them to risk-shift, exacerbating the over-investment and the extent of future defaults.

The opacity of banks' balance sheets is central to the analysis. Since size and composition of assets and liabilities are unobservable to other agents, there is no scope for direct inference from banks' investment choices. Critically, opacity also obscures bank leverage. As a consequence other market participants face uncertainty regarding bank's incentives. They cannot determine whether high asset prices reflect the economy's fundamental or are a consequence of excessive risk-taking by global banks enabled by their ample access to funding. An analogous inference problem emerges if there is a chance that bank funding is constrained so the asset may be under-priced.

In the second chapter I introduce a voting model into a setting with negative borrowing externalities to study voter's preferences for prudential regulation. In the model, borrowers do not internalize how their choice of initial debt exacerbates a welfare-reducing fall in collateral price. This results in excessive borrowing. Previous research established that a social planner can improve welfare using prudential policies such as debt limits (Jeanne and Korinek, 2020). I study what is the strictness and efficiency of prudential regulation implemented by an elected politician and explore the role of income inequality and imperfections in the political process.

If the political process is smooth, politician can commit to universally enforce regulation. In this case borrowers internalize the effect of the debt limit on collateral prices and access to credit in the future. They support an implementation of a binding prudential policy. With income heterogeneity among borrowers, falling collateral prices have an additional, re-distributive effect. Since lower prices enable high-income borrowers to buy the assets cheaply from the low-income borrowers, they have an incentive to allow for a larger drop in prices. As a result, high-income borrowers support lax prudential policy, while the low-income borrowers prefer a strict debt limit. The equilibrium policy is strict when low-income borrowers have more electoral power, which occurs when their other political interests are highly concentrated. The resulting policy lies on the Pareto Frontier of a social planner constrained by the same financial frictions as the market.

With political imperfections, such as regulatory capture, equilibrium policy differs from the constrained efficient benchmark. I study this case by assuming that the politician can grant exemptions from regulation to borrowers with political connections. I show that such exemptions crucially affect the policy preferences of all voter groups. Borrowers without connections see the effectiveness of the policy decrease. Due to these depressed marginal benefits of regulation they prefer a laxer debt limit. On the other hand, those with political connections anticipate the exemptions, and thus support a very strict limit, shifting the burden of regulation onto to the other borrowers. Either too lax or too strict equilibrium policy may emerge depending on the electoral power of politically connected borrowers.

The third chapter is joint work with Enrico Perotti and Marcel Vorage. We explore how a semi-benevolent politician chooses between directly controlling firm entry and introducing a rule that specifies a minimum entry requirement. Critical to this choice is the difference in structure of competition among special interest groups induced by these two forms of governance.

Under direct control the politician can grant exclusive entry right to the group that offers the highest bribe, but faces a risk of prosecution due to illegal nature of bribery. Narrow access rights make entry very valuable for all bribing groups. As a result they compete to make a winning offer, driving up the political contributions, so that the politician can extract all of the available rents.

Under the minimum requirement rule, the politician sets a cut-off level of an observable characteristic of citizens. This choice may be influenced by lobbying. Since for a given level of the requirement those with high enough characteristic cannot be barred from entering the market, other lobbying groups face lower benefit of making a winning offer. This decreases the bargaining power of the politician in the game with the lobbying group composed of those with highest characteristics. As a result the politician shares rents with the lobbyists.

The politician prefers direct control and bribing whenever legal institutions are weak and she faces a low probability of prosecution. Otherwise governance by minimum requirement rules is optimal. We further examine the possibility that the likelihood of prosecution for bribery depend on the identity of entrepreneurs who are allowed to enter. This can reflect differences in power or access to legal representation among citizens. Heterogeneous distribution of legal power undermines the competition between bribing groups, so that those with high power can now extract some of the politicians' rents. In this case the choice of the form of governance depends on both the quality of legal institutions and the distribution of legal power in the economy.

Chapter 1

The Good, the Bad and the Missed Boom

1.1 Introduction

In the classic view of business cycle the volume of credit is driven by real shocks, and financial intermediation affects it only via contractual frictions. However, recent evidence points to an independent role of credit supply in explaining output fluctuations (Krishnamurthy and Vissing-Jorgensen, 2012; Mian et al., 2017). Credit booms with weak productivity are more likely to end in financial crises (Gorton and Ordonez, 2016; Mian et al., 2019). This evidence suggests that instability may stem from excess lending relative to productive demand, and raises the question of why market participants condone such an unbalance.

A diffused view holds that the recent financial crisis was caused by deliberate risk taking, while an alternative cause for excess credit may have been investor inability to assess the risk accumulation. During the 2002-2007 credit boom financial prices such as bank equity returns and credit spreads suggest that investors did not anticipate rising losses (Baron and Xiong, 2017; Krishnamurthy and Muir, 2016). Historical studies of credit expansions confirm that risk accumulation is often not recognized and financial instability comes as a surprise (Reinhart and Rogoff, 2009; Richter et al., 2017).

Why would most investors and banks not recognize increasing risk? Behavioral biases are likely to play a key role (Gennaioli et al., 2015). Yet even rational agents may be unable to correctly assess the state of the economy from distorted signals. This paper offers a rational explanation for episodes of excess credit, where deliberate risk taking by some may induce a further amplification due to imprecise inference by other players. It thus reconciles the risk shifting view with the evidence of market participants underestimating rising risk during booms. The approach also identifies a complementary possibility of distorted inference inducing underinvestment.

In the model, abundant funding supply may encourage risk shifting by global intermediaries, leading to a bad boom characterized by large exposures to risky assets and inflated prices. Because global banks' balance sheets are opaque, other agents cannot infer banks' incentives. As outsiders cannot disentangle demand and supply effects, they may misinterpret high asset prices driven by speculation as reflecting strong economic fundamentals. Overestimating productive opportunities in turn can amplify the credit and investment expansion. Likewise when funding supply is low, agents may underestimate the true quality of opportunities and invest too conservatively.

The setup considers two types of agents. Global intermediaries integrated in the international financial system have access to external capital flows and enjoy superior information about aggregate productivity. Local banks face fixed deposit supply and do not observe productivity. All bank debt is insured.[1] Bank assets and liabilities are opaque, so that funding position as well as portfolio allocations are banks' private information. Each bank can issue loans to a productive sector to earn marginally decreasing returns. Moreover, global banks can also invest in a risky long term asset, whose expected payoff increases in aggregate productivity. As in McKinnon and Pill (1997) uninformed agents try to infer the productivity from the actions of the better-informed global banks, so that to inform their investment choices. Faced with the opacity of balance sheets, local banks turn to asset prices to asses the aggregate state.

In equilibrium global banks choose between a solvent and a risk shifting strategy. A solvent strategy is characterized by more productive lending and lower risk exposure, so that losses never compromise deposit repayment. The risk shifting strategy entails a high exposure to the risky asset that may lead to bank default. We show that intermediaries choose to risk shift whenever funding supply is excessive relative to their productive lending opportunities. Intuitively, abundant funding grants them the option to increase leverage and scale up their gamble.

Three possible outcomes may arise. If funding supply is low relative to the quality of productive opportunities, global intermediaries have insufficient resources to fully support their valuable lending, so that the economy ends up in *a missed boom.* As funds are scarce, risky long term assets are undervalued. Under a balanced funding supply intermediaries follow a solvent strategy, optimally using their lending capacity. In such *a good boom*

[1] While in reality not all bank liabilities are insured, global banks are deemed too big to fail. Our results remain even if some risk is priced as long as depositors are uninformed about the aggregate state.

assets are priced at fundamental value, and correctly signal actual productivity. When funding supply is excessive banks scale up their speculative bets and leverage in order to risk shift, resulting in *a bad boom.* As more banks pursue this risky strategy, assets become overvalued.[2] This reduces risk shifting profits, so in equilibrium only a fraction of banks chooses to speculate, and the equilibrium asset price ensures indifference between the two strategies.

Critically, in states with an imbalance of savings relative to profitable investment asset prices reflect both productive opportunities and available funding. This may cause local banks to misjudge the state of the economy. A high price can reflect either strong productivity under a good boom, or weak economic fundamentals under a supply-fueled bad boom. Uninformed agents may also be unable to distinguish between a good boom and a missed boom with high productivity but insufficient funding supply.

The key factor confusing the inference process is the opacity of bank balance sheets. It implies that uninformed agents observing only asset prices cannot assess bank incentives and thus cannot extract a precise signal on productivity. Actual bank leverage can be hard to infer due to hidden contingent liabilities, unrecognized losses or indirect risk exposures via off balance sheet vehicles.[3]

An imprecise inference results in amplification of lending by local banks when the funding supply is high (e.g. in a bad boom), as well as in credit dampening when funding is scarce (e.g. in a missed boom). This occurs particularly when productivity shocks are persistent, so that strong fundamentals today boost the expected payoff of durable assets. As a result, when inference is imprecise local uninformed banks may lend excessively (from the ex-post perspective) when global funding supply is higher than expected, and too little when lower.

Since uninformed banks are assumed to be rational, their inference mistakes are zero in expectation. However, this does not imply that their average lending is generally unbiased. We show that when inference is sufficiently imprecise, local banks' incentives are distorted. High uncertainty about productivity may lead them into a form of *induced risk shifting*, where they lend on the base of the higher productivity estimate. Thus, high opacity of global banks may lead to distress whenever high asset prices are driven by abundant funding, significantly broadening the scale of financial risk beyond what is taken up by

[2] Moral hazard justifies global banks' investment in the asset even when it is overpriced as in Allen and Gorton (1993).

[3] During the 2002-08 credit boom banks were able to shift assets to shadow banks while retaining exposure, and even outright hide assets. This was the case of Lehman's Repo 105, a UK legal entity which hid almost 10% of its risky assets and debt.

global banks.

Our positive model of misunderstood credit volume presumes that regulatory intervention is quite difficult, as regulators have limited ability to control actual bank leverage. This setup does define a key role for a global macro-prudential authority in easing the inference problem. Truly global institutions such as the Bank of International Settlements or the Financial Stability Board may not regulate intermediaries but do collect and disclose measures of aggregate credit by global banks. Offering a credit quantity signal next to the observable asset prices helps resolve the inference problem in our basic setting. Yet even in our context of rational inference confusion may persist if uninformed agents face additional (and plausible) uncertainty on global leverage, for example due to unobservable losses on legacy assets. In other words, a high degree of bank opacity leads to imperfect inference even if agents observe both credit quantity and asset prices. Proper policy recommendations would require defining welfare issues of instability and asset mispricing beyond the scope of our approach.

Section 2 discusses how this work relates to the literature. Section 3 presents the baseline model and its main results. Section 4 studies the inference problem with additional observable signal and source of uncertainty about leverage. Section 5 concludes.

1.2 Related Literature

Recent evidence suggests that a rapid credit growth is a good predictor of financial crisis (Borio, 2014; Reinhart and Rogoff, 2009; Schularick and Taylor, 2012). Credit booms funded by foreign inflows or wholesale funding often lead to surging house prices, and are more likely to end in crises (Richter et al., 2017), suggesting an imbalance between productive investment and funding volumes. In contrast, credit expansions accompanied by more investment and sustained productivity growth tend to produce stable growth (Gorton and Ordonez, 2016). Recent US evidence shows how in 2000s local credit supply shocks boosted house prices rather than local productivity (Mian and Sufi, 2009; Mian et al., 2019), and lead to a sharper cycle correction in the bust (Di Maggio and Kermani, 2017).

Abundant credit supply may be due to demographic shifts, safety-seeking capital inflows (Caballero and Krishnamurthy, 2008; Eichengreen, 2015) or financial deregulation (Favara and Imbs, 2015; Mian et al., 2019). A rising credit supply boosts economic performance when it attenuates financial frictions holding back profitable projects. Yet trends in the 2002-2008 credit expansion appear consistent with excess credit supply rather than a relaxation of borrowers' constraints, not least because it promoted higher asset prices rather than productive investment (Justiniano et al., 2019).

In our setup prudent lending is sustained when funding supply is aligned to productive lending needs. In this case assets are fairly priced, signaling correctly the level of productivity and guiding an appropriate lending volume by the less informed. Asset prices may be over- (under-) priced under excessive (insufficient) funding. Our approach shows how bank balance sheet opacity may hide the imbalance, so that risk taking may be propagated by imperfect inference.

A related view holds that rising risk is not fully anticipated as agents cannot form fully rational beliefs. Even a small fraction of overconfident agents can can lead to excessive asset prices thanks to rising leverage (Geanakoplos, 2010). Yet there is little evidence of marked differences in risk concerns during the recent boom even among experts (Baron and Xiong, 2017), suggesting diffused misjudgement of rising risk.[4]

Behavioral rules of posterior belief formation such as representativeness heuristics recognize that the structure of the economy evolves, so that agents are likely to miss rising risk signals (Gennaioli et al., 2015). The approach focuses on how circumstances affect the interpretation of signals, and may lead to neglect of contradictory facts (Bordalo and Shleifer, 2018). Our contribution is a rational benchmark on why public inference may be confused, without denying the role for limited rationality. In general, some form of imperfect information may be needed to explain why regulators failed to intervene in time.[5] This approach is related to work on how excess confidence and asset prices may arise under rational learning (Pástor and Veronesi, 2003; Biais et al., 2015). A distinct insight is that opacity of bank balance sheets may be an important factor obstructing the interpretation of price and quantity signals by market participants. This view is related to work by Thakor (2016), where uncertainty over banker quality may result in under- or overestimation of risk, and by Lee (2016) where investors cannot interpret bank lending by observing bank funding demand alone.

Bank opacity has an important role in managing liquidity risk (Dang et al., 2017), boosting the volume of intermediation and improving risk sharing (Hirshleifer, 1978).[6] A

[4] The nonfictional book "The Big Short" (Lewis, 2011) describes how few investors realized how risky lending had become even late in the boom. In fact, many of the few who did had autistic traits that may have made them less prone to social herding.

[5] Regulators may also fail to intervene because of political pressure (Müller, 2019), or face constrained capacity to enforce rules (Martynova et al.).

[6] Transparency can reduce adverse selection in a crisis, while in the absence of moral hazard it may be suboptimal in normal times (Alvarez and Barlevy, 2015; Bouvard et al., 2015; Goldstein and Leitner, 2018).

policy concern is that opacity may hamper market and supervisory discipline (Tarullo, 2010). Our aim is not to offer a recommendation on the optimal level of bank opacity. In particular, we abstract from its known benefits, discussed in the literature. Our novel result concerns its confusing effect on economic expectations, distorting investment choices in times of large funding imbalances.

A related literature studies the effect of low rates (Dell'Ariccia et al., 2017; Jiménez et al., 2014) and credit spreads on bank franchise value and risk incentives (Dell'Ariccia et al., 2014; Martinez-Miera and Repullo, 2017). Our approach focuses on credit volume rather than its price, with an inelastic funding supply boosting risk incentives by enabling more leverage. It abstracts from bank funding costs, either because bank funding is (de facto) insured or because safe asset markets are segmented, as recent evidence suggests (Krishnamurthy and Vissing-Jorgensen, 2012; Gorton et al., 2012). Empirically, the volume of savings appears fairly inelastic to interest rates (Canzoneri and Diba, 2007), so excess savings are not self correcting.

1.3 Model Set Up

In this section we introduce the model set up and solve for the equilibrium. We first study the equilibrium of a sub-game involving global informed banks and then explore its implications for the inference and choices by local less-informed agents.

There are two dates ($t = 0, 1$) and two types of active agents: a unit mass of global banks indexed by $i \in \{\mathbb{G}\}$, informed about the aggregate state and a unit mass of local, uninformed banks indexed by $k \in \{\mathbb{L}\}$. At $t = 0$ they make investment choices which pay off at $t = 1$. Critically, bank balance sheets are opaque so that their size as well as composition are banks' private information at the initial date.

1.3.1 Investment Opportunities

There are two investment opportunities in the economy: productive lending, available to all banks, and a risky asset in fixed supply (eg. land and real estate) whose long term value depends on a future state of the economy. Investment in the latter can be interpreted as an outright purchase of an asset or lending that finances asset acquisition by a borrower. For simplicity investment in the risky asset is only available to global banks.

Each global and local bank $j \in \{\mathbb{G}, \mathbb{L}\}$ has access to a bank specific pool of productive loans. Lending offers decreasing marginal returns at the bank level, reflecting a scarcity of good quality projects that require bank credit. Specifically, lending x_j yields a payoff of $f(x_j) = \alpha\sqrt{x_j}$ at $t = 1$, where α is a measure of aggregate productivity drawn at $t = 0$ from a uniform distribution:

$$\alpha \sim U(\underline{\alpha}, \overline{\alpha})$$

Thanks to the scope of their operations global banks have superior information about the aggregate component governing the productivity. They observe the realized α at $t = 0$, while other agents know only the distribution.[7]

The payoff of the risky asset at $t = 1$ depends on the future state of the economy, which could be good or bad and is correlated with current productivity. An interpretation is that the final payoff reflects the long term value of a durable asset and depends on future prospects, which are more likely to be high when current fundamentals are strong. The payoff of the asset $g(y)$ is drawn from the following binomial distribution:

$$g(y) = \begin{cases} Ry & \text{with probability } q(\alpha) \\ 0 & \text{with probability } 1 - q(\alpha) \end{cases}$$

From the perspective of $t = 0$ the probability that the economy will be in the good state next period is $q(\alpha) \in (0, 1)$, with $q'(\alpha) > 0$ that can be viewed as a proxy for the persistence of the productivity shock. When it is large, a high draw of productivity today implies a high likelihood of strong fundamentals in the future. This increases the probability of the good state and the high asset payoff at $t = 1$.

The initial asset owners are uninformed and derive utility only from $t = 0$ consumption, so they accept any positive price. Thus, the asset price p is determined by global banks' demand at $t = 0$. Uninformed local banks can observe the price of the asset but, due to balance sheet opacity not the portfolio allocation of global banks.

In order to streamline the discussion of the equilibrium, we introduce the following restrictions on parameters governing the payoffs of the investment opportunities.

Assumption 1.1. The parameters satisfy:

A. $2\,(1 + q(\alpha))\, q(\alpha) < q'(\alpha)\alpha \;\forall \alpha$

B. $R < (\frac{\alpha}{2})^2 \;\forall \alpha$

Assumption 1.A requires that the persistence of a productivity shock is not too low. It ensures that increases in productivity make the risky asset sufficiently more attractive so

[7] Our results are not affected if local banks are assumed to have superior information about the idiosyncratic quality of local investment opportunities.

its' equilibrium price always increases in productivity. While not necessary for our basic result, it is a sufficient condition for amplification of excess lending through confused inference. Assumption 1.B limits the upside payoff of the risky asset relative to returns on lending. It ensures an explicit equilibrium cut off for bank strategies. A higher return, R, makes investment in the risky asset relatively more profitable than productive lending and may result in multiple equilibrium cut offs.

1.3.2 Funding supply

Global and local banks have access to funding supply S and s respectively, reflecting aggregate global savings and local deposits. Banks choose how much funding to accept, with any residual placed in private storage by the savers. We assume that bank deposit markets are segmented so that each bank faces a price-inelastic funding supply. Moreover the deposits are insured.[8] Thus, the bank funding cost equals the return of private storage, which we normalize to 1.

Global banks are homogeneous in terms of their access to funding supply. The funding available to each global bank is given by S and subject to an aggregate shock:

$$S = \begin{cases} s^L & \text{with probability } \rho \\ s^H & \text{with probability } 1 - \rho \end{cases}$$

The funding availability is observed only by global banks. Each of them chooses how much of it to accept, denoted by s_i. Due to the opacity of bank balance sheets the choice of funding is global bank's private information.

The amount of funding available to local banks is predetermined and fixed at s with s_k denoting the amount accepted by local banks.

1.3.3 Timing

The timing is as follows:

- At $t = 0$:
  - Aggregate productivity α and global bank funding supply S are realized and observed by global banks;

[8] Another interpretation is that global banks are too big to fail. In any case the assumption is not critical for our results as long as savers are uninformed about the productivity.

- Global banks accept funding s_i and choose their portfolio: x_i, y_i;
- All funding not used by banks is stored by savers;
- Uninformed local banks observe the asset price p, and choose their productive lending x_k;

- At $t = 1$:
  - The state of the economy is realized;
  - All assets pay off;
  - Banks or deposit insurance pay back depositors;

1.4 Global Banks' Choices

After observing aggregate productivity and the availability of funding each global bank chooses its' portfolio so that to maximize the expected profits. We establish a benchmark by finding the optimal investment in the absence of a key friction: limited liability on deposit funding. The problem corresponds to that faced by unlevered, informed investors investing their equity. We then move to study the original problem of a levered bank and compare bank's investment strategies to those in the benchmark.

1.4.1 Benchmark: Unlevered Investor's Problem

Consider the investment choice by an unlevered, informed investor with endowment E and access to storage (with return equal to 1, equivalent to bank refusing some available funding). Investor chooses productive lending x_i, risky asset purchases y_i and amount put into storage z_i, so that to maximize expected profits subject to the budget constraint and the no-short-selling constraint.

$$\max_{x_i, y_i, z_i} \ \alpha\sqrt{x_i} + q(\alpha)Ry_i + z_i - E \tag{1.1}$$

subject to:

$$x_i + py_i + z_i = E \qquad \text{(budget constraint)}$$
$$y_i \geq 0 \qquad \text{(no-short-selling constraint)}$$

The optimal productive lending equalizes its marginal return with the opportunity cost of capital if the endowment is sufficient. The opportunity cost of capital is the expected return of the best alternative investment, which depending on the price is either the risky asset or storage.

$$x_i^* = \begin{cases} \min\left[\left(\frac{\alpha p}{2q(\alpha)R}\right)^2, E\right] & \text{if } p \leq (\alpha)R \\ \min\left[\left(\frac{\alpha}{2}\right)^2, E\right] & \text{if } p > q(\alpha)R \end{cases} \quad (y_i^*, z_i^*) = \begin{cases} \left(\frac{E-x_i^*}{p}, 0\right) & \text{if } p < q(\alpha)R \\ \left(\frac{E-x_i^*-z_i^*}{p}, E - x_i^* - py_i^*\right) & \text{if } p = q(\alpha)R \\ (0, E - x_i^*) & \text{if } p \geq q(\alpha)R \end{cases}$$

After choosing the level of lending investor allocates any remaining equity endowment into storage or the risky asset. The investor allocates all residual endowment to the risky asset if $p < q(\alpha)R$, is indifferent between the two opportunities if $p = q(\alpha)R$ and opts for investment in storage if $p > q(\alpha)R$.

1.4.2 The Problem of a Global Bank

After observing aggregate productivity and available funding, each global bank chooses how much funding to accept, s_i, as well as levels of productive lending, x_i, and investment in the risky long-term asset, y_i, to maximize expected profits subject to budget, funding and no-short-selling constraints.

$$\max_{x_i, y_i, s_i} q(\alpha)\left(\alpha\sqrt{x_i} + Ry_i - s_i\right) + (1 - q(\alpha))\max\left[\alpha\sqrt{x_i} - s_i, 0\right] \tag{1.2}$$

subject to:

$$\begin{aligned} & x_i + py_i = s_i && \text{(budget constraint)} \\ & s_i \leq S && \text{(funding constraint)} \\ & y_i \geq 0 && \text{(no-short-selling constraint)} \end{aligned}$$

The solution of a problem is either a solvent strategy or a risk shifting strategy. A solvent strategy requires a low amount of risky investment to ensure deposit repayment. A risk shifting strategy involves default in the bad state. Our basic result is that the optimal strategy depends on the level of available funding supply.

Lemma 1.1. There exists an *individual risk shifting threshold* of funding supply, given by:

$$\hat{s}(\alpha,p)=\begin{cases}\left(\frac{\alpha}{2}\right)^2\frac{p}{q(\alpha)R}[1+q(\alpha)] & \text{if } p\leq q(\alpha)R\\ \left(\frac{\alpha}{2}\right)^2\frac{1-q(\alpha)\frac{p}{R}}{q(\alpha)(\frac{R}{p}-1)} & \text{if } p>q(\alpha)R\end{cases} \tag{1.3}$$

such that:

- when funding supply is below $\hat{s}(\alpha,p)$ the bank chooses a solvent strategy:

$$x_s^*=\begin{cases}\min\left[\left(\frac{\alpha p}{2q(\alpha)R}\right)^2,S\right] & \text{if } p\leq q(\alpha)R\\ \min\left[\left(\frac{\alpha}{2}\right)^2,S\right] & \text{if } p>q(\alpha)R\end{cases}\qquad (y_s^*,s_s^*)=\begin{cases}\left(\frac{S-x_s^*}{p},S\right) & \text{if } p<q(\alpha)R\\ \left(\frac{s_s^*-x_s^*}{p},x_s^*+py_i^*\right) & \text{if } p=q(\alpha)R\\ (0,x_s^*) & \text{if } p>q(\alpha)R\end{cases}$$

- when funding supply is above $\hat{s}(\alpha,p)$ the bank chooses a risk shifting strategy:

$$x_r^*=\left(\frac{\alpha p}{2R}\right)^2\qquad (y_r^*,s_r^*)=\left(\frac{S-x_r^*}{p},S\right)\qquad \forall p$$

- when funding supply is equal to $\hat{s}(\alpha,p)$, the bank is indifferent between the two strategies.

Proof. In Appendix 1.8.1 □

In a solvent strategy, bank's portfolio corresponds to the choice of an unlevered agent. Global bank chooses its productive lending so that to equalize its' marginal return with the opportunity cost: the funding cost or the expected return on the risky asset. Any residual funding is either rejected or invested in the asset.

In a risk shifting strategy the bank defaults in the bad state, with probability $1-q(\alpha)$, so it maximizes profits conditional on the realization of the good state. Its portfolio choice equalizes the marginal productive return with the risky asset's return in the good state, $\frac{R}{p}$. This higher opportunity cost implies that a risk shifting bank issues fewer productive loans, compared to a solvent bank or an unlevered agent. The bank allocates all residual funding to the risky asset. Thus, the risk shifting strategy is characterized by overinvestment in the risky asset and misallocation of funding (due to too low loan issuance) relative to the unlevered investment benchmark.

There is a minimum (state-contingent) investment scale that justifies risk shifting. The strategic shift occurs because a large funding supply shock implicitly enables higher leverage, so the expected return on a larger risky portfolio exceeds the solvent strategy return on a smaller investment scale.

Lemma 1.2. The individual risk shifting threshold:

- increases in the price of the risky asset $\frac{\partial \hat{s}}{\partial p} > 0$,
- decreases in the productivity, $\frac{\partial \hat{s}}{\partial \alpha} < 0$, if Assumption 1.A holds.

Proof. In Appendix 1.8.1 □

Intuitively, an increase in the price of the risky asset decreases the relative profits under the risk shifting strategy, making it less attractive for the bank. As a result higher scale of investment (enabled by higher funding) is necessary to incentivize the bank to overinvest in the asset.

An increase in productivity rises the return on lending as well as the probability of a high asset payoff. If the latter effect is strong (ie. the measure of persistence of productivity, $q'(\alpha)$, is sufficiently high as ensured by Assumption 1.A), an increase in productivity disproportionately increases the profits from risk shifting, pushing the funding threshold downwards.[9]

1.4.3 Equilibrium Investment and Prices

The individual bank strategies and the decision rule determine the equilibrium of the global banks' game.

Proposition 1.1. If Assumption 1.B is satisfied, there exists a unique *equilibrium risk shifting threshold* of funding supply given by:

$$\mathcal{S}_r(\alpha) = \hat{s}(\alpha, q(\alpha)R) \tag{1.4}$$

such that when funding supply is above $\mathcal{S}_r(\alpha)$ a positive fraction of banks engages in risk shifting, else all banks choose the solvent strategy.

Proof. In Appendix 1.8.2 □

[9] If instead the persistence of the productivity shock was low, the risk shifting threshold may increase as a result of a rise in productivity.

A global bank prefers to risk shift only if the available funding supply is sufficiently high relative to the asset price. As established in Lemma 1.2, the individual risk shifting threshold increases in price. The maximum equilibrium price that can be achieved if all banks invest solvently reflects the fundamental value of the asset, $p = q(\alpha)R$. Thus, if funding supply exceeds the individual threshold evaluated at this point, banks prefer the risk shifting rather than the solvent strategy. A rising share of risk shifting banks inflates asset price until it is so high banks are indifferent between the two strategies, ie. when it reaches $p = \hat{p}(\alpha, S)$ implicitly defined in $S = \hat{s}(\alpha, \hat{p}(\alpha, S))$.

If funding is below the equilibrium risk shifting threshold, all banks invest solvently. In that case the demand for the risky asset is high enough to drive up the price to the fundamental value whenever funding supply is not too low. If it is low, banks hold insufficient resources to fully utilize available investment and lending opportunities. We define the cut off level of supply below which this problem emerges as the *balanced funding threshold*:

$$\mathcal{S}_b(\alpha) = q(\alpha)R + \left(\frac{\alpha}{2}\right)^2 \tag{1.5}$$

If the available funding is below the balanced threshold banks accept all of the supply and allocate it between productive lending and purchases of the risky asset. As funding is limited, bank's demand for the asset is insufficient to drive up the price to the fundamental value. Instead, the equilibrium price reflects the available "cash-in-the-market" as well as the relative productivity of the opportunities. As long as Assumption 1.B is satisfied (the marginal return of the productive lending is sufficiently high relative to the upside return of the asset) the discount on the price is not large enough to encourage risk shifting at this low level of funding. As a consequence $\mathcal{S}_r(\alpha)$ is the unique equilibrium risk shifting threshold.

Lemma 1.3. For a given level of productivity

- if $\mathcal{S}_b(\alpha) > S$, funding supply is *constrained*, all banks choose the solvent strategy: $x^* = \left(\frac{\alpha p^*}{2q(\alpha)R}\right)^2$, $y^* = S - \left(\frac{\alpha p^*}{2q(\alpha)R}\right)^2$; the asset is underpriced $y^* = p^* < q(\alpha)R$
- if $\mathcal{S}_r(\alpha) > S > \mathcal{S}_b(\alpha)$, funding supply is *balanced*, all banks choose the solvent strategy: $x^* = \left(\frac{\alpha}{2}\right)^2$, $y^* = q(\alpha)R$; the asset is fairly priced $y^* = p^* = q(\alpha)R$
- if $S > \mathcal{S}_r(\alpha)$, funding supply is *excessive*, fraction $\psi^*(\alpha, S) = \frac{\hat{p}(\alpha,S)}{y_r^*}$ of banks is risk shifting: $x_r^* = \left(\frac{\alpha p^*}{2R}\right)^2$, $y_r^* = S - \left(\frac{\alpha p^*}{2R}\right)^2$ and the remaining banks choose the solvent strategy: $x_s^* = \left(\frac{\alpha}{2}\right)^2$, $y_s^* = 0$; asset is overpriced $p^* = \hat{p}(\alpha, S) > q(\alpha)R$

Proof. In Appendix 1.8.2 □

When the funding supply is constrained, none of the banks is willing to risk shift. Banks invest solvently and balance their exposure to the risky asset with productive lending so that to equalize the marginal returns. Since funding is low, the demand for the risky long term asset is insufficient to drive the price up to its fundamental value and as a consequence, productive lending is also constrained. As banks are unable to make a full use of the available investment opportunities, we refer to the equilibrium under a constrained funding supply as a *missed boom*. A decrease in the funding supply leads to a fall in lending and more missed opportunities.

If funding is balanced, solvent investors demand the risky asset only until the price is equal to its expected payoff. Lending fully utilizes the productive potential. Any funding above the balanced threshold, $\mathcal{S}_b(\alpha)$, is rejected by banks. As they use all of the available investment opportunities and invest prudently, so that to avoid the risk of default, we refer to the equilibrium under a balanced funding supply as a *good boom*.

When funding supply is excessive, possibility of raising high leverage makes risk shifting attractive. This in turn increases the asset price. In equilibrium fraction $\psi^*(\alpha, S)$ of banks shifts risk driving up the price to $\hat{p}(\alpha, S)$. At this point banks are indifferent between the two strategies so that remaining $1 - \psi^*(\alpha, S)$ banks choose to invest solvently. Relative to the outcome in the absence of limited liability (ie. in an economy populated by unlevered informed investors instead of global banks), banks overinvest in the risky asset, at the cost of issuing too few productive loans. Thus, equilibrium with excessive funding is characterized by exorbitant total investment and a misguided allocation of the funds to the available opportunities. Consequently, we refer to it as a *bad boom*. An increase in the funding supply drives up the share of risk shifting banks, resulting in higher overinvestment in the asset and more misallocation, further deteriorating the quality of the boom.

Comparative Statics

The relationship between equilibrium prices and funding supply, follows directly from Lemma 1.3. Figure 1.1 provides an illustrative plot of price as a function of funding supply for some fixed realization of productivity.

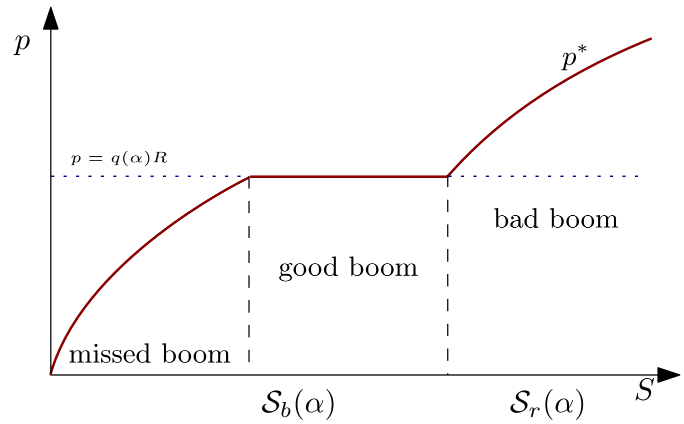


Figure 1.1: Asset price as a function of funding supply (red curve). Blue dotted line plots the fair price of the risky asset $p = q(\alpha)R$ for reference.

Corollary 1.1. For a given level of productivity, the equilibrium price is a weakly increasing function of the funding supply. The equilibrium price is constant in the balanced funding range and strictly increasing in the funding supply in the constrained and the excessive funding range.

In order to study the relationship between equilibrium price and productivity, for a given level of funding supply S, we define :

- the risk shifting productivity threshold $\hat{\alpha}_r(S)$ as the cut off level of productivity below which some banks risk shift in equilibrium: $\mathcal{S}_r(\hat{\alpha}_r) = S$;

- the balanced productivity threshold $\hat{\alpha}_b(S)$ as the cut off level of productivity above which banks are constrained and cannot make a full use of available opportunities: $\mathcal{S}_b(\hat{\alpha}_b) = S$;

Figure 1.2 below provides an illustrative plot of the relationship between price and productivity for some fixed value of funding supply.[10]

[10] The graph corresponds to the case when Assumption 1.A is satisfied. If it is not price may be decreasing in productivity in the excessive or constrained funding range.

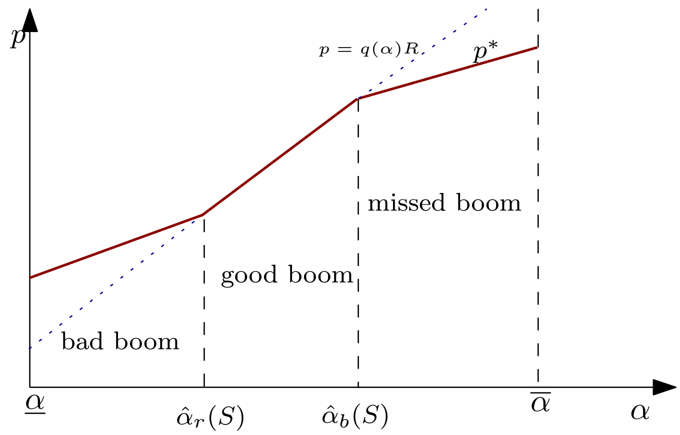


Figure 1.2: Asset price as a function of productivity (red curve). Blue dotted line plots the fair price of the risky asset $p = q(\alpha)R$ for reference

Corollary 1.2. The equilibrium price increases in productivity

- whenever funding is in the balanced range;
- when funding is in the constrained or the excessive range, if Assumption 1.A is satisfied.

Since probability of the good state increases in productivity, a rise in productivity increases the return on both, lending and the risky investment. When bank funding is balanced, the price of the risky asset reflects its' expected payoff and is thus increasing in the aggregate productivity.

If funding is excessive, the price is such that banks are indifferent between the risk shifting and the solvent strategy. An increase in productivity increases profits under both. If persistence of productivity is high (Assumption 1.A), the increase in profits is disproportionately larger under the risk shifting strategy, making it more attractive. As a result, for a given level of funding in the excessive range, when productivity increases more banks prefer to shift risk, driving up the equilibrium price.

In the case of constrained funding supply, the equilibrium price equates the marginal return on the productive lending with the risky asset's return, both of which increase as the aggregate productivity rises. If the persistence of the productivity shock is high, the impact on the risky payoff dominates and consequently the equilibrium price increases in productivity.

1.5 Uninformed Agents' Choices

1.5.1 Inference Problem

Uninformed agents do not observe the realization of the aggregate productivity, but can use asset prices to infer it. Since balance sheets of global banks are opaque, an uninformed bank does not observe their funding supply nor portfolio allocations. Consequently, it may be unable to asses global banks' incentives and to recognize whether they risk shift, invest solvently or are constrained. Since the good, the bad and the missed boom all yield different price schedules, precise inference from prices may be impossible.

Proposition 1.2. The uninformed infer multiple productivity values when the equilibrium price is in the imprecise inference set, $\mathcal{I}$, and make a correct inference of one productivity value when the equilibrium price is outside of this set. A necessary condition for the imprecise inference set to be non-empty is:

$$\hat{\alpha}_r(s^H) > \underline{\alpha} \ \vee \ \hat{\alpha}_b(s^L) < \overline{\alpha}$$

Proof. In Appendix 1.8.3 □

Whenever funding is balanced and the global banks game results in a good boom the asset price reflects the expected payoff and as a consequence, the productivity. If the good boom emerges under any combination of the productivity and the funding supply, the inference is always precise.

In both the constrained and the excessive funding range the price of the asset is pinned down by a form of cash in the market pricing. In the former case (missed boom), price equalizes marginal returns of the assets for a given funding constraint. In the latter (bad boom), the price equalizes expected profits of the two strategies. Therefore, in both a bad and a missed boom the equilibrium price is determined jointly by the realizations of the funding supply and the productivity. Since uninformed agents cannot observe global bank's funding, they may be unable to make precise inference. The inference problem may emerge only if a bad or a missed boom can occur in equilibrium, that is if the feasible values of funding supply are such that:

- high funding shock, s^H, is in an excessive range for some productivity realizations; or

- low funding shock, s^L, is in a constrained range for some productivity realizations

If either of these two conditions is satisfied, price schedules under the high and low funding are different for some values of productivity. If in this case, the minimum price achievable under the high funding supply is lower than the maximum price achievable under the low funding supply, $p^*(\underline{\alpha}, s^H) < p^*(\overline{\alpha}, s^L)$, some prices lie in the imprecise inference set. Observing a price within that set yields the following estimates:

$$\tilde{\alpha} = \begin{cases} \tilde{\alpha}(p, s^L) \text{ with probability } \rho \\ \tilde{\alpha}(p, s^H) \text{ with probability } 1-\rho \end{cases} \tag{1.6}$$

Lemma 1.4. If Assumption 1.A is satisfied, then whenever the price is in the imprecise inference set $p \in \mathcal{I}$, the expected value of the productivity inferred by the uninformed agents is:

- higher than the actual productivity if the funding supply is low
- lower than the actual productivity if the funding supply is high

Proof. In Appendix 1.8.3 □

For a given productivity the equilibrium price is a weakly increasing function of funding supply. Moreover, if the persistence in productivity is high (as in Assumption 1.A), the equilibrium price also increases in productivity. Consequently for a given price the inferred productivity that corresponds to the high realization of funding supply is lower or equal to the productivity level that would give rise to this price under the low funding supply, $\tilde{\alpha}(p, s^H) < \tilde{\alpha}(p, s^L)$.

To illustrate the problem of imprecise inference in a tractable way we consider two cases separately. First, we focus on an economy in which funding is never constrained but may be excessive, $s^L > \mathcal{S}_b(\overline{\alpha})$ and $s^H > \mathcal{S}_r(\underline{\alpha})$. This case can represent an advanced economy with developed financial markets in which there is a possibility of an abundance of savings (either domestic or foreign inflows) but scarcity is unlikely to be an issue. Second, we discuss the inference problem in an economy in which funding is never excessive but may be constrained, $s^L < \mathcal{S}_b(\overline{\alpha})$ and $s^H < \mathcal{S}_r(\underline{\alpha})$. This scenario resembles the conditions faced in some emerging market economies, in which savings available for investment may at times be insufficient to fully utilize the available investment opportunities. In reality an economy may experience excessive, balanced or constrained funding availability, so the inference problems discussed in the two cases may coexist.

Good and Bad Boom

Figure 1.3 below provides an illustrative plot of equilibrium prices as a function of productivity for two values of the funding shock, that satisfy $s^L > \mathcal{S}_b(\overline{\alpha})$ and $s^H > \mathcal{S}_r(\underline{\alpha})$. To explore the full array of possible imperfect inference conditions we study the case when the low funding supply is not too low, risk shifting can emerge in equilibrium under either funding realization.

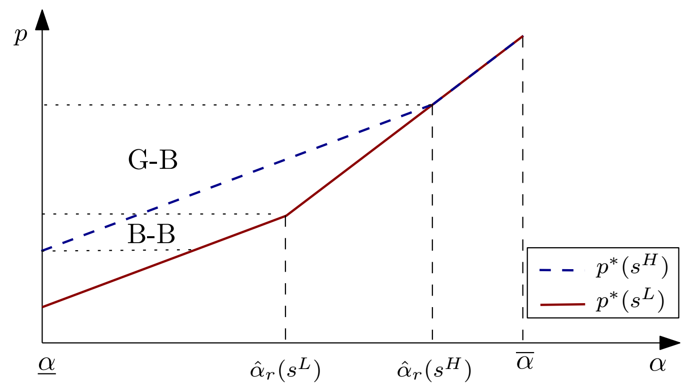


Figure 1.3: Inference from asset price. Red solid curve represents the equilibrium price as a function of productivity for the low funding shock $p^*(\alpha, s^L)$. Blue dashed curve corresponds to the equilibrium price under the high funding shock $p^*(\alpha, s^H)$

Two ranges of prices are marked on the plot, "G-B" and "B-B". If the observed price lies in "G-B" range, uninformed agents are unsure whether the price is a result of a prudent investment in a good boom or of an excessive speculation in a bad boom. In a bad boom risk shifting inflates asset prices, so that the same price is reached with a lower productivity than in the case of a good boom. Uninformed form their estimates accordingly and so on average they underestimate the productivity if in reality the economy is in a good boom and overestimate it if a bad boom is true.

Similarly, if the observed price lies in "B-B" range, uninformed agents cannot distinguish whether the price results from a bad boom under a low or high funding supply. While they can correctly infer that some banks shift risk, bank balance sheet opacity makes it impossible for them to precisely estimate the degree of speculation. A higher share of risk shifting banks inflates the price, for any productivity. Consequently, uninformed agents form a moderate productivity estimate corresponding to a bad boom (s^L) and a low productivity estimate corresponding to a "very" bad boom (s^H). They overrestimate the true productivity in the case when the true state a "very" bad boom.

When observed price lies outside of these ranges, uninformed agents can infer the productivity precisely. If price is above "G-B" range, it is clear that it results from a good boom as the high funding supply is not sufficient to induce risk shifting at such high price. If the price is below the "B-B" range, it so low that it could only be achieved in equilibrium when a low funding supply and low productivity are realized.

Good and Missed Boom

Figure 1.4 below provides an illustrative plot of equilibrium prices as a function of productivity for two values of the funding shock that satisfy $s^L < \mathcal{S}_b(\overline{\alpha})$ and $s^H < \mathcal{S}_r(\underline{\alpha})$. As in the previous case, in order to explore the full array of possible imperfect inference conditions we study the case when the high funding supply is not too high, so that investment may be constrained under either funding realization.

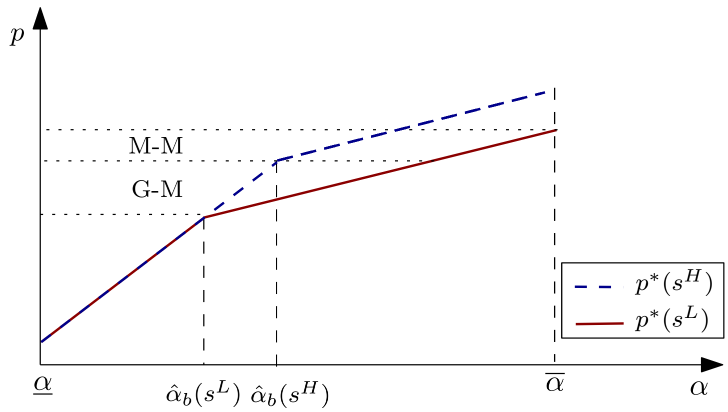


Figure 1.4: Inference from risky asset price. Red solid curve represents the equilibrium price as a function of productivity for the low funding shock $p^*(\alpha, s^L)$. Blue dashed curve corresponds to the equilibrium price under the high funding shock $p^*(\alpha, s^H)$

Two ranges of prices are marked on the plot ("G-M" and "M-M"). If the observed price lies in "G-M" range, uninformed agents are not able to distinguish whether the price results from a good boom under the high funding shock or a missed boom under the low funding. Since in a missed boom funding is insufficient to fully utilize the available opportunities, the same price level corresponds to a higher productivity under a missed than under a good boom. If the true state of the economy is a good boom, uninformed agents overestimate the productivity on average (and vice versa in a missed boom).

Price within the "M-M" range, can result from a missed boom under a low or a high funding supply. In a missed boom, price decreases as the funding supply falls. Thus, to give rise to the same price level a higher productivity is necessary under the low funding shock than under the high funding shock. This is reflected in the estimates formed by the uninformed, so that if the economy is severely constrained (the funding supply is low) they underestimate the productivity.

As in the previous example, when observed price lies outside of these ranges uninformed agents can infer the productivity precisely. When price is below "G-M" range it is clear that it results from a good boom as even low funding supply is sufficient to ensure the full use of the investment opportunities. When the price is above the "M-M" range it so high that it could only be achieved in equilibrium if a high funding supply and high productivity.

1.5.2 Lending by Local Banks

In this section we study the lending choice of uninformed local banks. We first consider a benchmark case in which uninformed agents are unlevered and can issue loans with the same payoff as those available to local banks. Next, we evaluate the consequence of imprecise inference if the uninformed agents are local banks investing using borrowed funds.

Benchmark: Uninformed Unlevered Investors

As a benchmark to the investment problem of local banks, consider uninformed investors funded by own capital endowment equal to e. They have access to the productive loans and to a storage technology with a unit return. This subsection describes the investment choice that maximizes their expected profits, subject to the budget constraint.

$$\max_{x_k, z_k} \rho \left[\tilde{\alpha}(p, s^L)\sqrt{x_k} + z_k - e\right] + (1-\rho)\left[\tilde{\alpha}(p, s^H)\sqrt{x_k} + z_k - e\right] \tag{1.7}$$

subject to:

$$x_k + z_k \leq e \qquad \text{(budget constraint)}$$

As long as investor's capital endowment is sufficient, their lending equalizes the expected marginal return and the return on storage. Excess capital is invested in storage. If the endowment is low, they lend all of the available capital:

$$x_k^* = \min\left[\left(\frac{\mathbb{E}(\alpha|p)}{2}\right)^2, e\right], \quad z_k^* = e - x_k^*$$

Whenever $p \notin \mathcal{I}$ the productive lending is optimal from ex-post perspective. Whenever $p \in \mathcal{I}$ lending is too high ex-post if the funding supply to global banks was high. It is too low ex-post if the funding supply to global banks was low.

Consider the case when the true outcome of the global banks' game is a bad boom driven by a high funding supply but uninformed investors understand that it may also be a good boom arising under a low funding shock (price falls in the "G-B" region in Figure 1.3). The investment by the uninformed will turn out to be too high when the true productivity is revealed at $t = 1$. However, if the true underlying state of economy was a good boom, investors find themselves under-investing from the ex-post perspective. Thus, the imprecise inference amplifies the overall investment level in a bad boom and dampens it in a good boom.

If the observed price lies in the "G-M" region in Figure 1.4, and the true equilibrium is a missed boom, uninformed investors will under-invest from the ex-post perspective. They will turn out to have over-invested if the true underlying state of the economy is a good boom. Therefore, the low level of investment is exacerbated in aggregate by the imprecise inference in a missed boom. In a good boom the outcome is a higher overall investment.

Investment by Uninformed Local Banks

We now study the problem faced by an uninformed local bank, subject to deposit insurance. Each bank chooses its productive lending so that to maximize profits subject to budget and funding constraints, while accounting for the limited liability.

$$\max_{x_k, s_k} \rho \left[\tilde{\alpha}(p, s^L)\sqrt{x_k} - s_k \right] + (1-\rho) \max \left[\tilde{\alpha}(p, s^H)\sqrt{x_k} - s_k, 0 \right] \tag{1.8}$$

subject to:

$$x_k \leq s_k \qquad \text{(budget constraint)}$$
$$s_k \leq s \qquad \text{(funding constraint)}$$

If uninformed local banks are able to precisely infer the productivity, $p \notin \mathcal{I}$, they face no risk. In this case, the problem is equivalent to the benchmark case of an unlevered investor and local banks choose lending levels that are ex-post optimal. If the equilibrium prices are such that precise inference is impossible, $p \in \mathcal{I}$, lending is risky from the perspective of the uninformed. If the risk that they are facing is not too high (ie. the two productivity estimates are not too dispersed) the level of lending is the same as the investment in the unlevered benchmark. However, if the risk is high and local bank are sufficiently levered, limited liability may imply that they prefer to optimize their payoff under the high productivity estimate. This exposes them to a risk of default if the true underlying fundamentals are weak. Thus, local banks engage in a form of risk shifting induced by the imprecise inference.

Lemma 1.5. If the inference is imprecise, $p \in \mathcal{I}$, the dispersion of estimates is large, $\tilde{\alpha}(p, s^H) < \frac{\sqrt{\rho}-\rho}{1-\rho}\tilde{\alpha}(p, s^L)$, and the supply of deposits to local banks is:

- high, $s > \left(\frac{\tilde{\alpha}(p,s^L)}{2}\right)^2$, then local banks risk shift and lend $x_k^* = \left(\frac{\tilde{\alpha}(p,s^L)}{2}\right)^2$, refusing the residual the funding;
- moderate, $\left(\frac{\tilde{\alpha}(p,s^L)}{2}\right)^2 > s > \max\left[\tilde{s}_k, \left(\tilde{\alpha}(p, s^H)\right)^2\right]$, where $\tilde{s}_k$ solves:

$$\rho\left(\tilde{\alpha}(p, s^L)\sqrt{\tilde{s}_k} - \tilde{s}_k\right) = \left(\frac{\mathbb{E}(\alpha|p)}{2}\right)^2$$

  then local banks accept all available funding and risk shift by lending $x_k^* = s$.

Otherwise, the optimal lending by uninformed local banks is given by:

$$x_k^* = \min\left[\left(\frac{\mathbb{E}(\alpha|p)}{2}\right)^2, s\right]$$

Proof. In Appendix 1.8.4 □

Facing a large uncertainty about the underlying productivity, due to their imperfect inference, local banks may find it optimal to risk shift by lending excessively. If the deposit supply is high, local banks are able to implement their optimal level of lending under the induced risk shifting: $x_k^* = \left(\frac{\mathbb{E}(\alpha|p)}{2}\right)^2$. If their deposits are insufficient to achieve this interior solution, the risk shifting level of lending is $x_k^* = s$. The corner level of lending is profitable only if the funding available to local banks allows for a sufficiently large gamble $s > \max\left[\tilde{s}_k, \left(\tilde{\alpha}(p, s^H)\right)^2\right]$.

Thus, whenever local banks leverage sufficient, high uncertainty about productivity induces local banks to risk shift and lend more than the benchmark of an uninformed local investor. If the true productivity is high (ie. funding supply to global banks is low), bank's lending is closer to the ex-post optimal level than that of the investor. If the true productivity is low (ie. funding supply to global banks is high), both the unlevered investor and the local bank may generate losses. However, since the bank lends excessively by focusing on the higher productivity estimates, it faces larger losses. The induced risk shifting by local banks can thus significantly amplify the degree of financial distress and bring in local bank defaults precisely at the time when global banks speculate on the asset.

1.6 Additional Signal

In this section we explore whether a global regulator with access to information on aggregate investment by global banks can alleviate the inference problem faced by the uninformed.[11]

We first show that in an economy, in which uncertainty about banks' leverage is driven solely by the funding supply and productivity (as in the baseline model), disclosing the scale of global bank's total investment (ie. aggregate spending on risky asset purchases and lending by global banks) leads to a precise inference from asset prices. Thus, a global supervisor may be able to prevent the amplification of the boom by aggregating information on total investment, a role similar to the Bank of International Settlements.

After providing this benchmark result, we study an economy in which uninformed agent also face uncertainty about other components of bank leverage, such as the value of pre-existing assets on the balance sheet. This additional layer of uncertainty makes bank balance sheets more opaque so that additional information on total investment may be unable to resolve the imperfect inference problem.

1.6.1 Observable Total Investment

We define the total investment as the sum of the productive lending and spending on purchases of the risky asset by all global banks. It is given by:

$$V(\alpha, S) = \begin{cases} S & \text{if } S < \mathcal{S}_b(\alpha) \\ \left(\frac{\alpha}{2}\right)^2 + q(\alpha)R & \text{if } \mathcal{S}_b(\alpha) < S < \mathcal{S}_r(\alpha) \\ (1-\psi(\alpha,S))\left(\frac{\alpha}{2}\right)^2 + \psi(\alpha,S)S & \text{if } \mathcal{S}_r(\alpha) < S \end{cases} \tag{1.9}$$

When funding is constrained total investment equals the size of the available deposit supply (missed boom). If funding is balanced, aggregate investment reflects the quality of the available opportunities (good boom). If the funding supply is excessive, some global banks are risk shifting, using up all the available funding to scale up their investment, while others engage only in productive lending (bad boom).

When uninformed agents observe only the quantity signal (and no prices), they infer the productivity level from the total investment equation (1.9). It is straightforward to

[11] Clearly the best policy would target risk taking by global banks by containing leverage. However, under opaque bank balance sheets, the amount of available funding taken up by a bank as well as its portfolio allocation between risky asset purchases and productive lending are private information and thus implementation of leverage limits may not be feasible.

show that in this case their inference may be confused, as in the case of price signal.

This inference error is resolved once uninformed agents observe both total investment and the asset price. When inference is based on both of the variables, each gives two estimates of productivity, one of which is correct. The perfect incidence which occurs only under the correct estimates allows uninformed to infer the productivity precisely.

Corollary 1.3. If uninformed agents observe the asset price and the total investment of the global banks the inference is precise.

Observing enough variables enables uninformed agents to solve the system of unknown economic conditions.[12] If funding supply and quality of their investments are the only sources of uncertainty about banks' leverage, access to precise information about the price of the risky asset and the total investment by global intermediaries, allows uninformed agents to correctly infer the aggregate productivity.

1.6.2 Uncertain Initial Leverage

In reality, regulators and the public face additional sources of uncertainty regarding bank leverage. While book equity is reported, the illiquid nature of bank assets implies that actual bank equity value may be lower due to legacy assets (hidden losses).[13] In this section we allow for uncertainty about the *initial* leverage of global banks and study how that affects the inference.

We show that in the presence of bank balance sheet opacity additional uncertainty on leverage confuses inference even in the presence of additional signals. Thus, under a realistic limit on regulators' information about the value of bank assets, even when aggregate credit is measured precisely the inference is still distorted by moral hazard, obscured by unobserved actual bank leverage.

Model with Uncertain Initial Leverage

We introduce additional uncertainty regarding global bank's actual leverage by assuming that banks hold legacy assets from previous periods at the beginning of $t = 0$ and that the size of the losses on these assets is subject to aggregate risk. Its realization is drawn from a binomial distribution at the beginning of $t = 0$ and due to opacity is bank's

[12] In all fairness to empirical researchers, uninformed agents in our model may come to such precise estimates because the postulated view of economic rationality involves not just rational updating, but a precise knowledge of all probability distributions and precise value of all economic parameters.

[13] Even an active market for bank shares could not reveal hidden losses, as bank share prices also reflects Merton's put value (the value of risk shifting without socialized losses).

private information. This assumption reflects a realistic view of banks' discretion regarding recognizing losses.

$$\lambda = \begin{cases} 0 & \text{with probability } \kappa \\ \bar{\lambda} & \text{with probability } 1-\kappa \end{cases}$$

In addition to parameter restrictions introduced in Assumption 1, we impose further assumptions to ensure the problem remains tractable.

Assumption 1.2. The parameters satisfy:

A. $q'(\alpha)(\frac{\alpha}{2} - \frac{2\bar{\lambda}}{\alpha}) > q(\alpha)(1 - q^2(\alpha))$

B. $(\frac{\alpha}{2})^2 > R + \frac{\bar{\lambda}}{q(\alpha)}$

C. $(\frac{\alpha}{2})^2 > \bar{\lambda}\frac{1+q(\alpha)}{1-q(\alpha)}$

D. $s^L > \mathcal{S}_b(\underline{\alpha})$

Assumptions 2.A and 2.B are more restrictive versions of Assumptions 1.A and 1.B. The former imposes a higher minimum persistence of the productivity shock, in order to ensure that the appeal of risk shifting increases in productivity, also in the presence of impaired assets. The latter requires that the return on lending is high relative to the asset's return and the past losses. It assures that risk shifting is not too attractive when funding supply is low. Assumption 2.C serves similiar role, ensuring that losses are not large enough to incentivize all banks to risk shift in equilibrium. Assumption 2.D rules out the case of constrained funding and focuses the discussion on economies that can be only in either a good or a bad boom.

Global Bank's Game with Initial Leverage

The size of impaired assets directly affects banks' leverage and thus their risk shifting incentives. In this section we show how that impacts the equilibrium of the global bank's game and asset prices.

Lemma 1.6. If Assumption 2.C is satisfied global bank's strategies and the choice rule are as characterized in Lemma 1.1, with the individual risk shifting threshold given by:

$$\hat{s}(\alpha, p, \lambda) = \begin{cases} (\frac{\alpha}{2})^2 \frac{p}{q(\alpha)R}(1+q(\alpha)) - \lambda & \text{if } p < q(\alpha)R \\ (\frac{\alpha}{2})^2 \frac{1-q(\alpha)\frac{p}{R}}{(\frac{R}{p}-1)q(\alpha)} - \lambda\frac{1-q(\alpha)}{(\frac{R}{p}-1)q(\alpha)} & \text{if } p \geq q(\alpha)R \end{cases} \tag{1.10}$$

The threshold:

- decreases in the losses on the impaired assets $\frac{\partial \hat{s}}{\partial \lambda} < 0$
- increases in the price of the risky asset $\frac{\partial \hat{s}}{\partial p} > 0$
- decreases in the productivity $\frac{\partial \hat{s}}{\partial \alpha} < 0$ if Assumption 2.A is satisfied

Proof. In Appendix 1.8.5 □

Higher losses on impaired assets increase the actual leverage of the bank for any level of funding. This makes risk shifting relatively more attractive, pushing the individual risk shifting threshold of funding downwards.

Aggregating the individual choices yields the equilibrium of the global bank game as summarized in the Proposition 1.3 below.

Proposition 1.3. If Assumptions 2.B, 2.C and 2.D are satisfied there exists a unique equilibrium risk shifting threshold of funding supply given by:

$$\mathcal{S}_r(\alpha, \lambda) = \hat{s}(\alpha, q(\alpha)R, \lambda) \tag{1.11}$$

Such that when funding is above $\mathcal{S}_r(\alpha, \lambda)$, equilibrium price solves $S = \hat{s}(\alpha, \hat{p}^*, \lambda)$ with a fraction $\psi^*(\alpha, \lambda) = \frac{\hat{p}^*}{S - (\frac{\alpha \hat{p}^*}{2R})}$ of banks engaging in risk shifting. Otherwise all banks choose the solvent strategy and the price solves: $p^* = q(\alpha)R$

Proof. In Appendix 1.8.5 □

Assumption 2.D rules out constrained funding and allows us to focus on equilibria with balanced or excessive funding, while Assumption 2.B ensures that despite the losses banks do not have risk shifting incentives when funding is at the balanced funding threshold. Thus, we focus on the case when losses on impaired assets only affect the equilibrium when funding is above the balanced level.

High losses increase the actual leverage, making risk shifting more attractive. This has two effects. First, it induces some banks to engage in risk shifting already at lower level of funding, pushing the equilibrium risk shifting threshold downwards. Second, if funding supply is already excessive $S > \mathcal{S}_r(\alpha, \lambda)$, a further increase in losses increases the share of banks willing to speculate. This inflates asset prices and increases the total investment for a given productivity and funding supply. Assumption 2.C ensures that it is never optimal for all banks to risk shift in equilibrium.

Inference with Uncertain Initial Leverage

To illustrate how the uncertainty about initial leverage affects the inference problem of the uninformed agents, we study the problem for a specific range of shock realizations. Specifically we focus on the funding shock such that:

- Low funding supply is above the equilibrium risk shifting threshold for some low realizations of productivity even if banks face no losses on impaired assets : $s^L > \mathcal{S}_r(\hat{\alpha}(s^L, 0)\, 0)$ for some $\hat{\alpha}(s^L, 0) \in (\underline{\alpha}, \overline{\alpha})$

- High funding supply is above the equilibrium risk shifting threshold for some realizations of productivity even if banks face no losses on impaired assets: $s^H > \mathcal{S}_r(\hat{\alpha}(s^H, 0), 0)$ for some $\hat{\alpha}(s^H, 0) \in (\underline{\alpha}, \overline{\alpha})$

Figure 1.5. below provides an illustrative plot of equilibrium price as a function of productivity for different realizations of funding and losses.

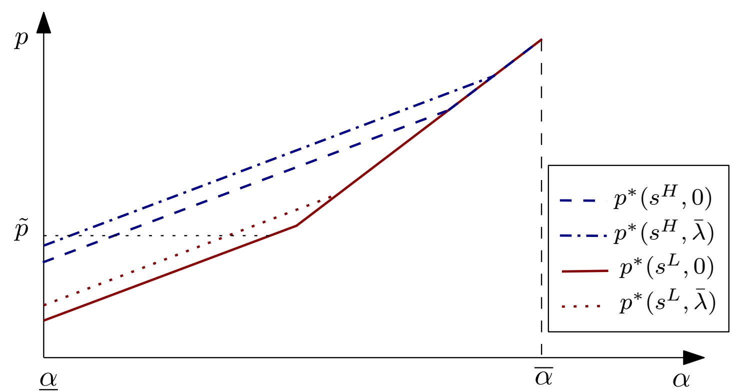


Figure 1.5: Inference from asset price. Red curves represents the equilibrium price as a function of productivity for the low funding shock; the solid line for no losses state $p^*(\alpha, s^L, 0)$, dotted curve the high loss state $p^*(\alpha, s^L, \bar{\lambda})$. Blue curve corresponds to the equilibrium price under the high funding shock: dashed for no losses state $p^*(\alpha, s^H, 0)$ and dash-dotted for the high losses state $p^*(\alpha, s^H, \bar{\lambda})$

Facing uncertainty about the losses, uninformed agents need to consider additional price-productivity schedules while making their inference. Precise inference is possible whenever price is too high for global banks to have incentives to risk shift even if losses are large, $\alpha > \hat{\alpha}_r(s^H, \bar{\lambda})$. As before the inference is also precise for very low prices which could only be achieved under the low funding realization and no losses. For other realized prices the inference is imprecise. Uninformed agents may form two, three or four estimates of productivity based on the prices that they observe. If the equilibrium price is $\tilde{p}$, the uninformed understand that it results from a bad boom. Yet, the uncertainty about global bank's leverage makes it impossible for them to assess what the exact underlying productivity is. They form the following estimates:

$$\tilde{\alpha} = \begin{cases} \tilde{\alpha}(p, s^L, 0) & \text{with probability } \rho\kappa \\ \tilde{\alpha}(p, s^L, \bar{\lambda}) & \text{with probability } \rho(1-\kappa) \\ \tilde{\alpha}(p, s^H, 0) & \text{with probability } (1-\rho)\kappa \\ \tilde{\alpha}(p, s^H, \bar{\lambda}) & \text{with probability } (1-\rho)(1-\kappa) \end{cases} \tag{1.12}$$

Uncertainty about initial bank leverage further undermines inference. This is because initial losses have their independent impact on bank risk shifting incentives and so affect the share of risk shifting banks as well as the equilibrium price. Through the impact on the share of risk shifting banks losses also affect the total investment. Since in a bad boom both price and total investment are determined jointly by the realization of three random variables (productivity, funding supply and losses), inference may be imprecise even with these two signals available to the uninformed.

Proposition 1.4. There exist parameter values and shock realizations such that if uninformed agents face uncertainty about size of impaired losses as well as funding supply of global banks, observing both asset price and total investment results in imprecise inference about the productivity.

Proof. In the Appendix 1.8.6 □

Specifically, with the binomial distribution of the impaired losses there may be two combinations of realizations of productivity, funding supply and losses such that price and total investment coincide:

$$p^*(\alpha, s^H, 0) = p^*(\alpha', s^L, \bar{\lambda})$$
$$V^*(\alpha, s^H, 0) = V^*(\alpha', s^L, \bar{\lambda})$$

Key for the inference problem to persist in our framework is that in the presence of opacity, uninformed agents face multifaceted uncertainty about the intensity of banks' risk shifting incentives. Increase in initial leverage encourages banks to risk shift even at higher prices. As a result more banks risk shift in equilibrium altering the equilibrium price and the total investment. As these signals are jointly determined by productivity, supply and losses, uncertainty about the realization of the shocks may make it impossible to form a precise inference. This example highlights that in reality, the high degree of complexity and opacity of bank balance sheets is likely to distort the inference of market participants, econometricians and policy-makers alike.

1.7 Conclusions

We argue that opacity of intermediary balance sheets may add noise to asset prices, and lead rational market participants to underestimate risk in supply-fueled credit booms or to overestimate it when bank funding is scarce.

Our basic insight is that imbalance of funding relative to the volume of productive investment alters the equilibrium relationship between economic fundamentals and prices. Scarce bank funding limits intermediaries ability to utilize their productive opportunities, while excessive funding gives rise to risk shifting incentives. Such imbalances may arise when interest rates alone cannot rebalance credit demand and savings supply, such as at the zero lower bound or because of an inelastic demand for retirement savings.

In our setting, a large expansion of available funding boosts banks' incentives to speculate. Other agents seeking to infer the underlying credit quality from asset prices may be unable to interpret it correctly. We show that if persistence of productivity is high, uninformed market participants may over-invest precisely at the time when global banks are risk shifting. A novel insight is that a very imprecise inference may induce also less informed banks to risk shift. As they may invest excessively precisely when the global economy is in a bad boom, imprecise inference amplifies both real and speculative investment, as well as future losses.

Observing additional signals on the economy, such as the volume of credit may be insufficient to resolve the inference problem. Under realistic assumptions about bank opacity (such as imprecise measures of bank leverage), the inference process remains distorted. A more general point is that while generally price and quantities offer information on supply and demand, in a banking context risk incentives confuse the inference.

The analysis offers a broader classification of forms of risk shifting in terms of awareness (deliberate versus induced) and in terms of channels (excessive lending or speculation). It offers a rational benchmark to interpret the emerging evidence on risk perception in credit booms, while introducing the symmetric possibility of missed and bad booms. Important future research themes would explore the regulatory consequences of distorted inference from asset prices, a regulatory theme much debated recently.

1.8 Appendix

1.8.1 Optimal Strategy of a Global Bank

Lemma 1.1

The two investment strategies follow directly from the bank's optimization. First we consider the case when the bank remains solvent in the bad state. The FOC's are:

$$\alpha\frac{1}{2}x_s^{-\frac{1}{2}} - \frac{q(\alpha)R}{p} = 0 \qquad \text{if } p > q(\alpha)R$$
$$\alpha\frac{1}{2}x_s^{\frac{-1}{2}} - 1 = 0 \qquad \text{if } p \geq q(\alpha)R$$

These yield the solvent investment levels as in Lemma 1.1. The bank remains solvent in the bad state while playing the solvent strategy if $s < \frac{\alpha^2 p}{2q(\alpha)R} = s_s(\alpha, p)$. We focus on the case when this condition is satisfied and Appendix 1.8.2 shows that this is the case in equilibrium.

Second we solve bank's problem in case it defaults in the bad state. The FOC is:

$$\alpha\frac{1}{2}x^{\frac{-1}{2}} - \frac{R}{p} = 0$$

The investment level specified in Lemma 1.1 follows directly. The above investment results in a risk of default only if $S > \frac{\alpha^2 p}{2R} = s_r(\alpha, p)$ (note that this implies that risk shifting is unfeasible if $S < \left(\frac{\alpha p}{2R}\right)$, so $x_r = \left(\frac{\alpha p}{2R}\right)$). It is straightforward that $s_s(\alpha, p) > s_r(\alpha, p)$.

If both strategies are feasible ($s_s > s > s_r$), the bank prefers a strategy that results in a higher expected profit. Plugging the investment under each strategy, allows us to find the level of funding at which the bank is indifferent between the two:

$$\hat{s}(\alpha, p) = \begin{cases} \left(\frac{\alpha}{2}\right)^2 \frac{p}{q(\alpha)R}\left(1 + q(\alpha)\right) & \text{if } p < q(\alpha)R \\ \left(\frac{\alpha}{2}\right)^2 \frac{1 - q(\alpha)\frac{p}{R}}{\left(\frac{R}{p} - 1\right)q(\alpha)} & \text{if } p \geq q(\alpha)R \end{cases}$$

The risk shifting threshold is given by $\max[s_r, \hat{s}]$. For $p < q(\alpha)R$, it is straightforward to show that $\hat{s}(\alpha, p) > s_r(\alpha, p)$ for any $q(\alpha) < 1$.

For $p \geq q(\alpha)R$, the inequality $\hat{s}(\alpha, p) > s_r(\alpha, p)$ can be rearranged as:

$$z(p) = 1 - 2q(\alpha) + \frac{p}{R}q(\alpha) > 0$$

where the left hand side of the inequality, $z(p)$, is an increasing function of price . Evaluating $z(p)$ at the lowest price, yields $z(p = q(\alpha)R) = 1 - 2q(\alpha) + q^2(\alpha) > 0$. Therefore the risk shifting strategy is always feasible when it is more profitable and the individual risk shifting threshold is given by $\hat{s}(\alpha, p)$.

Lemma 1.2

The first order derivative of the individual risk shifting threshold with respect to price at the interval where $p < q(\alpha)R$ is always positive:

$$\frac{\partial \hat{s}}{\partial p} = \left(\frac{\alpha}{2}\right)^2 \frac{1 + q(\alpha)}{q(\alpha)} > 0$$

At the interval where $p \geq q(\alpha)R$ the derivative yields:

$$\frac{\partial \hat{s}}{\partial p} = \left(\frac{\alpha}{2}\right)^2 \frac{-q(\alpha)pR + q(\alpha)p^2 + R^2 - q(\alpha)pR}{\left(\frac{R}{p} - 1\right)^2 q(\alpha)p^2 R}$$

The numerator of the expression is $w(p) = q(\alpha)p^2 - 2q(\alpha)pR + R^2$ and it decreases in p for all $p < R$. Evaluating it at the highest feasible p: $w(p = R) = q(\alpha)R^2 - 2q(\alpha)R^2 + R^2 = R^2(1 - q(\alpha))$. Therefore the numerator is positive for all $R > p \geq q(\alpha)R$ and the individual risk shifting threshold increases in price.

Taking the first order derivative of the individual risk shifting threshold with respect to productivity at the interval where $p < q(\alpha)R$ gives:

$$\frac{\partial \hat{s}}{\partial \alpha} = \left(\frac{\alpha}{2}\right) \frac{(1 + q(\alpha))\, p}{q(\alpha)R} + \left(\frac{\alpha}{2}\right)^2 \frac{pq'(\alpha)q(\alpha) - q'(\alpha)p\,(1 + q(\alpha))}{q^2(\alpha)R} > 0$$

Rearranging yields $\frac{\partial \hat{s}}{\partial \alpha} < 0$ for $p < q(\alpha)R \iff q(\alpha)(1 + q(\alpha)) < \left(\frac{\alpha}{2}\right) q'(\alpha)$ (as in Assumption 1.A)

Taking the derivative at the interval $p \geq q(\alpha)R$ gives:

$$\begin{aligned}\frac{\partial \hat{s}}{\partial \alpha} &= \left(\frac{\alpha}{2}\right) \frac{1 - q(\alpha)\frac{p}{R}}{\left(\frac{R}{p} - 1\right) q(\alpha)} + \left(\frac{\alpha}{2}\right)^2 \frac{-q'(\alpha)\frac{p}{R}q(\alpha) - q'(\alpha)\left(1 - q(\alpha)\frac{p}{R}\right)}{\left(\frac{R}{p} - 1\right) q^2(\alpha)} \\ &= \frac{\left(\frac{\alpha}{2}\right)}{\left(\frac{R}{p} - 1\right) q^2(\alpha)} * Z\end{aligned}$$

Where $Z = q(\alpha)\left(1 - q(\alpha)\frac{p}{R}\right) - q'(\alpha)\frac{\alpha}{2}$ and the derivative is negative if and only if $Z < 0$.

Since $\frac{\partial Z}{\partial p} < 0$ evaluating at the minimum feasible price gives the sufficient condition:

$$Z(p = q(\alpha)R) = (1 - q^2(\alpha))q(\alpha) - q'(\alpha)\frac{\alpha}{2}$$

Therefore the risk shifting threshold decreases in productivity for prices in this range if $(1 - q^2(\alpha))q(\alpha) < q'(\alpha)\frac{\alpha}{2}$, which is satisfied whenever Assumption 1.A holds.

Evaluating it at the maximum price $Z(p = R)$, yields the sufficient condition for the threshold to increase in productivity in this range: $Z(p = R) = (1-q(\alpha))q(\alpha)-q'(\alpha)\frac{\alpha}{2} > 0$.

1.8.2 Equilibrium of Global Bank's Game

Proposition 1.1 and Lemma 1.3

The equilibrium level of asset price equalizes its demand and supply: $D_y = S_y$, so it depends on banks' investment choice. Three types of equilibria can potentially emerge:

- A pure solvent equilibrium in which all banks play the solvent strategy and the price is $p_s = \min[q(\alpha)R, S - \left(\frac{\alpha p_s}{2q(\alpha)R}\right)^2]$; this is the equilibrium if $S < \hat{s}(\alpha, p_s)$.
- A pure risk shifting equilibrium in which all banks take risk and the price is $p_r = \max\left[S - (\frac{\alpha p_r}{2R})^2, R\right]$; this is the equilibrium if $S > \hat{s}(\alpha, p_r)$.
- A mixed equilibrium in which fraction $\psi(\alpha, S) = \frac{\hat{p}}{y_r^*}$ of banks risk shifts while the others choose the solvent strategy. The equilibrium price of the asset, $\hat{p}^*$, ensures that all banks are indifferent, that is it solves: $S = \hat{s}(\alpha, \hat{p})$; this is the equilibrium if $\hat{s}(\alpha, p_r) > S > \hat{s}(\alpha, p_s)$

The proof of Proposition 1.1 is in three steps:

1. A pure solvent equilibrium emerges whenever $S < \hat{s}(\alpha, q(\alpha)R) = \mathcal{S}_r$
2. A pure risk shifting equilibrium never emerges
3. A mixed risk shifting equilibrium emerges whenever $S > \mathcal{S}_b$

Let $\hat{p}$ denote the inverse of the individual risk shifting threshold, $S = \hat{s}(\alpha, \hat{p})$.

1. Consider the case of a constrained funding supply $S < \mathcal{S}_b(\alpha) = q(\alpha)R + \left(\frac{\alpha}{2}\right)^2$. If all banks invest solvently, the price is a monotonically increasing function of funding implicitly defined by $S = p_s + \left(\frac{\alpha p_s}{2q(\alpha)R}\right)^2$. To establish that banks never have risk shifting incentives at this funding level, first note that the price-funding schedule and the inverse of the individual risk shifting threshold schedule, $\hat{p}$, cross at $S = 0$ and $p_s = 0$. Both schedules are monotonically increasing in S whenever $p < q(\alpha)R$.:

$$\frac{\partial p_s}{\partial s} = \frac{1}{1 + 2p_s\left(\frac{\alpha}{2q(\alpha)R}\right)^2}$$
$$\frac{\partial \hat{p}}{\partial s} = \frac{1}{\left(\frac{\alpha}{2}\right)^2 \frac{1+q(\alpha)}{q(\alpha)R}}$$

For p close to zero, the price-funding schedule p_s increases more steeply. Moreover, it reaches $p_s = q(\alpha)R$ at $S = \mathcal{S}_b(\alpha)$ while the inverse of the individual risk shifting threshold schedule reaches that price level at $S = \left(\frac{\alpha}{2}\right)^2 (1 + q(\alpha)) = \mathcal{S}_r$. It is easy to show that $\mathcal{S}_r > \mathcal{S}_b$ whenever Assumption 1.B is satisfied. Thus, $p_s < \hat{p}$ for all $S < \mathcal{S}_b$. Beyond $\mathcal{S}_b$ the price under the all solvent equilibrium is $p = q(\alpha)R < \hat{p}$ for all $S < \mathcal{S}_r$.

2. Notice that $p_r > p_s > \hat{p}$, thus a pure risk shifting equilibrium cannot emerge if $S < \mathcal{S}_r$. To see that it does not emerge also for high values of funding supply, note that p_r and $\hat{p}$ are both increasing in S. The price under all risk shifting equilibrium reaches $p_r = R$ at $S = R + (\frac{\alpha p_r}{2R})^2$. The inverse of the individual risk shifting threshold tends to R as funding tends to infinity as follows from

$$\lim_{p \to R} \hat{s}(\alpha, p) = \infty$$

Therefore, $p_r > \hat{p}$ for all $S < \infty$.

3. When funding supply is above the equilibrium risk shifting threshold $S > \mathcal{S}_r$:

- If all banks play solvent, bank i has incentive to deviate and play risk shifting strategy
- If all banks shift risk, bank i has incentive to deviate and play risk shifting strategy
- Bank i is indifferent between the risk shifting and the solvent strategy if $p = \hat{p}$, which happens when fraction $\psi(\alpha, S) = \frac{S - \left(\frac{\alpha\hat{p}}{2R}\right)^2}{\hat{p}}$ of banks risk-shift.

Feasibility of solvent investment strategy

In Appendix 1.8.1 we show that solvent strategy with positive investment in the risky asset is feasible only if $S < s_s = \frac{\alpha^2 p}{2q(\alpha)R}$. Positive investment in the risky asset occurs only if $p < q(\alpha)R$ in which case an all solvent equilibrium price solves $p_s = S - \left(\frac{\alpha p_s}{2q(\alpha)R}\right)^2$. For any level of funding $S < \mathcal{S}_b$ the equilibrium price is such that $S < \frac{\alpha^2 p_s}{2q(\alpha)R}$ as follows from comparing the inverse of the all solvent equilibrium price function $s^* = p_s + \left(\frac{\alpha p_s}{2q(\alpha)R}\right)^2$ with

s_s

$$p + \left(\frac{\alpha p}{2q(\alpha)R}\right)^2 < \frac{\alpha^2 p}{2q(\alpha)R}$$

$$p\left(1 - \frac{\alpha^2}{2q(\alpha)R} + p\left(\frac{\alpha}{2q(\alpha)R}\right)^2\right) < 0$$

$$p > 0 \;\&\; p < \frac{\frac{\alpha^2}{2q(\alpha)R} - 1}{\left(\frac{\alpha}{2q(\alpha)R}\right)^2} = 2q(\alpha)R - (q(\alpha)R)^2\left(\frac{2}{\alpha}\right)^2 = p_T$$

Thus, $p_T > q(\alpha)R$ whenever $\left(\frac{\alpha}{2}\right)^2 > q(\alpha)R$. So, for any $S < \mathcal{S}_b$ the equilibrium price is such that solvent strategy is feasible $s^* < s_s$.

Comparative statics on equilibrium price

Taking the first order derivative of equilibrium price in each segment of the schedule yields:

- For $S < \mathcal{S}_b$:

$$\frac{\partial p}{\partial \alpha} = \frac{2\alpha p^2\left(\alpha q'(\alpha) - q(\alpha)\right)}{q(\alpha)\left[\left(2q(\alpha)R\right)^2 + 2\alpha^2 p\right]}$$

  The price increases in productivity in this range of funding supply if and only $\alpha q'(\alpha) > q(\alpha)$. This is the case if Assumption 1.A is satisfied

- For $\mathcal{S}_b < S < \mathcal{S}_r$:

$$\frac{\partial p}{\partial \alpha} = q'(\alpha)R > 0$$

  The price increases in productivity in this range of funding supply.

- For $\mathcal{S}_r < s$ the equilibrium price ensures that $S = \hat{s}(p)$. Since individual risk shifting threshold increases in price, the equilibrium price:

  – decreases in productivity if $(1 - q(\alpha))q(\alpha) > q'(\alpha)\frac{\alpha}{2}$ so that the individual risk shifting threshold increases in productivity

  – increases in productivity if $(1 - q^2(\alpha))q(\alpha) < q'(\alpha)\frac{\alpha}{2}$ so that the individual risk shifting threshold decreases in productivity (this is the case if Assumption 1.A is satisfied)

1.8.3 Imprecise Inference

Because price increases in both productivity (due to Assumption 1.A) and (if equilibrium is not in a good boom) in funding supply, the Imprecise Inference Set is non-empty whenever there exists a price that could result from either a high funding supply and low productivity or a low funding supply and high productivity. As price is determined by both funding and productivity only in a missed or a bad boom, the imprecise inference can only occur if one of the two emerges in equilibrium (the inference is always precise if the good boom emerges for any combination of productivity and funding). If either a missed or a bad boom occurs in equilibrium and the prices are such that $p(\underline{\alpha}, s^H) < p(\overline{\alpha}, s^L)$.

Price under a bad boom is higher than under a good boom with the same productivity and price under a missed boom is lower than under a good boom with the same productivity. Consequently, if the price lies in the imprecise inference set, the inferred productivity that corresponds to the high funding state is always lower than the inferred productivity that corresponds to the low funding state.

If price was decreasing in productivity in either missed or a bad boom, the reverse may hold.

1.8.4 Choice of Local Banks

For ease of notation let $\tilde{\alpha}(p, s^H) = \alpha^L$, $\tilde{\alpha}(p, s^L) = \alpha^H$.

If local banks do not default in case of low productivity the interior solution for optimal investment is:

$$x_S^* = (\frac{\mathbb{E}(\alpha|p)}{2})^2$$

This investment level is consistent with there being no risk of default (ie. is feasible) if $\alpha^L(\frac{\mathbb{E}(\alpha|p)}{2}) - (\frac{\mathbb{E}(\alpha|p)}{2})^2 > 0$ which simplifies to: $\alpha^L > \frac{\rho}{1+\rho}\alpha^H = z$.

If local banks face default under low productivity the interior solution for optimal investment is:

$$x_R^* = (\frac{\alpha^H}{2})^2$$

This investment level is consistent with there being risk of default (ie. is feasible) if $\alpha^L(\frac{\alpha^H}{2}) - (\frac{\alpha^H}{2})^2 < 0$ which simplifies to: $\alpha^L < \frac{1}{2}\alpha^H = w$.

Since $z > w$ (as $1 > \rho > 0$), it is possible that both investment strategies are feasible.

If that's the case, the local bank chooses the one that yields higher profits. This is x_R^* if

$$\rho(\frac{\alpha^H}{2})^2 > (\frac{\mathbb{E}(\alpha|p)}{2})^2$$

Simplifying, this yields: $\alpha^L < \frac{\sqrt{\rho}-\rho}{1-\rho}\alpha^H = y$.

We can establish that $y > z$, as follows from

$$\frac{\sqrt{\rho}-\rho}{1-\rho} > \frac{\rho}{1+\rho} \Rightarrow \sqrt{\rho}(1-2\sqrt{\rho}+\rho^2) > 0$$

Also $w > y$ as follows from:

$$\frac{\sqrt{\rho}-\rho}{1-\rho} < \frac{1}{2} \Rightarrow (1-2\sqrt{\rho}+\rho) > 0$$

Thus, if funding is sufficient to reach the interior solution local banks lend x_R if $\alpha^L < \frac{\sqrt{\rho}-\rho}{1-\rho}\alpha^H$ and invest x_S otherwise.

If $\alpha^L < \frac{\sqrt{\rho}-\rho}{1-\rho}\alpha^H$ but funding is insufficient to implement the interior solution under risk shifting yet sufficient to implement the "solvent" strategy $\left(\frac{\alpha^H}{2}\right)^2 > s > \left(\frac{\mathbb{E}(\alpha)}{2}\right)^2$, then risk shifting is feasible if $\alpha^L\sqrt{s} - s < 0$, so if $s > (\alpha^L)^2$. If risk shifting is feasible than it is more profitable than the solvent investment if:

$$\rho(\alpha^H\sqrt{s} - s) > (\frac{\mathbb{E}(\alpha)}{2})^2$$

The left hand side of the inequality increases in s for any $s < (\frac{\alpha^H}{2})^2$ so the cut off level of funding supply above which local banks can be induced to risk shift is

$$\hat{s}_k = \min\left[\left(\frac{\tilde{\alpha}(p, s^L)}{2}\right)^2, \max\left[\tilde{s}_k, \left(\tilde{\alpha}(p, s^H)\right)^2\right]\right]$$

where $\tilde{s}_k$ solves:

$$\rho\left(\tilde{\alpha}(p, s^H)\sqrt{\tilde{s}_k} - \tilde{s}_k\right) = \left(\frac{\mathbb{E}(\alpha|p)}{2}\right)^2$$

1.8.5 Global bank's game with losses

Proof of Lemma 1.6

The presence of the legacy asset does not affect the FOCs of bank's problem. Thus, the solvent and the risk shifting allocations are characterized as before. For the risk shifitng strategy to be feasible the funding supply needs to exceed: $s_r = \left(\frac{\alpha^2 p}{2R}\right) - \lambda$. The solvent strategy is feasible whenever $p \geq q(\alpha)R$ and otherwise if funding is below: $s_s = \left(\frac{\alpha^2 p}{2q(\alpha)R}\right) - \lambda$.

To derive the level of funding at which banks are indifferent between the two strategies, compare the profits under the two allocations. This yields the following threshold of funding supply:

$$\hat{s} = \begin{cases} (\frac{\alpha}{2})^2 \frac{p}{q(\alpha)R}(1 + q(\alpha)) - \lambda \ if \ p < q(\alpha)R \\ (\frac{\alpha}{2})^2 \frac{1-q(\alpha)\frac{p}{R}}{(\frac{R}{p}-1)q(\alpha)} - \lambda \frac{1-q(\alpha)}{(\frac{R}{p}-1)q(\alpha)} \ if \ p \geq q(\alpha)R \end{cases}$$

Solvent strategy is feasible whenever it is optimal if $s_s > \hat{s}$ for $p < q(\alpha)R$ which always holds.

The risk shifting is feasible whenever it is optimal if $s_r < \hat{s}$. For $p < q(\alpha)R$ this always holds:

$$\frac{\alpha^2 p}{2R} - \lambda < \frac{\alpha^2 p}{4q(\alpha)R}(1 + q(\alpha)) - \lambda$$

For $p \geq q(\alpha)R$ this is the case if:

$$(\frac{\alpha}{2})^2(1 + q(\alpha)\frac{p}{R} - 2q(\alpha)) + \lambda(q(\alpha)\frac{p}{R} - 1) > 0$$

The left hand side of the inequality is an increasing function of p whenever $(\frac{\alpha}{2})^2 > \lambda$, so evaluating it at $p = q(\alpha)R$ yields the sufficient condition: $(\frac{\alpha}{2})^2 > \lambda\frac{1+q(\alpha)}{1-q(\alpha)}$.

The individual risk shifting threshold is thus given by $\hat{s}$. The partial derivatives are the same as without the losses if $p < q(\alpha)R$. For $p \geq q(\alpha)R$ taking a partial derivative with respect to price yields:

$$\frac{\partial \hat{s}}{\partial p} = \frac{\alpha^2}{4} \frac{\frac{-q(\alpha)}{R}(\frac{R}{p} - 1) + \frac{R}{p^2}(1 - q(\alpha)\frac{p}{R})}{q(\alpha)(\frac{R}{p} - 1)^2} - \lambda \frac{(1 - q(\alpha)\frac{R}{p^2}}{q(\alpha)(\frac{R}{p} - 1)}$$

The derivative is positive if $z(p) = \frac{\alpha^2}{4}(R^2 - 2q(\alpha)pR + q(\alpha)p^2) - \lambda R^2(1-q) > 0$. Since $z(p)$

decreases in price, the sufficient condition for the threshold to be increasing in price can be obtained by evaluating the function at maximum price $z(p=R) = R^2(1-q(\alpha))(\frac{\alpha^2}{4}-\lambda) > 0$.

The partial derivative of the threshold with respect to productivity is:

$$\frac{\partial \hat{s}}{\partial \alpha} = \frac{\alpha}{2}\frac{1-q(\alpha)\frac{p}{R}}{q(\alpha)(\frac{R}{p}-1)} + \frac{\alpha^2}{4}\frac{(-q'(\alpha)\frac{p}{R}q(\alpha) - q'(\alpha)(1-q(\alpha)\frac{p}{R})}{q^2(\alpha)(\frac{R}{p}-1)} - \lambda\frac{-q'(\alpha)q(\alpha) - q'(\alpha)(1-q(\alpha))}{q^2(\alpha)(\frac{R}{p}-1)}$$

It is negative if and only if $w(p) = q(\alpha)(1-q(\alpha)\frac{p}{R}) - q'(\alpha)(\frac{\alpha}{2} - 2\frac{\lambda}{\alpha}) < 0$. Since $\frac{\partial w(p)}{\partial p} < 0$, evaluating at highest and lowest feasible price gives sufficient conditions:

- If $w(p = q(\alpha)R) = q(\alpha)(1-q^2(\alpha)) - q'(\alpha)(\frac{\alpha}{2} - \frac{2\lambda}{\alpha}) < 0$ the threshold decreases in productivity
- If $w(p = R) = q(\alpha)(1-q(\alpha)) - q'(\alpha)(\frac{\alpha}{2} - \frac{2\lambda}{\alpha}) > 0$ the threshold increases in productivity

Proof of Proposition 1.3

We follow the same three steps as in proving Proposition 1.1.

1. With losses the inverse of the individual risk shifting threshold is $\hat{p} > 0$ when $S = 0$, while constrained price-funding schedule $p_s = 0$. Thus, for very low levels of funding supply risk shifting may be attractive. The comparison of derivatives is not affected by the losses, so as before price-funding schedule increases more steeply in funding. The two schedule cross at $S_c > 0$ beyond which point $p_s(\alpha, S, \lambda) > \hat{p}(\alpha, S, \lambda)$. If Assumption 2.B is satisfied, then $p_s(\alpha, \mathcal{S}_b(\alpha), \lambda) > \hat{p}(\alpha, \mathcal{S}_r(\alpha), \lambda)$, so the inverse of the individual risk shifting threshold crosses the all solvent price schedule at the point when $p = q(\alpha)R$.

We focus on funding levels that are at least balanced, $s^L > \mathcal{S}_b(\underline{\alpha})$, so that to streamline our discussion and focus on the problem of inference.

2. The equilibrium is never a pure risk shifting equilibrium if the lowest feasible funding supply is $s^L > \mathcal{S}_b(\underline{\alpha})$. Evaluating the inverse function of price under pure risk shifting equilibrium ($s_r(\alpha, p, \lambda) = (\frac{\alpha p}{2R})^2 - p$) and under the mixed risk shifting equilibrium ($\hat{s}(\alpha, p)$) at $p = q(\alpha)R$, we can show that the funding $s_r(\alpha, q(\alpha)R, \lambda) < \hat{s}(\alpha, q(\alpha)R, \lambda)$ if

$$\lambda < (\frac{\alpha}{2})^2(1-q^2(\alpha)) + q(\alpha)((\frac{\alpha}{2})^2 - R)$$

It always holds under Assumption 1.C , which limits the size of the losses to $\lambda < (\frac{\alpha}{2})^2\frac{1-q(\alpha)}{1+q(\alpha)}$. As in the case without losses, $s_r(\alpha, p, \lambda) < \hat{s}(\alpha, p, \lambda)$ continues to holf for all $p \in (q(\alpha)R, R)$

following from comparing $s_r(\alpha, R, \lambda)$ and $\lim_{p\to R} \hat{s}(\alpha, p, \lambda)$.

3. When funding supply is above the equilibrium risk shifting threshold $S > \mathcal{S}_r$:

- If all banks play solvent, bank i has incentive to deviate and play risk shifting strategy
- If all banks shift risk, bank i has incentive to deviate and play risk shifting strategy
- Bank i is indifferent between the risk shifting and the solvent strategy if $p = \hat{p}$, which happens when fraction $\psi(\alpha, S) = \frac{S - \left(\frac{\alpha\hat{p}}{2R}\right)^2}{\hat{p}}$ of banks risk-shift.

1.8.6 Confusion with uncertainty on losses

We show existence of the parameter values for which the inference problem may prevail even with two signals by solving the inference problem numerically. We parametrize the model in line with the Assumptions 1.A, 1.B, 2.A and 2.B. Assumption 2.C is not essential as we focus on the problem only under high funding supply realizations so that problem of emergence of a risk shifting equilibrium at constrained levels of funding is not a problem.

$\underline{\alpha}$	1
$\overline{\alpha}$	1.3
R	0.2
$q(\alpha)$	$-1.5 + 1.65\alpha$
s^L	1.42
s^H	1.42

Take an asset price that could emerge in this economy only under a risk shifting equilibrium: $p = 0.13 > q(\overline{\alpha})R$. We evaluate the individual risk shifting threshold at this price and to make sure that, banks always have risk shifting incentives at that equilibrium price $s^L = 1.42 > \hat{s}(p = 0.13, \alpha, \lambda)$. Feeding the equilibrium expression for prices under risk shifting equilibrium,we infer the value of productivity and a share of risk shifting banks that could give rise to $p = 0.13$ for different values of losses (100 increments of values from 0 and 0.05) and funding supply. Next we use these estimates to calculate the the total investment level consistent with that α and ψ. Below are plots two plots. First shows total investment that is consistent with the different values of productivity inferred from the price, for various values of funding supply and losses. Second shows total investment that is consistent with the different values of productivity inferred from the price, for various values of funding supply and productivity.

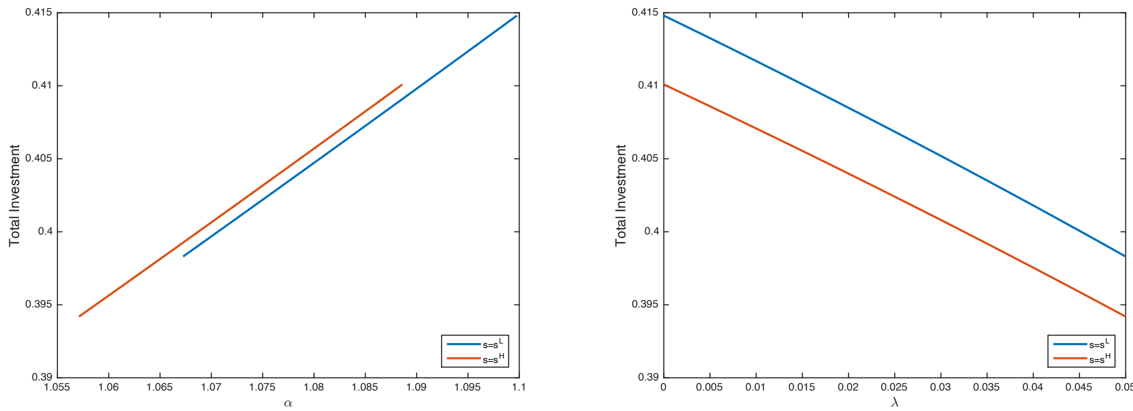


Figure 1.6: Total investment that's consistent with the values of productivity inferred for the feasible values of funding supply and losses as a function of productivity and losses.

Examining the plots above one can find combinations of productivity, funding supply and losses that yield the same value of total investment and asset price. Thus, if the maximum losses on impaired assets are $\bar{\lambda} = 0.015$, uninformed agents will make imprecise inference if the realized price is $p = 0.13$ and the realized total investment is 0.4101. In this case, uninformed agents infer that productivity is either: $\tilde{\alpha}(s^H, p = 0.13, 0) = 1.089$ or $\tilde{\alpha}(s^L, p = 0.13, \bar{\lambda}) = 1.09$.

Chapter 2

The Political Economy of Prudential Regulation

2.1 Introduction

Prudential policies such as bank capital and liquidity requirements or loan-to-value limits aim to prevent a build-up of excessive risk in financial markets. The academic literature motivates the use of these tools by externalities associated with borrowing (Lorenzoni, 2008) which can arise in economies with incomplete markets (Geanakoplos and Polemarchakis, 1986; Greenwald and Stiglitz, 1986). In particular, in the presence of financial constraints equilibrium borrowing may be excessive as agents do not internalize how their actions exacerbate welfare-reducing price declines (Davila and Korinek, 2018). Recent contributions identify regulatory tools available to a social planner to improve efficiency in this context.[1] They abstract, however, from the question of political feasibility of these measures.

Yet, the political economy plays an important role in shaping both the design and the implementation of financial policy (Kroszner and Strahan, 1999; Calomiris and Haber, 2015). Interest groups, such as voter constituencies and lobbies, effectively influence politicians' support for financial reforms (Mian et al., 2010; Igan and Mishra, 2014). Moreover, the complexity and opacity of financial regulation make it particularly prone to imperfect enforcement (Gai et al., 2019), which tends to benefit the politically connected (Lambert, 2018).

Building on these insights, this paper aims to deepen the theoretical understanding of

[1] See for example: Bianchi (2011); Bianchi and Mendoza (2011); Gersbach and Rochet (2012, 2017); He and Kondor (2016); Jeanne and Korinek (2018, 2020); Perotti and Suarez (2011).

how political economy factors affect prudential policy. By introducing a voting model into a framework with negative borrowing externalities I derive novel insights on how agent's preferences for policy are affected by income inequality and political imperfections such as regulatory capture (understood as a favorable treatment of politically connected agents by politicians). I show how the electoral power of different income groups and the extend of regulatory capture determine the strictness and efficiency of the equilibrium prudential policy.

Without regulatory capture, policy enforcement is frictionless and the limit on over-borrowing that emerges from the electoral game is constrained efficient. If borrowers' incomes are heterogeneous, a binding limit on current debt distributes wealth from high- to low-income borrowers through its' impact on future asset prices. As a result, in the absence of political imperfections high-income borrowers prefer lax policy, while low-income borrowers vote for strict debt limits.

The policy preferences are altered if the enforcement of regulation is imperfect. A captured politician exempts connected agents from regulation, thereby distorting its marginal costs and benefits to voters. First, due to reduced effectiveness of policy, agent's without connections may prefer laxer regulation. Second, heterogeneous exposure to the costs of regulation generates by capture induces the connected agents to support excessively strict policy in elections. Through this novel channel, anticipation of capture may result in an inefficiently strict equilibrium regulation if connected voters are pivotal. Moreover, if connections and income are correlated, political imperfections can reverse the policy preferences of high- and low-income borrowers.

In the model prudential regulation is motivated by negative externalities of borrowing modeled as in Davila and Korinek (2018) and Jeanne and Korinek (2020). Borrowers issue debt in order to smooth consumption. A price-dependent collateral constraint limits their ability to borrow at an interim date. Any drop in asset prices tightens the constraint, thereby reducing consumption. A pecuniary externality arises because atomistic borrowers do not internalize the impact of their initial borrowing on asset prices at the interim date. They over-borrow relative to the allocation of a constrained social planner. Regulation in the form of a limit or a tax on initial debt can restore constrained efficiency. My analysis focuses on the debt limit, but the appendix shows that the results are robust to using tax as the regulatory tool.

Prudential policy is implemented by a politician appointed through majoritarian elections. Politicians compete by announcing a limit on debt that they are committed to implement upon victory. In a tradition of probabilistic voting a'la Coughlin and Nitzan

(1981) and Lindbeck and Weibull (1987) agents differ in their responsiveness to changes in policy when voting. In equilibrium politicians offer a policy that caters to the more responsive voters. Consequently, the equilibrium policy weighs preferences of the voter groups by their population shares and a measure of their responsiveness to policy. I refer to the latter as a measure of an electoral power per population share.

A key mechanism is that, when voting, borrowers internalize the general equilibrium effect of the policy on the aggregate level of initial debt, and consequently, the equilibrium collateral price. Thus, borrowers have preference for a debt limit that curbs their over-borrowing.

In a benchmark setting the political process is frictionless and politician can commit to enforce the policy onto all borrowers. In this case, voters fully internalize the borrowing externality. Thus, as is standard in probabilistic voting models with a committed politician (Coughlin, 1982), the equilibrium policy restores constrained efficiency. However, in the presence of borrower heterogeneity the policy generally differs from that of a utilitarian social planner.

If borrowers' incomes are heterogeneous a decline in asset prices affects borrowers through two channels. First, it tightens the collateral constraint thereby decreasing welfare of all borrowers (*collateral channel*). Second, since high-income borrowers can purchase capital cheaply from the low-income types they partially benefit from falling prices (*capital trade channel*). Thus, high-income borrowers trade-off the immediate cost of regulation and the trade losses due to higher capital prices against the gains due to more relaxed collateral constraints. As a result, they support laxer debt limits than the low-income borrowers, who suffer a larger negative externality of the aggregate initial debt.

An increase in income inequality exacerbates the policy conflict, shifting the preferred policies of the two types further apart. Since the equilibrium policy is set in favor of groups with higher electoral power, an increase in inequality results in laxer regulation if high-income types have more power. This result relates to the hypothesis put forward by Rajan (2011) and Calomiris and Haber (2015) who argue that the lax regulatory environment in the US prior to the recent financial crisis was a means of garnering support of voters from lower income groups. They see this form of tacit redistribution as a response of politicians to growing income inequality. My analysis shows that in an environment with rational agents and the inefficiency deriving from pecuniary externalities of borrowing, the relation may be reverse than what they postulate. I show that, a preference of low-income voter for lax policy could emerge if enforcement of regulation is imperfect due to regulatory capture.

To study the impact of regulatory capture, I assume that a fraction of borrowers are endowed with political connections, which allow them to seek exemption from regulation. The resulting imperfect enforcement gives rise to two distortions. First, connected borrowers who are exempt from the limit do not internalize the price impact of their borrowing. They over-borrow and thus impose a pecuniary externality on all borrowers, as in the laissez-faire equilibrium. This reduces the effectiveness of the policy, decreasing the marginal benefits of implementing a strict debt limit. Second, as the cost of regulation is borne only by those without access to politicians, connected borrowers prefer the strictest policy. This allows them to reap the benefits of alleviating the asset price declines while shifting the costs of regulation onto borrowers without connections. The anticipation of exemption distorts their preferences for the ex-ante policy.

The two distortions can affect the equilibrium policy in opposite directions. Consequently, the debt limit implemented after elections may be either too lax or too strict relative to the policy implemented by a constrained social planner with perfect enforcement. If the relative electoral power of the connected borrowers is sufficiently high, the outcome is an excessively strict debt limit. Conversely, an inefficiently lax debt limit may emerge in equilibrium if politicians need to cater to borrowers without political connections to win elections.

If income inequality and political access are positively correlated, capital trade channel and distortions caused by imperfect enforcement work in opposite directions. As fewer of the low-income types are connected, they may prefer an overly lax policy if politicians are highly susceptible to capture. Thus, the policy preferences of the low-income borrowers critically depend on the quality of political institutions.

This analysis relates to the literature studying the role of capture in shaping regulation. Early contributions analyze the emergence of regulatory capture in the context of asymmetric information and the design of optimal contracts that maximize social welfare (Laffont and Tirole, 1991; Laffont et al., 1993). Recent work focuses on how regulatory capture exacerbates the moral hazard problem in financial institutions (Acharya, 2003; Martynova et al., 2019). This paper takes capture as given and explores how anticipation of favorable treatment affects the preference for the strictness of policy ex-ante. It points to a novel source of inefficiency associated with imperfect enforcement of regulation, working through the political economy channel. Anticipation of exemption distorts the policy preferences of connected borrowers. They support excessively strict ex-ante policy, externalizing the burden of regulation on those without connections. This mechanism is consistent with the empirical findings by **?**, who documents that firms lobbying on legislature exert a negative externality on their close competitors. Her evidence suggests that lobbying firms can secure their narrow interests at the expense of the non-lobbyists.

This work contributes to a growing theoretical literature on the political economy of financial regulation. Herrera et al. (2014) and Hakenes and Schnabel (2014) show that inefficiently lax regulation can be implemented by a politician concerned with his reputation, if the quality of credit booms or ability to understand complex arguments are a signal of her quality. In a related framework, Almasi et al. (2018) studies the pro-cyclicality of prudential policy. My model abstracts from the problem of reputation and studies the policy set by a politician who implements the policy she announced in the campaign, but may be unwilling to enforce it on all borrowers. It complements the existing studies by deepening the understanding of voters' policy preferences and their impact on strictness of equilibrium regulation in a micro-founded model of inefficient over-borrowing.

The analysis also relates to a large body of literature on the political economy of regulating externalities. Contributions in this field focus on the application to environmental regulation and view its' distributive effects as a source of a policy conflict. Fredriksson (1997) shows that in the presence of industrial and environmentalist lobbies, environmental policy may fail to maximize utilitarian social welfare. In the context of voting, Alesina and Passarelli (2014) and Masciandaro and Passarelli (2013) evaluate the equilibrium choice of a regulatory tool and its' level of stringency when agents differ in the cost of producing the externality. Other contributions focus on the potential of a re-distributive use of proceeds from environmental tax and explore how the refund rule affects the equilibrium level of tax (Cremer et al., 2004; Fredriksson and Sterner, 2005; Aidt, 2010). As in Masciandaro and Passarelli (2013), my analysis focuses on the application to financial regulation. In my setting the policy conflict emerges endogenously because of the distributive effects of the capital trade channel of the fire sale. Moreover, my analysis moves beyond the assumption of perfect commitment to policy by politicians, which underlies these models. I explore the problem of imperfect enforcement, which is of particular relevance in the context of financial regulation, due to its' opaque and discretionary nature.

Section 2.2. provides the model set up and solves the benchmark framework with homogenous borrowers and perfect enforcement. In Section 2.3. I study the implications of income heterogeneity on equilibrium prudential regulation. In Section 2.4. I explore the implications of regulatory capture on the efficiency and strictness of the equilibrium. Section 2.5. concludes.

2.2 Model Set Up

This section introduces the benchmark model in which borrowers are homogenous and the political process is frictionless, ie. politicians enforce the regulation on all agents. I first outline the elements of the economic environment and then introduced the assumptions on the political process. The section solves for the laissez faire equilibrium, compares it to the allocation of a constrained social planner and then studies the equilibrium with the political game.

2.2.1 Economic Environment

There are 3 dates, $t = 0, 1, 2$, two goods: capital and a perishable consumption good (the numeraire) and two groups of agents: a unit mass of borrowers and a unit mass of lenders. The role of lenders in this framework is to provide funding to borrowers. Borrower's are the key actors in this setting, as they are directly affected by the inefficiency and engage in externality-generating overborrowing. In the baseline set up borrower's are homogenous, Sections 2.3 and 2.4 relax this assumption, and study the equilibrium with heterogeneous borrowers. To nest this case in the exposition of the model, I index borrower types by $B \in \mathbb{B}$, where $\mathbb{B}$ is the set of borrower types and denote by θ^b share of type b in the population of borrowers. In the baseline setting $\mathbb{B} = \{b\}$ and $\theta^b = 1$.

Agents derive utility from consumption according to:

$$u^B(c) = log(c_0^B) + log(c_1^B) + c_2^B \tag{2.1}$$

$$u^L(c) = c_0^L + c_1^L + c_2^L \tag{2.2}$$

Thereafter, I refer to these as consumption-utilities. Lenders are risk-neutral at all dates, with linear consumption-utility. Borrower's consumption utility is quasi-linear. The curvature at $t = 0$ and $t = 1$ generates a consumption smoothing motive, which is key for the welfare impact of a fire sale. Linearity in $t = 2$ consumption makes the framework tractable, by ensuring that the demand for consumption at the initial and interim date are independent of income .

Lenders receive large income (endowment of the consumption good) equal to $y^L \geq 1$ at $t = 0, 1, 2$. Borrowers are endowed with $y_1^B = y$ units of the consumption good at $t = 1$ and receive no endowment at other dates $y_0^B = y_2^B = 0$.

Borrowers are endowed with 1 unit of capital at the beginning of $t = 1$, $k_1^B = 1$. Agents can trade capital at $t = 1$. The endogenously determined equilibrium price of capital in terms of the consumption good is denoted by p. The capital holding of agent J after the trade, so between $t = 1$ and $t = 2$, is given by k_2^J. Borrower's can use it to produce a consumption good between through a linear production technology, which yields payoff, $f^b(k_2^B) = k_2^B$, at $t = 2$. Lenders receive no capital endowments, $k_0^L = 0$, and are unproductive, $f^L(k_2^L) = 0$.

At dates $t = 0$ and $t = 1$, agents J can trade in 1-period risk-free debt (d_t^J) with a promised repayment of $r_{t+1}d_t^J$ at $t+1$. The resulting budget constraints for agent J are:

$$c_0^J \leq d_0^J + y_0^J \tag{BC0-J}$$

$$r_1 d_0^J + c_1^J \leq d_1^J + y^J + p(k_1^J - k_2^J) \tag{BC1-J}$$

$$r_2 d_1^J + c_2^J \leq y^J + f^J(k_2^J)) \tag{BC2-J}$$

Imperfect contract enforcement introduces a financial friction in this model. The debtor can renege on the contract at any time, in which case the creditor can grab a fraction $\phi \leq \frac{1}{2}$ of his assets. This gives rise to collateral constraints that limit borrowers ability to take on debt at any date. The collateral constraint at $t = 1$ is given by:

$$d_1^B \leq \phi p k_2^B \tag{CC-B}$$

The constraints of this type are widely used in the macro-finance literature (Kiyotaki and Moore, 1997; Lorenzoni, 2008; Davila and Korinek, 2018). To ensure that it binds in the competitive equilibrium, Assumption 2.1 (a) below introduces an upper-bound on borrower's income.

Appendix 2.6.1 provides explicit characterization of $t = 0$ collateral constraint. In the analysis I focus on the environments in which the $t = 0$ collateral constraint is slack, by assuming that borrower's income is not too low (see Assumption 2.1 (b) below).

Assumption 2.1. ***Income***
Borrowers' income is low: $y < 2 - \phi$ (a), but not too low $y > \frac{1-\phi}{\phi}$ (b).

The assumptions on borrower's income limit the number of cases that ought to be considered and focus the discussion on the setting in which efficiency can be improved by a policy intervention[2].

[2] Inefficient overborrowing at $t = 0$, and thus a motive for policy may arise even in the case of a binding $t = 0$ collateral constraint. However allowing for that would add more complexity to the exposition, without providing additional insights.

2.2.2 Political Process

The prudential policy is implemented through a political process governed by standard assumptions of a probabilistic voting model. At the beginning of $t = 0$, two politicians, $g = \{A, Z\}$, compete for the governmental office in majoritarian elections. Each agent can cast one vote and the politician who receives the majority of the votes wins. In case of tie, the winner is drawn randomly. The politician who takes the governmental office receives exogenous private benefits that give her a motive to run. Politicians compete by announcing the level of prudential policy (limit on debt $\bar{d}_g$) that they will implement upon winning the elections. In the baseline model I assume that politicians can commit to perfectly enforce the announced policy, I relax this assumption in Section 2.4.

Each agent belongs to a voter group $v \in \mathbb{V}$. Lenders and borrowers (potentially of different types) form separate voter groups $\mathbb{V} \in \mathbb{B} \cup \{L\}$. Agents derive consumption-utility from the implemented policy and a political-utility from the identity of the elected politician. The political-utility is an ideological bias towards one of the candidates. It measures the preference for politician A's characteristics that are unrelated to the economic policy, such as individual features, socio-cultural policies, etc. The bias is random and composed of an idiosyncratic ($b^{i,v}$) and an aggregate (b) component. The total utility of agent i in voter group v is given by:

$$U^{i,v} = \begin{cases} u(\bar{d}_A) + b^{i,v} + b & \text{if A wins} \\ u(\bar{d}_Z) & \text{if Z wins} \end{cases} \tag{2.3}$$

The idiosyncratic component of the ideological bias, is drawn for each individual i from a voter-group-specific distribution, $b^{i,v} \sim U\left[-\frac{1}{\psi^v}; \frac{1}{\psi^v}\right]$. The more ideologically concentrated a given voter group (the higher ψ^v), the more important the economic policy is for it's members when they make their voting choices. The concentration can also be interpreted as a proxy for economic literacy, interest or ease of participation in elections. This is a key parameter which determines the relative importance of different voter groups in equilibrium. The aggregate component is drawn from a uniform distribution $b \sim U\left[-\frac{1}{\Psi}; \frac{1}{\Psi}\right]$ and measures the average political preference in the population. It helps smoothen the problem of politicians, so that to avoid corner solutions.

The assumption of a probabilistic ideological bias by voters allows for differences in non-policy attributes of politicians and in voters preferences for these characteristics. It is widely used in the political economy literature (see for instance Lindbeck and Weibull (1987), Yang (1995), Persson and Tabellini (1999) or Pagano and Volpin (2005)) as it results in a smooth problem of a politician and allows for characteristics other than the population share to affect the relative political influence of different constituencies.

The timing of the political game is as follows: (1) Politicians announce their platforms, (2) Ideological bias is realized, (3) Agents vote in elections (denote by $e^{i,v} = 1$ agents' i choice to vote for politician A and by $e^{i,v} = 0$ his choice to vote for politician Z) and (4) The policy is implemented[3].

2.2.3 Competitive Equilibrium

This section derives the equilibrium in the absence of policy. I show that the collateral constraint limits borrowers ability to smooth consumption at the interim date, which results in a low price of capital and generates a positive relationship between price and borrower's income).

Definition 2.1. ***Competitive Equilibrium***
A competitive equilibrium is a vector of allocations, $\{c_0^J, c_1^J, c_2^J, d_0^J, d_1^J, k_2^J\}$ $\forall J \in \{L, B\}$, and prices, $\{r_0, r_1, p\}$, such that lenders and borrowers maximize their consumption-utilities (2.1) and (2.2), subject to the budget constraints at each date (BC0-J, BC1-J, BC2-J) and the collateral constraint (CC-B). Debt and capital markets clear at all dates:

$$d_t^L + \sum_{B\in\mathbb{B}} \theta^B d_t^B = 0, \;\; t = 0, 1 \tag{2.4}$$

$$k_2^L + \sum_{B\in\mathbb{B}} \theta^B k_2^B = 1 \tag{2.5}$$

The problem of lenders is to maximize (2.2) subject to budget constraints (BC0-L, BC1-L, BC2-L). Since they are unproductive, lenders do not demand any capital, $k_2^L = 0$. The linearity of their consumption-utility ensures that they are indifferent between consumption at all dates, $c_1^L + c_2^L + c_3^L = 3y^L$ and pin down the interest rates on the riskless debt, $r_1 = r_2 = 1$

Borrower's Problem at the Interim Date

Solving the borrower's problem using backwards induction, the consumption and debt repayment at $t = 2$ follow directly from the budget constraint. At $t = 1$, the problem of

[3] This framework can be easily extended to allow for ex-ante lobbying by different voter groups. I discuss this setting in Appendix 2.6.8.

a borrower can be expressed as:

$$V^B(d_0^B) = \max_{c_1^B, c_2^B, d_1^B, k_2^B} log(c_1^B) + c_2^B \text{ s.t. CC-B, BC1-B, BC2-B}$$

Denote by λ_t^{bB} the Largrange multipliers on budget constraints (Bt-B) and by κ_1^B the multiplier on the collateral constraint (CC-B). The first order conditions with respect to consumption require that $\lambda_1^B = \frac{1}{c_1^B}$ and $\lambda_2^B = 1$. The first order condition with respect to capital, k_1^B is:

$$-p\lambda_1^B + \kappa_1^B p\phi + \lambda_2^B = 0 \tag{2.6}$$

It implies that the borrower is willing to hold any amount of capital as long as the marginal benefits are equal to the marginal costs of holding capital. The former is the value of increased consumption at $t = 2$ (captured by λ_2^B) and the increase in $t = 1$ consumption through a more relaxed collateral constraint (captured by $\kappa_1^B p\phi$), while the latter corresponds to the increase in $t = 1$ consumption due to gains from selling capital (captured by $p\lambda_1^B$) .

Borrower's choice of debt at $t = 1$ follows from the following Euler equation:

$$\lambda_1^B - \lambda_2^B - \kappa_1^B = 0 \tag{2.7}$$

There are two cases, the collateral constraint may be either slack or binding. If the collateral constraint is slack, $\kappa_1^B = 0$, the borrower is able to smooth consumption between $t = 1$ and $t = 2$, $c_1^B = 1$. The price of capital reflects its' marginal productivity $p = 1$. The assumption on the minimum income ensure that this case does not arise in the competitive equilibrium.

If the collateral constraint is binding, $\kappa_1^B > 0$, consumption smoothing is inhibited as borrower's debt is limited by the value of collateral $d_1^B = \phi p k_2^B$. Combing the Euler equation (2.7) with the capital FOC yields (2.6):

$$c_1^B = \frac{(1-\phi)p}{1-\phi p}$$

The budget constraint (BC1-B) pins down the individual demand for capital by borrowers. With the null demand by unproductive lenders, the market clearing requires that equilibrium price solves:

$$\frac{\sum_{B\in\mathbb{B}}\theta^B(y^B-d_0^B)+p}{p(1-\phi)}-\frac{1}{1-\phi p}=1 \tag{2.8}$$

Focusing on the homogenous case where $B=b$, and using D_0^b to denote the aggregate $t=0$ debt of borrowers, the Lemma below that re-establishes the result on the existence of a fire sale from the previous literature.

Lemma 2.1. ***Fire Sale***
If borrowers' net income at $t=1$ is high, $1-\phi\leq y-D_0^b$, the price of capital is $p=1$. If it is low, $1-\phi>y-D_0^b$, the price of capital solves (2.8). It is lower than capital's marginal productivity, $p<1$, and increases in borrower's net income, $\frac{\partial p}{\partial y}>0$ & $\frac{\partial p}{\partial D_0^b}<0$.

Proof. Taking a derivative of (2.8) yields $\frac{\partial p}{\partial y}=\frac{1}{\frac{1-\phi}{(1-\phi p)^2}-\phi}$ and $\frac{\partial p}{\partial D_0^b}=\frac{-1}{\frac{1-\phi}{(1-\phi p)^2}-\phi}$. Since $\phi<\frac{1}{2}$, $\frac{\partial p}{\partial y}>0$ & $\frac{\partial p}{\partial d_0^b}<0$. □

If borrower's net income at $t=1$, $y-D_0^b$, is sufficiently high, consumption smoothing across $t=1$ and $t=2$ is achieved. If it is low, borrower is unable to reach a sufficiently high level of consumption at $t=1$ because the collateral constraint limits his borrowing. The marginal utility of consumption at $t=1$ is higher than at $t=2$, making the output produced by capital at the final date relatively less valuable to the borrower. A decrease in the net income decreases the marginal rate of substitution, which implies a larger discount on the marginal value of $t=2$ output and drives down the equilibrium price. I follow the literature and refer to the above mechanism as a "fire sale".

Borrower's Problem at the Initial Date

At $t=0$ the borrower chooses the level of consumption and debt so that to maximize his consumption-utility, taking as given his optimal choices at $t=1$:

$$\max_{c_0^B,d_0^B}\ log(c_0^B)+V^B(d_0^B)\text{ s.t. (BC0-B)}$$

With λ_0^B denoting the Lagrange multiplier on the $t=0$ budget constraint, the first order condition of this problem is:

$$\lambda_0^B-\lambda_1^B=0 \tag{2.9}$$

The borrower's optimal choice is to smooth consumption between $t = 0$ and $t = 1$, so $c_0^B = c_1^B$. He does not internalize the effect that the aggregate debt of has on prices. This yield the equilibrium price of capital:

$$2\frac{(1-\phi)p}{1-\phi p} - \phi p = y \tag{2.10}$$

Under assumption 2.1 (a) the equilibrium price given by (2.10) is lower than the productivity of capital and the fire sale characterized in Lemma 2.1 emerges in equilibrium.

2.2.4 Planner's Policy

In this section I define the welfare benchmark and evaluate the efficiency of the competitive equilibrium. I show that a social planner can restore constrained inefficiency by implementing a debt limit.

Whenever the collateral constraint is binding the competitive equilibrium is inefficient relative to the first best. An unconstrained social planner is not restricted by the constraint arising from the financial friction and can freely choose allocations as long as they respect the resource constraints. Consequently, in the first best the allocation is such that borrowers smooth consumption across all dates. This benchmark is not particularly useful for informing policy, as it assumes that the planner can work around the key friction in the economy, the imperfect contract enforcement.

I follow the literature studying the normative implications and the optimal policy in economies with financial frictions and use constrained efficiency as the welfare benchmark (see for instance: Stiglitz (1982); Greenwald and Stiglitz (1986); Geanakoplos and Polemarchakis (1986); Lorenzoni (2008); He and Kondor (2016); Davila and Korinek (2018)). The constrained efficient allocation is the choice by a constrained social planner who can set the initial allocations (group-specific level of consumption and debt, denoted here with capital symbols) so that to maximize social welfare but has to respect the financial constraints and market clearing.

Definition 2.2. ***Constrained Social Planner***
The constrained social planner chooses initial allocations $\{C_0^L, D_0^L, C_0^B, D_0^B\}$ so that to maximize the social welfare for given Pareto Weights (χ^L, χ^B), subject to the same constraints as the market, respecting the debt and capital market clearing conditions and leaving $t = 1$ and $t = 2$ decisions to private agents.

The full formulation of the planner's problem is provided in Appendix 2.6.3. The first order conditions for consumption and lender's debt coincide with those of private agents, while the condition for borrower's debt reads:

$$\lambda_0^B - \lambda_1^B + \phi K_2^B \kappa_1^B \frac{\partial p}{\partial D_0^B} = 0 \tag{2.11}$$

Comparing the planner's choice of initial debt (2.11) with the optimal individual choice of borrowers (2.9), yields the result on constrained inefficiency (as in Jeanne and Korinek (2020) or Davila and Korinek (2018)).

Proposition 2.1. ***Constrained Inefficiency***
The competitive equilibrium is constrained inefficient characterized by overborrowing at $t = 0$.

Proof. The debt level set by the planner solves (2.11). Comparing it to (2.9) and using Lemma 2.1 yields $D_0^b < d_0^b$. □

The constrained social planner takes into account that the debt taken up by borrowers at $t = 0$ affects the price of collateral at $t = 1$. Whenever the borrowers are constrained in the competitive equilibrium, this price effect generates welfare losses as it further tightens the collateral constraint, inhibiting borrowers' ability to smooth consumption between $t = 1$ and $t = 2$. Thus, the pecuniary effects operate through a collateral channel (captured by $\phi K_2^B \kappa_1^B \frac{\partial p}{\partial D_0^B}$ in planner's FOC) resulting in an inefficiency. An individual borrower is atomistic, so does not take into account the impact of his actions on price. Thus, his choice of initial debt generates a pecuniary externality on all borrowers, as it depresses collateral prices and tightens their collateral constraints.

Corollary 2.1. ***Constrained Efficient Debt Limit***
The constrained social planner can implement the efficient allocation using a debt limit $\bar{d}^{SP} = D_0^{*B}$.

In the presence of the debt limit, agents optimizing at $t = 0$ have to account for an additional constraint:

$$d_0^B \leq \bar{d} \tag{DL}$$

The optimal choices of borrowers are affected through the $t = 0$ Euler equation, which now reads:

$$\lambda_0^B - \lambda_1^B - \kappa_0^b = 0$$

where κ_0^B is the Lagrange multiplier of the debt limit. If the debt limit is slack $\kappa_0^B = 0$ and the equilibrium corresponds to the competitive equilibrium. If the debt limit is binding, $\kappa_0^B > 0$, the debt and consumption at $t = 0$ are pinned down by the limit $c_0^B = d_0^B = \bar{d}$. In what follows I refer to the debt limit set by the social planner as the efficient debt limit and compare the policy implemented by a politician to this benchmark.

2.2.5 Political Equilibrium

With the benchmark of the competitive (laissez faire) economy and the planner's optimal policy, I now turn to studying the equilibrium of the political economy in which the limit on initial debt is implemented by an elected politician. This section derives the solution of the probabilistic voting game and shows that the political equilibrium implements planner's policy in the benchmark model.

Definition 2.3. ***Political Equilibrium***
The political equilibrium is a vector of allocations, $\{c_0^J, c_1^J, c_2^J, d_0^J, d_1^J, k_2^J\}$ $\forall j \in L, B$, policies announced by each politician $\{\bar{d}_A, \bar{d}_Z\}$, voting strategies, $\{e^{i,v}\}\forall i, v$, and prices, $\{r_0, r_1, p\}$, such that agents choose debt, consumption and capital holding and decide on voting strategies to maximize their total utilities (2.3), subject to the budget constraints at each date (BC0-J, BC1-J, BC2-J), the collateral constraint (CC-B) and the debt limit (DL). Politicians A and Z maximize the probability of winning, taking as given agent's voting strategies. Debt and capital markets clear (2.4) and (2.5).

When choosing his voting strategy, an agent evaluates the policy proposals of the two politicians and votes for the one whose policy offers him a higher total utility. Politicians maximize their probability of winning the elections and thus, receiving private benefits of holding office.

The probability of winning the elections by a politician A depends on the expected share of votes that she receives. To find the vote share, define the voter indifferent between either of the politicians in each of the groups, a group specific swing voter $b^{s,v} = U^v(\bar{d}_B) - U^v(\bar{d}_A) - b$. The candidate A (Z) receives the votes from all agents, whose realized bias is larger (smaller) than that of the swing voter of the group. .

Using the uniform distributions of the individual biases and taking into account the distribution of the aggregate bias, the ex-ante probability of winning by the politician A for a given policy of the competitor $\overline{d}_Z$ is:

$$\pi_A = \frac{1}{2} + \frac{\Psi}{\bar{\psi}} \left[\sum_{v \in \mathbb{V}} \psi^v \theta^v [U^v(\overline{d}_A) - U^v(\overline{d}_Z)] \right] \tag{2.12}$$

Where $\bar{\psi} = \psi^L + \sum_{B \in \mathbb{B}} \theta^B \psi^B$ is the average ideological concentration of the two groups of agents. The policy affects the probability of winning directly through its impact on agents' utilities. Each politician chooses the policy platform so that to maximize this probability. The resulting optimality condition of the problem of the politician A is:

$$\frac{\mathrm{d}\pi_A}{\mathrm{d}\overline{d}_A} = \sum_{v \in \mathbb{V}} \theta^v \psi^v \frac{\mathrm{d}U^v(\overline{d}_A)}{\mathrm{d}\overline{d}_A} = 0 \tag{2.13}$$

Therefore, to maximize her probability of winning the politician chooses a policy that maximizes the sum of weighted utilities of agents within each voter group. The weight assigned to a voter group in the politician's optimization reflects the concentration of ideological biases among its' members. The politician anticipates that voting strategies of agents in groups with a high dispersion of ideological bias are less responsive to changes in the prudential policy. Consequently, voters in these groups are relatively less important in her objective function. Thus, the electoral power of each of the groups per population share is proportional to their ideological concentration (in what follows I use these terms interchangeably).

The problem of the politician Z is symmetric, thus the equilibrium of the political subgame is characterized by the convergence of the policy platforms of the two politicians, $\bar{d}_A = \bar{d}_Z = \bar{d}^*$, where $\bar{d}_A$ solves (2.13). Consequently, the voting strategies of agents are determined by the realization of the ideological biases and each politician has an equal probability of winning in equilibrium.

Proposition 2.2. ***Equilibrium Debt Limit***
The equilibrium debt limit is binding and corresponds to the choice of the constrained social planner $\bar{d}^* = \bar{d}^{SP} < d_0^{*B}$.

Proof. Follows from aggregating the policy preferences according to (2.13). □

Since lenders are not affected by the debt limit, they are indifferent between any policy, so that $\frac{\mathrm{d}U^l(\bar{d})}{\mathrm{d}\bar{d}} = 0$. Borrower's consider the effect of the debt limit on their ability to smooth consumption between $t = 0$ and $t = 1$ as well as the indirect effect of the regulation through its impact on capital prices:

$$\frac{\mathrm{d}U^b(\bar{d})}{\mathrm{d}\bar{d}} = \kappa_0^b + \phi k_2^b \kappa_1^b \frac{\partial p}{\partial \bar{d}}$$

Borrower's preferred level of the debt limit equalizes the marginal benefit of allowing more consumption smoothing between $t = 1$ and $t = 2$, by limiting the fire sale and thus making the collateral constraint more slack (captured by $\phi k_2^b \kappa_1^b \frac{\partial p}{\partial \bar{d}}$) against the marginal cost of limiting the consumption smoothing between $t = 0$ and $t = 1$ (captured by κ_0^b). Borrowers internalize the externality associated with overborrowing when forming their preferences for a universally applicable rule. As a result both politician's offer a debt limit that corresponds to the planner's policy.

In an environment with homogenous borrowers and perfect enforcement, the equilibrium prudential policy is constrained efficient. The intuition is that ability to introduce a universally applicable rule allows the borrowers to coordinate so that to limit the self-inflicted externality. Borrowers are the only group of agents affected by the fire sale. They are all harmed by it to an equal extend and agree on the optimal level of regulation. These preferences directly translate to policy because the political process is frictionless.

In the following sections I sequentially relax the assumption of borrower homogeneity (Section 2.3) and perfect enforcement of the policy (Section 2.4) in order to study their role in yielding this result. The analysis reveals that absence of frictions in the political process is critical for the efficiency of the equilibrium policy.

2.3 Heterogenous Borrowers

In the benchmark case, homogeneity of borrowers ensures that the policy preferences of voters are aligned. This section studies the equilibrium policy in a setting where this no longer holds. It introduces heterogeneity with respect to income among borrowers and studies the resulting conflict over the preferred policies. In this framework, I explore how income inequality affects the strictness of equilibrium regulation.

Assume now that there are two types of borrowers: $\mathbb{B} = \{r, p\}$. A fraction θ^r of borrowers are high-income types and receive $y_1^r = y^r$ at $t = 1$. The remaining $1 - \theta^r = \theta^p$ are low-income types with $y_1^p = y^p < y^r$. The type is drawn at the beginning of $t = 0$ and is private information.[4] The two types form separate voter groups, that is their ideological

[4] This assumption allows me to focus on a problem with a single debt limit policy. In Appendix 2.6.6 I show that if type is public information, type-specific debt limits emerge in equilibrium, but the results on the efficiency and strictness derived in this section remain the same.

biases are drawn from different distributions: ψ^r, ψ^p.

Assumption 2.2. ***Income and Inequality***

(a) The average income of borrowers is low, $\bar{y} = \sum_{B \in \mathbb{B}} \theta^B y^B < 2 - \phi$;

(b) The income of each borrower type is not too low, $y^B > \frac{1-\phi}{\phi}\ \forall B$;

(c) The income inequality is not too high, $y^r < \rho(\bar{y})$

Assumptions 2.2 (a) and 2.2 (b) ensure that the collateral constraint is binding at $t = 1$ but slack at $t = 0$. Under Assumption 2.2 (c) both types of borrowers face a negative externality in the competitive equilibrium (see the Proof of Proposition 2.3 for the definition of $\rho(\bar{y})$).

2.3.1 Competitive Equilibrium

Heterogeneity in income affects borrower's choices at $t = 1$. Both types of borrowers are indifferent between any capital holding as long as price satisfies (2.6). This condition pins down the relation between consumption and price and is the same for both types. Thus, clearing of capital markets requires that high- and low-income borrowers choose the same level of consumption in equilibrium.[5] Consequently, the collateral constraint is either binding or slack for both.

If the collateral constraint is slack, consumption smoothing between $t = 1$ and $t = 2$ is uninhibited and both types choose $c_1^B = 1$. The capital markets clear at $p = 1$. Borrowing and capital trade are equally costly, so borrowers are indifferent between these two. The budget and collateral constraint pin down the optimal combinations.

If the collateral constraint is binding, neither type is able to choose debt freely. They achieve equal consumption through trade in capital. The budget constraints pin down the choice of capital holding of each type. Aggregating these in the capital market clearing condition yields (2.8), with $\mathbb{B} = \{r, p\}$. This implicitly pins down the price of capital. It follows that, with heterogeneous borrowers, the price depends on their aggregate net income $\sum_{B \in \mathbb{B}} \theta^B (y^B - d_0^B)$.

Corollary 2.2. ***Effect of Changes in Inequality***
A mean preserving increase in inequality in net incomes, $(y^r - d_0^r) - (y^p - d_0^p)$, *has no effect*

[5] This is the interior solution of their problem. In Appendix 2.6.4 I show that the interior solution constitutes the unique equilibrium under the assumptions on minimum income of each borrower type (Assumption 2.2 (b)).

on capital price. It increases the difference in capital holding of the high- and low-income types at the end of the interim date ($k_2^r - k_2^p$).

The choice of the initial debt and consumption completes the description of the competitive equilibrium. Quasilinear consumption-utility ensures that both types choose the same level of initial debt: $d_0^B = c_1^B$. Since they borrow the same amount, in equilibrium high-income types have higher net income at $t = 1$. Consequently, they purchase capital from low-income borrowers $k_2^r > 1 > k_2^p$. Solving for price using the optimal initial debt yields the following Lemma.

Lemma 2.2. ***Fire Sale with Income Heterogeneity***
In the competitive equilibrium the collateral constraint is binding for both borrower types. A fire sale emerges in equilibrium so that the price solves (2.8) and is $p < 1$.

Proof. Follows from using $d_0^B = c_1^B$ in (2.8). The resulting price is $p = 1$ if $\bar{y} = 2 - \phi$. Using that the price is increasing in income, if income satisfies Assumption 2.2 (a) the price is $p < 1$. □

2.3.2 Social Planner

To evaluate the efficiency of the equilibrium allocation, I compare it to the choice of a constrained social planner who assigns Pareto weights χ^L, χ^r, χ^p to lenders, high-income and low-income borrowers respectively. The first order condition of the planner's problem with respect to the initial debt reads:

$$\lambda_0 - \lambda_1 + \underbrace{\frac{\partial p}{\partial D_0} \phi \kappa_1^b \frac{\sum_{h \in \mathbb{B}} \theta^h \chi^h K_2^h}{\sum_{h \in \mathbb{B}} \theta^h \chi^h}}_{X_c} + \underbrace{\frac{\partial p}{\partial D_0} \lambda_1^b \frac{1 - \sum_{h \in \mathbb{B}} \theta^h \chi^b K_2^h}{\sum_{h \in \mathbb{B}} \theta^h \chi^h}}_{X_t} = 0 \tag{2.14}$$

Where $D_0 = D_0^B$, $\lambda_0 = \lambda_0^B$ and $\lambda_1 = \lambda_1^B$ for all $B \in \mathbb{B}$, as the planner does not observe type.

When choosing the optimal level of debt, the planner takes into account the consumption smoothing motive between $t = 0$ and $t = 1$ as well as the pecuniary effects of the initial debt. As in the case of homogenous borrowers, the planner accounts for the welfare loss associated with tightening of the collateral constraint at $t = 1$. The externality that emerges through this collateral channel (captured by X_c) negatively affects both borrower types. The key difference relative to the benchmark, is that with income heterogeneity, fire sales generate additional, distributive effects through a capital trade channel (captured by X_t).

High-income borrowers experience welfare gains associated with a fall in prices, because it allows them to purchase capital cheaply. The reverse holds for low-income borrowers. They suffer losses through the capital trade channel, as a larger fire sale implies that they need to sell their capital at a lower price. The social planner weighs these gains and losses by the Pareto Weights of the two types and may thus view the capital trade channel as having either a negative (if poor have higher Pareto Weights) or a positive (if rich have higher Pareto Weights) welfare impact.

Proposition 2.3. ***Constrained Inefficiency with Heterogenous Borrowers***
If the income inequality is not too high, borrowing at $t = 0$ *imposes an overall negative externality on both types of borrowers. In this case the competitive equilibrium is constrained inefficient characterized by overborrowing at* $t = 0$ *for any set of Pareto Weights.*

Proof. The overall externality on borrower of type B is given by $X^B = \frac{1}{c_1^B}\frac{\partial p}{\partial D_0^B}[1 - k_2^B(1 - \phi(1 - c_1^B))]$. It is negative for low-income types, since $k_2^p < 1$. For high-income borrowers it is negative if and only if $k_2^r < \frac{1}{1-\phi(1-c^r)}$. This is the case if the income inequality satisfies Assumption 2.2 (c): $y^r < \bar{y} + \phi p(\bar{y})(1 - p(\bar{y})) \equiv \rho(\bar{y})$. Thus, for any set of Pareto Weights, the planner chooses initial debt at a lower level than borrowers. □

If the income inequality among borrowers is not too large, the gains of the high-income types through the capital trade are not high enough to compensate for the losses through the collateral channel. In this case, both high- and low-income borrowers suffer from a negative pecuniary externality of the initial debt. There is overborrowing in the competitive equilibrium relative to the constrained planner's allocation.

Corollary 2.3. *The constrained social planner can implement constrained efficient allocation by imposing a debt limit* $\bar{d}^{SP} = D_0^{SP}$ *that solves (2.14).*

Since gains of high-income borrowers through the capital trade channel represent the losses of the low-income borrowers, for a utilitarian social planner ($\chi^r = \chi^p$) the distributive effects of the capital trade channel cancel out. Thus, the utilitarian-constrained efficient level of debt is equivalent to that in the benchmark case with homogenous borrowers whose income satisfies $y^b = \bar{y}$. Since low-income borrowers experience larger losses associated with the fire sale, if they have a higher Pareto weight than the high-income types, the inefficiency is larger and planner prefers a lower (stricter) debt limit than in the benchmark. Reverse holds if the utility of high-income borrowers is more important in the social welfare function.

2.3.3 Political Equilibrium

This section evaluates the policy preferences of different types of borrowers and shows that the equilibrium policy lies on the Pareto Frontier. It provides insights on how income inequality and ability to influence election outcomes of the two types affect the strictness of regulation.

The solution of the political sub-game is equivalent to the case of homogenous borrowers, just that now high- and low-income borrowers constitute two separate voter groups.

Thus, the equilibrium policy satisfies the optimality condition of politician's (2.13) with $\mathbb{V} = \{r, p, L\}$. The politician weighs the preferences of each borrower type by the population share and the measure of sensitivity of their voting behavior to economic policy (the ideological concentration, ψ^v). I denote the policy-sensitivity of the high-income borrowers relative to the sensitivity of low-income borrowers by $\gamma^r = \frac{\psi^r}{\psi^p}$. For equal population shares, this reflects the relative influence of the two groups on the policy choice of the politician. I refer to this measure as the relative electoral power of the high-income types

The policy preferences of borrowers are specific to the type and given by:

$$\frac{\mathrm{d}U^B(\bar{d})}{\mathrm{d}\bar{d}} = \kappa_0^B + \phi k_2^B \kappa_1^B \frac{\partial p}{\partial \bar{d}} + \lambda_1^B (1 - k_2^B) \frac{\partial p}{\partial \bar{d}} = 0 \tag{2.15}$$

When determining their policy preferences, high- and low-income borrowers internalize the effects of the debt limit on their utility through both the collateral and the capital trade channels. The distributive effects associated with the trade channel generate a policy conflict. The capital trade channel decreases (increases) the pecuniary externality for high-income (low-income) borrowers, giving them a motive to impose a laxer (stricter) debt limit. Thus, high-income borrowers prefer a laxer debt limit than the low-income types $\bar{d}^{*r} > \bar{d}^{*p}$. The preferred debt limit is lower than the individually optimal choice of debt, $\bar{d}^r < d^{*B}$, as long as the total externality on high-income borrowers is negative. Proof of Proposition 2.3 shows that this is the case if income inequality satisfies Assumption 2.2 (c).

Proposition 2.4. ***Equilibrium Debt Limit with Heterogenous Borrowers***
The equilibrium debt limit is binding and corresponds to the debt limit set by a constrained social planner with the ratio of the Pareto weights of high- and low-income types equal to the relative electoral power of the high-income borrowers $\frac{\chi^r}{\chi^p} = \gamma^r$.

Proof. Follows from using (2.15) in (2.13) and comparing with (2.14). □

The outcome of the majoritarian elections is a policy that maximizes weighted social welfare, in which utilities of different voter groups are weighed by their population share and the ideological concentration (proxy for sensitivity to changes in policy). The policy generally differs from the policy of the utilitarian social planner. It is stricter if the low-income borrowers have higher electoral power than high-income borrowers, and laxer otherwise. However, since the problem of the politician corresponds to that of the social planner with appropriate Pareto weights, the equilibrium policy is on the Pareto Frontier.

Critical in arriving at this result is the assumption of a frictionless political process. The heterogeneity in the concentration of ideological biases translate to different sensitivities to policy changes. This affects the relative weighting of preferences in the politician's objective just as Pareto weights do in the planner's problem. As politicians are fully committed to implement and enforce the policy, the majoritarian elections allow direct translation of voters' preferences to policy.

Proposition 2.5. ***Impact of Electoral Power and Inequality***

I. The equilibrium debt limit increases in the relative electoral power of high-income types,

II. A mean preserving increase in income inequality increases (decreases) the equilibrium debt limit if the electoral power of high-income types is higher (lower) than that of low-income borrowers.

Proof. See Appendix 2.6.5 □

High-income borrowers prefer a lax policy. An increase in their relative electoral power implies that both politicians announce a policy that is more favorable to this group. The outcome is a laxer debt limit which allows high-income types to reap larger benefits of trade.

The policy conflict between high- and low-income types is proportional to the difference in their capital holding. The higher the income inequality, the larger the difference in the amount of capital each type holds at the end of $t = 1$. Therefore, an increase in income inequality intensifies the policy conflict, pushing the policy preferences of the two groups further apart. The impact on the equilibrium policy depends on which group is more important in politician's objective. If high-income types have a higher electoral power per population share, $\gamma^r > 1$, the politician sets a higher (laxer) debt limit when inequality increases. The reverse occurs if low-income borrowers have a higher electoral power than the high-income types, $\gamma^r < 1$.

These insights contribute to the discussion on the role of inequality in affecting the regulatory environment. Previous contributions point to the possibility that overly lax regulation may be benefiting the poor. Rajan (2011) and Calomiris and Haber (2015) argue that easing access to credit of the poor voters can be seen as a redistributive policy. Politician's implement lax financial regulation in order to gain the support of the lower-income voters. According to this view increasing inequality exacerbated the need for this stealthy redistribution. Critical for this mechanism is that the policy of granting easy access to credit is seen as beneficial by the low-income voters.

In the current framework, in which overborrowing occurs due to the pecuniary externalities associated with the fire sale, this is not the case. Low-income borrowers are particularly harmed by the fire sale and thus view policies that limit ex-ante credit as beneficial. Their policy preferences may be reversed in the presence of government guarantees (such a subsidy for debt repayment at the interim date). In the absence of such guarantees a politician who seeks support of the low-income types would offer a strict prudential policy in order to limit the redistribution towards high-income types through the fire sale. Conversely, a lax regulatory environment would emerge if the high-income types are a key voter constituency for the politicians.

2.4 Imperfect Enforcement

In this section I relax the assumption of perfect enforcement of regulation. As before, the policy platform of the winning politician is introduced after the elections. However, now the politician in office has discretion regarding the extend to which it is enforced. She may choose to exempt some of the borrowers from the regulatory limit.

Borrowers differ in their ability to access politicians. A fraction θ^c of borrowers are politically connected, $B = c$. The politician does not enforce the debt limit on the connected borrowers.[6] The remaining borrowers $\theta^n = 1 - \theta^c$ are non-connected, $B = n$, they face the limit introduced through elections. For tractability, I first analyze the framework under the assumption of homogenous income that satisfies Assumption 2.1, as in Section 2.2. I allow for heterogeneity and study the effect of correlation between income and political access in subsection 2.4.3.

Borrowers privately observe own type prior to elections. An interpretation is that connected borrowers are endowed with technology that enables them to negotiate with politicians or bureaucrats who enforce the policy. It could represent the their own political or persuasion ability or access to information or resources that can be leveraged in a way that grants them access to the enforcer. The connected and the non-connected borrowers may differ in their ideological concentration, and thus constitute separate voter groups: $\mathbb{V} = \{L, c, n\}$. This allows studying how the equilibrium regulation depends on the relative electoral power of politically connected borrowers per population share, $\gamma^c = \frac{\psi^c}{\psi^n}$.

[6] In the Appendix 2.6.7 I micro-found this by assuming connected borrowers and the politician enter into negotiations after the elections.

As heterogeneity in this setting is directly related to the political process, the competitive equilibrium and the policy implemented by the constrained social planner are the same as in the benchmark model. Therefore, I move directly to solving the political equilibrium. I first study the impact of exempting the connected borrowers from the rule on $t = 1$ consumption, debt, capital holding and price. Next, I solve the individual optimization of a connected borrower and the problem of the politician. Finally, I turn to studying the political equilibrium.

2.4.1 Impact of Exemption

This subsection studies how the imperfect enforcement of the debt limit at $t = 0$ affects the allocation and prices at the interim date for a given debt limit. Throughout this analysis I focus on the case in which the debt limit is binding, so that all borrowers without access borrow up to the limit $d_0^n = \bar{d}$. This will be true in equilibrium as both types prefer to implement a binding debt limit.

Problem at the Interim Date

At $t = 1$ the two borrower types may differ in the amount of debt they took on at the previous date. Their respective budget constraints are:

$$r_1 d_0^c + c_1^c \leq d_1^c + y + p(1 - k_2^c) \qquad \text{B1-C}$$
$$r_1 \bar{d} + c_1^n \leq d_1^n + y + p(1 - k_2^n) \qquad \text{B1-N}$$

Imperfect enforcement leads to heterogeneity in net incomes, $y - d_0^b$, at $t = 1$, even with homogenous endowments of the consumption good. The net income of borrowers without political access is at least as high as that of the connected types $(y - \bar{d} \leq y - d_0^c)$. Therefore, the optimization at $t = 1$ parallels the problem studied in Section 2.3. In the current setting borrowers differ in the size of their debt repayment and not the endowment. If the collateral constraint binds, the price solves 2.8 with $\mathbb{B} = \{c, n\}$ and $d_0^n = \bar{d}$.

The heterogeneity in the net income implies that the two types trade capital in equilibrium. Connected borrowers spend more of their income on repaying debt, leaving them with fewer resources available for consumption. As both types wish to achieve the same consumption levels, connected borrowers sell some of their asset to the borrowers without political access, $k_2^c < 1 < k_2^n$.

Problem at the Initial date

At $t = 0$ a politically connected borrower can freely choose the level of debt and consumption. Being atomistic, he does not internalize how his choice of debt affects the prices, so his first order condition with respect to debt is:

$$\lambda_0^c - \lambda_1^c = 0$$

This corresponds to the unconstrained optimal choice of a borrower and is therefore higher than the level of debt required by the limit $d_0^c = c_0^c = c_1^c > \bar{d}$. The following Lemma, describes the equilibrium price for a given level of a debt limit.

Lemma 2.3. ***Fire Sale with Imperfect Enforcement***
If $y - (1 - \theta^c)\bar{d} > 1 - \phi + \theta^c$, the collateral constraint is slack and the price of capital is $p = 1$. Otherwise, the collateral constraint is binding, a fire sale emerges in equilibrium, so the price of capital is given by (2.8) with $d_0^c = c_1^c$ and $d_0^n = \bar{d}$. It decreases in:

- *the debt limit rule, $\frac{\partial p}{\partial \bar{d}} < 0$,*
- *the share of politically connected borrowers, $\frac{\partial p}{\partial \theta^c} < 0$,*

Proof. The collateral constraint is binding whenever $p < 1$, conditions on y and $\bar{d}$ follow from using $p = 1$ and in (2.8). The comparative statics follow directly from the derivatives. □

As politically connected borrowers do not internalize their impact on prices when choosing initial debt, they over-borrow leading to higher aggregate level of initial debt. The repayment of these claims drains the aggregate resources of borrowers at $t = 1$, leading to a lower aggregate net income and a larger fire sale. As the share of politically connected increases, more borrowers follow the individual optimization and fewer are subject to the debt limit. This reduces the equilibrium price for any given debt limit.

2.4.2 Political Equilibrium with Imperfect Enforcement

The optimal decision of the politicians is to propose a debt limit that solves (2.13) with $\mathbb{V} = \{L, c, n\}$, so that the equilibrium policy weighs the preferences of the two borrower groups by their population share and ideological concentration.

Politically connected borrowers anticipate the exemption from regulation when choosing their preferred policy. They stand to benefit from limiting the fire sale without facing the costs of regulation. The first order derivative of their indirect consumption utility with respect to the policy is given by:

$$\frac{\mathrm{d}U^c(\bar{d})}{\mathrm{d}\bar{d}} = \kappa_1^c \phi k_2^c \frac{\partial p}{\partial \bar{d}} + \lambda_1^c (1 - k_2^c) \frac{\partial p}{\partial \bar{d}} < 0 \tag{2.16}$$

Since they face a strictly negative externality, $\frac{\mathrm{d}U^c(\bar{d})}{\mathrm{d}\bar{d}} < 0$, their preferred policy is a minimum debt limit. That is, either a complete prohibition of borrowing, $\bar{d} = 0$, or a debt limit which is strict enough to prevent the fire sale (implicitly defined in $p(\bar{d}) = 1$).

Borrowers without political access bear the costs of regulation. Moreover, as the net buyers of capital they partially benefit from the fire sale through the capital trade channel. Overall, they are subject to full regulatory costs and face a lower negative externality of the initial debt, thus their preferred debt limit is higher than that of the politically connected. Their preferred policy solves:

$$\frac{\mathrm{d}U^n(\bar{d})}{\mathrm{d}\bar{d}} = \kappa_0 + \kappa_1^n \phi k_2^n \frac{\partial p}{\partial \bar{d}} + \lambda_1^n (1 - k_2^n) \frac{\partial p}{\partial \bar{d}} = 0 \tag{2.17}$$

Lemma 2.4. ***Policy Preferences with Imperfect Enforcement***
Politically connected borrowers prefer a minimum debt limit $\bar{d}^{*c} = \max[0, \hat{d}_0]$*, the debt limit preferred by borrowers who are non-connected solves (2.17).*

Both types take into account how the debt limit affects their utility through pecuniary externalities. They benefit from higher equilibrium prices through the collateral channel (captured by $\kappa_1^B \phi k_s^B \frac{\partial p}{\partial \bar{d}}$). The effect of the capital trade channel is distributive (captured by $\lambda_1^B (1 - k_2^B) \frac{\partial p}{\partial \bar{d}}$). Politically connected borrowers are net sellers of capital, so they reap additional benefits from an increase in prices at the expense of the non-connected borrowers. This policy conflict corresponds to the disagreement between high- and low-income borrowers discussed in Section 2.3.

A novel source of conflict arises due to the heterogeneous political access. Since the full burden of regulation lies on the non-connected borrowers, only they face the costs associated with the debt limit, namely the inability to smooth consumption between $t = 0$ and $t = 1$ (captured by κ_0^n). Connected borrowers do not internalize these costs when forming their policy preferences.

Overall, connected borrowers face larger marginal benefits of strict regulation (due to the distributive effects) and lower marginal costs relative to the borrowers without political access.

Lemma 2.5. ***Impact of Electoral Power of the Connected***
The equilibrium debt limit decreases (becomes more strict) in the relative electoral power of politically connected borrowers.

Proof. Follows directly, as the policy preferred by the politically connected is lower than that of borrowers without political access. □

As politically connected borrowers prefer a lower debt limit, the more important they are in politician's optimization (ie. the higher their electoral power per population share), the lower the equilibrium limit. Thus, imperfect enforcement results in two distortions. First, the exemption from the debt limit increases the overall debt levels at $t = 0$, directly lowering the equilibrium price of capital. As a result, politically connected borrowers impose a negative pecuniary externality on all other borrowers by overborrowing (borrowing distortion). Second, as they stand to benefit from the implementation of a low debt limit without incurring the costs, politically connected favor strict policy. If their electoral power is high, they may be imposing a negative externality on non-connected borrowers, by supporting an overly low debt limit (policy preference distortion).

Proposition 2.6. ***Equilibrium Debt Limit with Imperfect Enforcement***
The equilibrium regulation may be too strict or too lax relative to the policy implemented by a constrained social planner with perfect enforcement. The policy is too strict whenever the relative electoral power of the connected is sufficiently high.

Proof. See Figure 2.1 for existence. Since $\frac{\mathrm{d}U^c(\bar{d})}{\mathrm{d}\bar{d}} < 0$ politically connected prefer a minimum debt limit, so $\bar{d}^{*c} < \bar{d}^{SP}$. From Lemma 2.5, the debt limit increases as the relative electoral power of politically connected decreases. Thus, there exists a threshold χ^c below which the policy is too strict. □

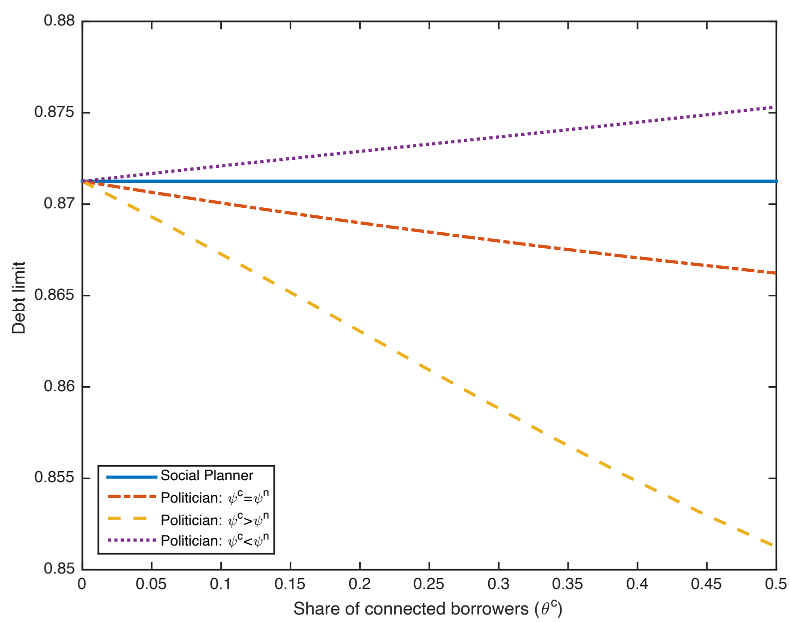
The constrained social planner who can implement the policy to all borrowers sets the debt limit so that to satisfy (2.11) from Section 2.2. He internalizes the effect of the debt on the price and consequently, borrowers ability to smooth consumption between $t = 1$ and $t = 2$. Planner weighs these benefits against the costs of impaired consumption smoothing between $t = 0$ and $t = 1$. The political equilibrium differs from the planner's solution as imperfect enforcement affects both the marginal benefits and the distribution of marginal costs of regulation.

The borrowing distortion lowers the effectiveness of policy in increasing the equilibrium price as some of the borrowers are exempt from the limit (the marginal effect of debt limit on price is smaller). Thus, for any given debt limit, the price under politician's regulation is lower than the price under the planner. Lower prices, imply a higher marginal value of relaxing the collateral constraint. Therefore, the overall impact of the borrowing distortion is ambiguous. It can generate the pressure pushing the policy either above or below the social planner's choice.

The policy preference distortion implies that connected borrowers do not internalize the costs of the regulation. This puts a downward pressure on the policy implemented by the politician. The higher the electoral power of the connected borrowers, the lower the resulting policy. If their relative electoral power is sufficiently high, the equilibrium policy is stricter than that of a social planner.

A numerical example illustrates, that the equilibrium regulation can be either inefficiently lax or inefficiently strict. The figure below plots the equilibrium debt limit rule implemented by a politician as a function of the share of politically connected borrowers for different values of relative electoral power. The solid line in the figure is the benchmark policy implemented by a constrained social planner with perfect enforcement.

Figure 2.1: Equilibrium Debt Limit with Imperfect Enforcement



In this example, the borrowing distortion induces the non-connected borrowers to prefer laxer regulation than the social planner. That is, the negative impact of the exemption of connected borrowers from regulation on the effectiveness of regulation dominates the effect on its' marginal value. In this case, the preferences of two types are polarized. with one group preferring an inefficiently strict and the other inefficiently lax policy. The impact of imperfect enforcement on the strictness of ex-ante regulation depends on their relative electoral power.

If the electoral power of connected borrowers is equal to (dash-dotted line) or higher than (dashed line) that of borrowers without political access, the equilibrium policy is stricter than the policy implemented by the planner. It decreases in the share of the politically connected. If the electoral power of borrowers without political access is sufficiently high (dotted line), the equilibrium policy is laxer than planner's policy.

The analysis provides a novel intuition on the impact of imperfect enforcement on the ex-ante policy. If some agents anticipate the exemption from a rule, they are keen to impose overly strict regulation. The aggregation of preferences through majoritarian elections implies that these views are reflected in the equilibrium policy. Therefore, political access of some may impose a negative externality on others, as it results in the implementation of an overly strict regulation. This result relates to the recent evidence by Neretina (2019) who finds that lobbying on legislation generates negative externalities on the non-lobbying firms. Firms with political access may be able to affect the formulation of policy in a way that favors their narrow interests at the expense of the competitors. The ability to influence the specific shape of legislature may allow lobbyist to codify some form of imperfect enforcement. In the case of financial regulation, the discretion of the regulators and the complexity of the system may further facilitate unequal enforcement through regulatory capture, making the inefficiency of overall policy particularly relevant in this context.

2.4.3 Imperfect Enforcement and Heterogenous Income

This subsection relaxes the assumption of income homogeneity and studies the possibility of correlation between income and political access. As in Section 2.3, assume that fraction θ^r of borrowers receives a high income and remaining θ^p receives low income at $t = 1$ and that these endowments satisfy Assumption 2.2. Let ρ^r and ρ^p denote the fraction of politically connected borrowers among the high- and low- income types respectively. Thus, the share of the politically connected borrowers in the population is given by:

$$\theta^c = \rho^r\theta^r + \rho^p\theta^p$$

The difference between the share of connected borrowers within each income-type scaled by the share of connected in the population, $\frac{\rho^r-\rho^p}{\theta^c} = \frac{\Delta_\rho}{\theta^c}$, is a proxy for correlation between political access and income.

There are potentially four types of borrowers in this setting, $\mathbb{B} = \{pn, pc, rn, rc\}$, low-income non-connected ($B = pn$), low-income connected ($B = pc$), high-income non-connected ($B = rn$) and high-income connected ($B = rc$). To simplify the exposition, I assume that the ideological concentration of agents is heterogeneous only along the political access dimension. That is unconnected borrowers of high-income and low-income types have the same level of ideological concentration, $\psi^{pn} = \psi^{rn} = \psi^{n}$. The same holds for connected borrowers in both income groups, $\psi^{pc} = \psi^{rc} = \psi^{c}$. This allows, the four agent types to aggregate into two voter groups: $v = \{L, c, b\}$. As before, I denote by $\gamma^c = \frac{\psi^c}{\psi^n}$ the relative electoral power of the connected borrowers per population share.

The problem at $t = 1$ now includes four types, each with a different net income $y^B - d_0^B$. As connected borrowers choose their debt freely at $t = 0$, opting for higher borrowing than that imposed by regulation, connected low-income types have the lowest net income at $t = 1$. Consequently, they are net sellers of capital, $k_2^{pc} < 1$. Non-connected high-income types have the highest net income at $t = 1$ and are thus net buyers of capital, $k_2^{rn} > 1$. Whether high-income connected and low-income non-connected types buy or sell capital in equilibrium depends on the extend of income heterogeneity and the strictness of the limit. The equilibrium price ensures that the capital markets clear $1 = \sum_{B\in\mathbb{B}} \theta^B k_2^B$.

Since all borrower types choose the same level of consumption at $t = 1$, the choice of debt by connected borrowers at $t = 0$ is independent of income. Both low- and high-income connected borrowers choose it so that to smooth consumption, so that their debt corresponds to the optimal choice of an unconstrained borrower: $d_0^B = c_1^B > \bar{d},\ B \in \{pc, rc\}$.

The impact of heterogeneous income in the setting with regulatory capture is the same as in the case of perfect enforcement. Namely, it leads to heterogeneous capital holding at the end of $t = 1$. The distributive effects that result from the capital trade channel benefit high-income types at the expense of the low-income types and non-connected borrowers at the expense of connected borrowers. That is the marginal benefits of regulation are different for each of the four borrower types.

For a given debt limit, non-connected borrowers with high-income face lower marginal benefits of increasing the price of capital than the low-income types. However, as long as the debt limit is not too strict, assumption 2.2(c) ensures that non-connected borrowers benefit from the increase in price of capital, regardless of their income-type. Both also face the costs of regulation through impaired consumption smoothing at $t = 0$ and $t = 1$.

Their preferred policy solves:

$$\frac{\mathrm{d}U^B(\bar{d})}{\mathrm{d}\bar{d}} = \kappa_1^B \phi k_2^B \frac{\partial p}{\partial \bar{d}} + \lambda_1^B (1 - k_2^B) \frac{\partial p}{\partial \bar{d}} + \kappa_0 = 0 \qquad \text{if } B \in \{pn, rn\} \tag{2.18}$$

The connected borrowers do not face the costs of regulation. The marginal benefits of limiting the fire sale are higher for the low-income types than for the high-income types. But, while the magnitude of benefits varies across the income-types, strict regulation is unequivocally beneficial to the connected as both high- and low-income types suffer from the negative externality. They prefer a debt limit to be set at the minimum:

$$\frac{\mathrm{d}U^B(\bar{d})}{\mathrm{d}\bar{d}} = \kappa_1^B \phi k_2^B \frac{\partial p}{\partial \bar{d}} + \lambda_1^B (1 - k_2^B) \frac{\partial p}{\partial \bar{d}} < 0 \qquad \text{if } B \in \{pc, rc\} \tag{2.19}$$

The politician aggregates these preferences weighing them by the population share and the ideological concentration of each group-type according to equation (2.13). This can be represented as a sum of weighted policy preference schedules of the connected and non-connected borrowers ($\frac{\mathrm{d}U^C(\bar{d})}{\mathrm{d}\bar{d}}$ and $\frac{\mathrm{d}U^N(\bar{d})}{\mathrm{d}\bar{d}}$ respectively) as:

$$\underbrace{\psi^c \sum_{b=pc,rc} \theta^b \frac{\mathrm{d}U^b(\bar{d})}{\mathrm{d}\bar{d}}}_{\frac{\mathrm{d}U^C(\bar{d})}{\mathrm{d}\bar{d}}} + \underbrace{\psi^n \sum_{b=pn,rn} \theta^b \frac{\mathrm{d}U^b(\bar{d})}{\mathrm{d}\bar{d}}}_{\frac{\mathrm{d}U^N(\bar{d})}{\mathrm{d}\bar{d}}} = 0$$

Lemma 2.6. *Consider a change in correlation between political access and income,* $\mathrm{d}\Delta_\rho$*, that leaves the share of politically connected,* θ^c*, unchanged.*

- *If* $\mathrm{d}\Delta_\rho > 0$*, the weighted policy preference schedule of connected borrowers,* $\frac{\mathrm{d}U^C(\bar{d})}{\mathrm{d}\bar{d}}$*, shifts upwards, while the schedule of non-connected borrowers,* $\frac{\mathrm{d}U^N(\bar{d})}{\mathrm{d}\bar{d}}$*, shifts downwards;*
- *If* $\mathrm{d}\Delta_\rho < 0$*, the weighted policy preference schedule of connected borrowers,* $\frac{\mathrm{d}U^C(\bar{d})}{\mathrm{d}\bar{d}}$*, shifts downwards, while the schedule of non-connected borrowers,* $\frac{\mathrm{d}U^N(\bar{d})}{\mathrm{d}\bar{d}}$*, shifts upwards.*

Proof. In the Appendix 2.6.5 □

Due to the distributive effects of the fire sale, low-income types face higher marginal benefits of regulation than the high-income types in the same group. A higher positive correlation between income and political access, means that a larger share of connected borrowers is of a high-income type, while more of the unconnected borrower are low-income types. This implies a fall in the weighted marginal benefits of regulation for the whole population of connected borrowers and an increase in that measure for the non-connected borrowers.

Proposition 2.7. ***Impact of Change in Correlation***
There exists a threshold relative electoral power of connected borrowers $\hat{\gamma}^c$ such that an increase (a decrease) in correlation between income and political access that keeps the share of connected borrowers constant increases (decreases) the equilibrium debt limit if the relative electoral power of connected borrowers is above that threshold, $\gamma > \hat{\gamma}^c$.

Proof. In the Appendix 2.6.5 □

An increase in correlation between income and political access moves the preferred policies of connected and non-connected borrowers closer to one another. This decreases the policy conflict and so alleviates the impact of imperfect enforcement. The effect on the equilibrium policy depends on the relative electoral power of the two groups. If connected borrowers dominate, the equilibrium policy becomes more relaxed. If borrowers without political access have a sufficiently high electoral power, the equilibrium policy is stricter as a result of the increase in correlation.

2.5 Conclusions

This paper studies how political factors affect the equilibrium prudential policy in a setting with pecuniary externalities. Borrowers do not internalize the impact of their initial indebtedness on the severity of a welfare reducing fire sale and thus, impose an externality on all borrowers. The possibility to vote on a regulatory rule applicable to all, serves as a coordination device, allowing them to internalize the externality. In a setting with homogenous borrowers and perfect commitment by a politician, this results in a constrained efficient equilibrium policy.

Income inequality between borrowers implies a distributive effect of the fire sale. High-income borrowers benefit from low prices at the expense of the low-income types, by being able to buy capital at a discount. Both types remain unable to perfectly smooth consumption, making some level of regulation preferred by all. However, trade in capital generates a conflict over the strictness of the debt limit. High-income borrowers prefer a laxer regulation as they wish to allow for a larger price discount. The equilibrium policy weighs the preferences of each type by their population share and a measure of responsiveness to policy, and thus lies on a Pareto frontier of a constrained social planner.

In this framework an increase in income inequality increases the policy conflict between voters as it increases the volume of capital trade in equilibrium. The impact on equilibrium policy depends on the relative electoral power of the two groups. If high-income borrowers have higher electoral power, the outcome is laxer policy. If low-income borrowers are more influential in the elections, the policy becomes stricter after an increase in inequality.

Regulatory capture, modeled as exemption from regulation of politically connected borrowers results in an inefficient equilibrium regulation, due to two distortions. First, as some borrowers are exempt from the limit, all voters anticipate the regulation to be less effective in curbing the fire sale. This may lower the marginal benefit of regulation relative to the environment in which planner enforces the policy on all borrowers. Second, since the costs of regulation are borne solely by borrowers without political access, the policy preference of connected borrowers are distorted. They prefer an overly strict regulation.

In equilibrium the strictness of policy depends on the relative electoral power of the two groups. The equilibrium regulation may be either too strict or too lax. In environments in which the politically connected have higher electoral power than those without access, the equilibrium debt limit rule is excessively strict. This result is weakened if the politically connected borrowers are more likely to have high income. However, the inefficiently strict limit may result even if the political access and income are perfectly correlated.

This analysis points to the importance of the political context for equilibrium regulation. It provides novel insights on the role of income inequality and political access in shaping the prudential policy. I show that low-income voters may prefer strict regulation, if they stand to lose from fire-sales. Moreover, the analysis underscores the role of political institutions in determine the financial regulation.

In economies with strong political institutions and transparent regulatory environment, which can ensure perfect enforcement of the policies, there is less scope for inefficient regulation. Such political systems may favor redistribution towards specific groups through prudential regulation, but are able to restore constrained efficiency.

In economies with weaker institutions, imperfect enforcement undermines the effectiveness of regulation. The impact on the equilibrium debt limit depends the ability of the connected groups to influence elections. If they are the pivotal voters, the equilibrium outcome is an inefficiently strict regulation, imposed on the borrowers without political connections. If the non-connected borrowers are sufficiently important in elections, the regulation may be inefficiently lax.

This study highlights a need for further formal political economy analysis of regulation in the context of other financial frictions. A systematic study of regulation in an economy with investment, a setting with aggregate demand externalities or with government guarantees can help further deepen our understanding of the directions in which various political forces affect financial regulation.

2.6 Appendix

2.6.1 Micro-foundations of Collateral Constraint

Consider the environment in which debtors can attempt to renegotiate the debt contract at any time, ie. make a take-it-or-leave-it offer to lower the repayment. If creditors reject the offer they can turn to legal authorities to repossess the assets (current and future consumption and capital goods) of the debtor in order to cover the promised repayment. The authorities are able to repossess only a fraction ϕ of the assets. The creditor can then sell the capital goods and consume the proceeds as well as the consumption good.

In this environment, the repayment of debt is incentive compatible for the borrower if:

- $d_0^B < \phi \frac{u_1^{'bB}(c_1^B)}{u_0^{'B}(c_0)}(y^B + pk_1^B)$, CC00, ensures no renegotiation of $t = 0$ debt at $t = 0$
- $d_0^B < \phi(y^B + pk_1^B)$, CC01, ensures no renegotiation of $t = 0$ debt at $t = 1$
- $d_1^B < \phi pk_2^B$, CC11, ensures no renegotiation of $t = 1$ debt at $t = 1$
- $d_1^B < \phi k_2^B$, CC12, ensures no renegotiation of $t = 1$ debt at $t = 2$

In a competitive equilibrium the individually optimal choice of debt by borrowers is $d_0^B = \frac{(1-\phi)p}{(1-\phi p)}$ and the MRS between $t = 0$ and $t = 1$ is $\frac{u_1^{'B}(c_1)}{u_0^{'B}(c_0)} = 1$. Thus both CC01 and CC11 can be expressed as :

$$w = \frac{(1-\phi)p}{(1-\phi p)} - \phi p < \phi y^b$$

The left hand side of the inequality increases in p :

$$\frac{\partial w}{\partial p} = \frac{(1-\phi)(1-\phi p) + \phi(1-\phi)p}{(1-\phi p)^2} - \phi = \frac{(1-\phi)}{(1-\phi p)^2} - \phi > 0$$

whenever $(1-\phi) > \phi(1-\phi p)^2$, which holds for $\phi < \frac{1}{2}$). So if inequality holds for $p = 1$ it holds always, which yields: $y^B > \frac{1-\phi}{\phi}$. In the case of heterogeneous borrowers (in terms of income or political access), this condition needs to be satisfied for each borrower type.

2.6.2 Individual Optimization

The problem of lenders is:

$$\max_{c_0^L,c_1^L,c_2^L,d_0^L,d_1^L,k_2^L} V_0^L = c_0^L + c_1^L + c_2^L - \lambda_0^L(c_0^L - d_0^L - y^L)$$
$$-\lambda_1^L(r_1 d_0^L + c_1^L - d_1^L - y^L - p(k_1^L - k_2^L)) - \lambda_2^L(r_2 d_1^L + c_2^L - y^L)$$

The first order conditions read:

$$\begin{aligned} 1 - \lambda_0^L &= 0 & \lambda_0^L - r_1\lambda_1^L &= 0 \\ 1 - \lambda_1^L &= 0 & \lambda_1^L - r_2\lambda_2^L &= 0 \\ 1 - \lambda_2^L &= 0 & -p\lambda_1^L &= 0 \end{aligned}$$

The problem of the borrower of type B is:

$$\max_{c_0^B,c_1^B,c_2^B,d_0^B,d_1^B,k_2^B} V_0^B = log(c_0^B) + log(c_1^B) + c_2^B - \lambda_0^B(c_0^B - d_0^B) -$$
$$\lambda_1^B(r_1 d_0^B + c_1^B - d_1^B - y^B - p(k_1^B - k_2^B)) - \kappa_1^B(d_0^B - \phi p k_2^B) - \lambda_2^B(r_2 d_1^B + c_2^B - k_2^B)$$

The first order conditions read:

$$\begin{aligned} \frac{1}{c_0^B} - \lambda_0^B &= 0 & \lambda_0^B - r_1\lambda_1^B &= 0 \\ \frac{1}{c_1^B} - \lambda_1^B &= 0 & \lambda_1^B - \kappa_1^B - r_2\lambda_2^B &= 0 \\ 1 - \lambda_2^B &= 0 & -p\lambda_1^B + \kappa_1^B\phi p + \lambda_2^B &= 0 \end{aligned}$$

2.6.3 Social Planner's Problem

The problem of the constrained social planner with homogenous borrowers can be expressed as:

$$\max_{C_0^L,D_0^L,C_0^B,D_0^B} \chi^B \left(log(C_0^B) + V^B(D_0^B)\right) + \chi^L(C_0^L + V^L(D_0^L))$$
$$-\mu(C_0^B + C_1^L - Y^L) - \omega(D_0^B + D_0^L)$$

Where $V^B(D_0^B)$ and $V^L(D_0^L)$ are the value functions of borrowers and lenders following from their $t = 1$ optimization. The first order conditions of the planner problem are:

$$\begin{aligned}
\chi^B \frac{1}{C_0^B} - \mu =& 0 \\
\chi^L - \mu =& 0 \\
\chi^B(-\lambda_1^B + \kappa_1^B \phi k_2^B \frac{\partial p}{\partial D_0^B}) - \omega =& 0 \\
-\chi^L \lambda_1^L - \omega =& 0
\end{aligned}$$

Using the first two to establish that $\frac{\chi^B}{\chi^L} = C_0^B = \frac{\lambda_0^L}{\lambda_1^L}$ and the fact that $\lambda_1^L = 1$, the third and fourth FOC yield the following optimality condition for debt:

$$\lambda_0^B - \lambda_1^B + \kappa_1^B \phi k_2^B \frac{\partial p}{\partial D_0^B} = 0$$

In the case of heterogenous borrowers, if the type is private information the social planner can only choose a lender and borrower specific level of consumption and debt C_0^h and D_0^h for all B. His problem is:

$$\begin{aligned}
\max_{C_0^L, D_0^L, C_0^h, D_0^h} \sum_B \chi^B \theta^B \left(log(C_0^h) + V^B(D_0^h) \right) + \chi^L (C_0^L + V^L(D_0^L)) \\
-\mu(\sum_B (\theta^B C_0^h) + C_1^L - Y^L) - \omega(\sum_B (\theta^B D_0^h) + D_0^L)
\end{aligned}$$

Where $V^B(D_0^h)$ and $V^L(D_0^L)$ are the value functions of borrowers and lenders following from their $t = 1$ optimization. The first order conditions of the planner problem are:

$$\begin{aligned}
\sum_B [\chi^B \theta^B \frac{1}{C_0^h} - \theta^B \mu] =& 0 \\
\chi^L - \mu =& 0 \\
\sum_B \chi^B \theta^B [-\lambda_1^B + \kappa_1^B \phi K_2^B \frac{\partial p}{\partial D_0^h} + \lambda_1^B (1 - K_2^B) \frac{\partial p}{\partial D_0^h}] - \sum_B \theta^B \omega =& 0 \\
-\chi^L \lambda_1^L - \omega =& 0
\end{aligned}$$

Using first and second equation to get $\chi^L = \sum_B [\chi^B \theta^B \frac{1}{C_0^h} - \theta^B]$, using this and $\lambda_1^L = 1$ and substituting that into the fourth and then rearranging the third yields:

$$\sum_B \chi^B \theta^B [-\lambda_1^B + \kappa_1^B \phi K_2^B \frac{\partial p}{\partial D_0^h} + \lambda_1^B (1-K_2^B) \frac{\partial p}{\partial D_0^h}] + \sum_B [\chi^B \theta^B \frac{1}{C_0^h}] = 0$$

Since $\lambda_1^B = \lambda_1^h$ and $\kappa_1^B = \kappa_1^h$ for all B, in interior equilibrium:

$$\lambda_0^h - \lambda_1^h + \frac{1}{\sum_B [\chi^B \theta^B]} \sum_B \chi^B \theta^B [\kappa_1^h \phi K_2^B \frac{\partial p}{\partial D_0^h} + \lambda_1^h (1-K_2^B) \frac{\partial p}{\partial D_0^h}] = 0$$

2.6.4 Interior Solution as Unique Equilibrium

When borrowers are ex-post heterogeneous they trade capital at $t = 1$. The borrower of type h demand for capital follows from the FOC and is given by:

$$k_2^B = \begin{cases} 0 \text{ if } p > \frac{c_1^B}{1-\phi(1-c_1^B)} \\ k \in (0, \frac{1}{1-\theta^B}) \text{ if } p = \frac{c_1^B}{1-\phi(1-c_1^B)} \\ \frac{1}{1-\theta^B} \text{ if } p < \frac{c_1^B}{1-\phi(1-c_1^B)} \end{cases}$$

In the interior solution, both borrowers choose positive level of capital holding, so that $p = \frac{c_1^B}{1-\phi(1-c_1^B)}$ with $c_0^B = c_0^B \; \forall B$. The capital demands follow from their budget constraints:

$$k_2^B = \frac{y^B - d_0^B + p}{p(1-\phi)} - \frac{1}{1-\phi p}$$

The low-income type has positive asset holdings if

$$y^p - d_0^p > \frac{p(1-\phi)}{1-\phi p} - p \tag{2.20}$$

Where p solves $1 = \frac{\sum_b \theta^B [y^B - d_0^B + p]}{p(1-\phi)} - \frac{1}{1-\phi p}$. Since the right-hand side of the inequality is negative (as $\frac{(1-\phi)}{1-\phi p} \leq 1$), the condition is satisfied whenever $y^p - d_0^p > 0$. In the competitive equilibrium $d_0^p = c_1^p < 1$, thus if $y^p > 1$ the interior solution is an equilibrium.

In the corner solution, the borrower with high net income buys off all of the capital from the borrower with low net income, so that price reflects his marginal valuation of capital: $\frac{1}{\theta^r} = \frac{y^r - d_0^r + p}{p(1-\phi)} - \frac{1}{1-\phi p}$. If low net income types sell off their capital, their consumption follows from the budget constraint $c_1^p = y^p - d_0^p + p$. The equilibrium is indeed in a corner if the price pinned down by the valuation of high-income types is such that $p > \frac{c_1^p}{1-\phi(1-c_1^p)}$, which requires:

$$c_1^r > c_1^p \Rightarrow y^p - d_0^p < \frac{p(1-\phi)}{1-\phi p} - p \tag{2.21}$$

Building on the previous argument, this condition is never satisfied if $y^p > 1$. Thus if $y^p > 1$ the interior solution is the unique equilibrium.

Assumption 2.2.II requires that $y^B > \frac{1-\phi}{\phi}$, since $\phi > \frac{1}{2}$, this ensures that $y^B > 1$ for all borrower types.

In the case of heterogenous political access, both borrowers receive the same income y^B, however politically connected borrowers borrow more than those without access: $d_0^c = c_1^c = \frac{p(1-\phi)}{1-\phi p} < 1$. Thus, the interior solution constitutes a unique equilibrium for all $y^B > 1$.

2.6.5 Equilibrium with Income Inequality

Proof of Proposition 2.5.

I. High-income borrowers face a lower negative externality, so $\frac{dU^r(\bar{d})}{d\bar{d}} > \frac{dU^p(\bar{d})}{d\bar{d}}\ \forall \bar{d}$. As the weight of high-income borrowers in politician's objective increases, her FOC shifts upwards resulting in a higher equilibrium debt limit.
II. Let $\psi^r = \psi^p + \epsilon$, then and aggregating the preferences using politicians' FOC (where $c_1^b = c_1^r = c_1^p$) :

$$(2\psi^p + \epsilon)[\frac{1}{\bar{d}} - \frac{1}{c_1^b}(1 - \frac{\partial p}{\partial \bar{d}})] - \frac{1}{c_1^b}\frac{\partial p}{\partial \bar{d}}(1 - \phi(1 - c_1^b))\underbrace{[\psi^p(\theta^r k_2^r + \theta^p k_2^p) + \epsilon\theta^r k_2^r]}_{=1+\epsilon\theta^r k_2^r} = 0$$

Using Corrolary 2.2 a mean preserving change in inequality increases capital trade, so that capital holdings of high income types, k_2^r raise, but leaves consumption unchanged. Thus, if $\epsilon > 0$ increasing inequality shifts politicians' FOC upwards resulting in a higher equilibrium debt limit. If $\epsilon < 0$ increasing inequality shifts politicians' FOC downwards resulting in a higher equilibrium debt limit.

Proof of Lemma 2.6.

For a change in correlation $d\Delta_\rho$ to keep the share of connected borrowers fixed, the share of connected poor income borrowers must adjust by $\frac{d\rho^p}{d\Delta_\rho} = -\theta^r$. The impact on the weighted preference of connected and non-connected borrowers respectively:

$$\frac{\mathrm{d}^2 U^C(\bar{d})}{\mathrm{d}\bar{d}\ \mathrm{d}\Delta_\rho} = \psi^c(1-\theta^r)(\theta^r)\left(\frac{\mathrm{d}U^{rc}(\bar{d})}{\mathrm{d}\bar{d}} - \frac{\mathrm{d}U^{pc}(\bar{d})}{\mathrm{d}\bar{d}}\right)$$
$$\frac{\mathrm{d}^2 U^N(\bar{d})}{\mathrm{d}\bar{d}\ \mathrm{d}\Delta_\rho} = \psi^n(1-\theta^r)(\theta^r)\left(\frac{\mathrm{d}U^{pn}(\bar{d})}{\mathrm{d}\bar{d}} - \frac{\mathrm{d}U^{rn}(\bar{d})}{\mathrm{d}\bar{d}}\right)$$

Since $\frac{\mathrm{d}U^{rc}(\bar{d})}{\mathrm{d}\bar{d}} > \frac{\mathrm{d}U^{pc}(\bar{d})}{\mathrm{d}\bar{d}}$, an increase (decrease) in Δ_ρ increases (decreases) $\frac{\mathrm{d}U^{C}(\bar{d})}{\mathrm{d}\bar{d}}$. The reverse is the case for $\frac{\mathrm{d}U^{N}(\bar{d})}{\mathrm{d}\bar{d}}$, as $\frac{\mathrm{d}U^{rn}(\bar{d})}{\mathrm{d}\bar{d}} > \frac{\mathrm{d}U^{pn}(\bar{d})}{\mathrm{d}\bar{d}}$.

Proof of Proposition 2.7.

The total derivative of politicians' optimality condition with respect to Δ_ρ is:

$$\frac{\mathrm{d}^2\pi}{\mathrm{d}\bar{d}\ \mathrm{d}\Delta_\rho} = \psi^c\frac{\mathrm{d}^2 U^C(\bar{d})}{\mathrm{d}\bar{d}\ \mathrm{d}\Delta_\rho} + \psi^n\frac{\mathrm{d}^2 U^N(\bar{d})}{\mathrm{d}\bar{d}\ \mathrm{d}\Delta_\rho}$$

From Lemma 2.6, if a change in correlation keeps the share of connected borrowers fixed: $\frac{\mathrm{d}^2 U^N(\bar{d})}{\mathrm{d}\bar{d}\ \mathrm{d}\Delta_\rho} > 0$ and $\frac{\mathrm{d}^2 U^C(\bar{d})}{\mathrm{d}\bar{d}\ \mathrm{d}\Delta_\rho} < 0$. The threshold $\gamma^c = \hat{\gamma}^c$ is the ratio of the electoral powers at which the two effects exactly cancel out, such that $\frac{\mathrm{d}^2\pi}{\mathrm{d}\bar{d}\ \mathrm{d}\Delta_\rho} = 0$

2.6.6 Heterogenous Borrowers: Public Information

With public information about the borrower type, the social planner problem is:

$$\max_{C_0^L, D_0^L, C_0^B, D_0^B} \sum_B \chi^B\theta^B\left(log(C_0^B) + V^B(D_0^B)\right) + \chi^L(C_0^L + V^L(D_0^L))$$
$$-\mu(\sum_B(\theta^B C_0^B) + C_1^L - Y^L) - \omega(\sum_B(\theta^B D_0^B) + D_0^L)$$

The first order conditions read:

$$\begin{aligned}
\chi^B\theta^B\frac{1}{C_0^B} - \theta^B\mu &= 0\ \forall B \\
\chi^L - \mu &= 0 \\
-\lambda_1^B + \sum_{j\in\mathbb{B}}\chi^j\theta^j[+\kappa_1^j\phi K_2^j\frac{\partial p}{\partial D_0^B} + \lambda_1^{j\in\mathbb{B}}(1-K_2^j)\frac{\partial p}{\partial D_0^B}] - \theta^B\omega &= 0\ \forall B \\
-\chi^L\lambda_1^L - \omega &= 0
\end{aligned}$$

Rearranging yields the following optimality conditions:

$$\theta^r \chi^r (\lambda_0^r - \lambda_1^r) + \sum_B \chi^B \theta^B [\kappa_1^B \phi K_2^B \frac{\partial p}{\partial D_0^r} + \lambda_1^B (1 - K_2^B)] \frac{\partial p}{\partial D_0^r} = 0$$
$$\theta^p \chi^p (\lambda_0^p - \lambda_1^p) + \sum_B \chi^B \theta^B [\kappa_1^B \phi K_2^B \frac{\partial p}{\partial D_0^p} + \lambda_1^B (1 - K_2^B)] \frac{\partial p}{\partial D_0^p} = 0$$

The price impact of the debt of the two borrower types differs as they constitute different population shares:

$$\frac{\partial p}{\partial D_0^r} = \theta^r \frac{\partial p}{\partial D_0^b}$$
$$\frac{\partial p}{\partial D_0^p} = \theta^p \frac{\partial p}{\partial D_0^b}$$

So the conditions that define the choice of debt limit for each borrower type are:

$$\chi^r (\lambda_0^r - \lambda_1^r) + \sum_B \chi^B \theta^b [\kappa_1^B \phi K_2^B \frac{\partial p}{\partial D_0^r} + \lambda_1^B (1 - K_2^B)] \frac{\partial p}{\partial D_0^r} = 0$$
$$\chi^p (\lambda_0^p - \lambda_1^p) + \sum_B \chi^B \theta^B [\kappa_1^B \phi K_2^B \frac{\partial p}{\partial D_0^p} + \lambda_1^b (1 - K_2^B)] \frac{\partial p}{\partial D_0^p} = 0$$

The planner weighs the total benefits of limiting the aggregate debt and distributes the costs of regulation between the two groups according to their Pareto Weights. The total benefit of setting a low debt comes from utility gains of limiting the fire sale and correspond to the negative externality of debt. The size of externality is the same as in the case of public information and depends on the Pareto weights of the two types and volume of capital trade between them. Thus, if the Pareto weight on high-income types is low, the negative externality of initial borrowing is larger, than if the Pareto weight is high. This results in the same pressure on the overall tightness of regulation as with private information on types. With public information on types, the social planner distributes the costs of limiting the externality according to the Pareto weights. For a utilitarian social planner the distributive effects coming through the capital trade channel cancel out, so that all of the externality comes from the collateral channel. He chooses equal level of debt for the two types of borrowers.

- If $\chi^r > \chi^p$ the negative externality is lower (less need for limiting debt), than under a utilitarian social planner; constrained efficient allocation has higher debt of high-income types relative to low-income types;

- If $\chi^r < \chi^p$ the negative externality is larger (less need for limiting debt) than under a utilitarian social planner; constrained efficient allocation has lower debt of high-income types relative to low-income types;

If the politician can only implement one policy, she would implement the policy as described in Section 2.3. In this case the policy would be inefficient as the politician is unable to distribute the costs of regulation between different types.

- If $\chi^r > \chi^p$ the debt limit is inefficiently strict for the high-income types and inefficiently lax for the low-income types

- If $\chi^r < \chi^p$ the debt limit is inefficiently lax for the high-income types and inefficiently strict for the low-income types

With public information the equilibrium policy is distributive in itself as higher regulatory burden is placed on the less influential voter groups. Some of the transfers intended by the social planner now take form of different distribution of the policy burden.

If however, the politician can also implement type-specific policies, the first order conditions of his problem are:

$$\sum_{v=p,r} \theta^v \psi^v \frac{\partial U^v(\bar{d})}{\partial \bar{d}^r} = 0 \tag{2.22}$$

$$\sum_{v=p,r} \theta^v \psi^v \frac{\partial U^v(\bar{d})}{\partial \bar{d}^p} = 0 \tag{2.23}$$

Which yield the following optimality conditions:

$$\psi^r(\lambda_0^r - \lambda_1^r) + \sum_{h\in\mathbb{B}} \psi^h \theta^h [\kappa_1^h \phi K_2^h \frac{\partial p}{\partial D_0^r} + \lambda_1^b (1 - K_2^h)] \frac{\partial p}{\partial D_0^r} = 0$$

$$\psi^p(\lambda_0^p - \lambda_1^{bp}) + \sum_{h\in\mathbb{B}} \psi^h \theta^h [\kappa_1^h \phi K_2^h \frac{\partial p}{\partial D_0^r} + \lambda_1^h (1 - K_2^h)] \frac{\partial p}{\partial D_0^p} = 0$$

Thus, the equilibrium policy corresponds to that of the social planner with the Pareto weights that satisfy $\frac{\chi^r}{\chi^p} = \frac{\psi^r}{\psi^p}$. With public information the equilibrium policy is distributive in itself as higher regulatory burden is placed on the less influential voter groups.

2.6.7 Negotiations Between Connected Borrowers and Politician

After the elections are resolved at $t = 0$, but before the agents choose their allocations, each politically connected borrower can negotiate with the politician. I assume all bargaining power lies with the borrower. He decides whether to seek exemption ($n = 1$) or to remain subject to the debt limit ($n = 0$) and chooses the level of initial debt (d_0^c) and the rents to the politician (R) conditional on seeking exemption, so that to maximize his utility, subject to the budget constraints and the participation constraint of the politician. Let $V_1(d_0^b)$ be the indirect utility as of $t = 1$ of a borrower with the initial debt d_0^b, then the problem is:

$$\max_{n, d_0^c, R} n[log(c_0^c) + V_1(d_0^c, p) - R] + (n-1)[log(\bar{d}) + V_1(\bar{d}), p]$$

subject to:

$$\begin{aligned} & c_0^c \leq d_0^c \\ & R \geq 0 \qquad\qquad\qquad \text{PC-POL} \end{aligned}$$

The connected borrower finds it optimal to offer a minimal rent to the politician so $R = 0$ in equilibrium. He chooses the level of debt conditional on exemption, so that to maximize his utility. Being atomistic, he does not internalize how his choice of debt affects the prices, so the first order condition with respect to debt is given by:

$$\lambda_0^c - \lambda_1^c = 0$$

This corresponds to the unconstrained optimal choice of a borrower. So, whenever the debt limit rule binds, all connected borrowers seek exemption and choose $d_0^c = c_1^c(p)$.

2.6.8 Lobbying via Campaign Effort

The political game can be extended to take into account other forms of political activity by voters, such as campaign contributions. Consider the political subgame introduced in Section 2.2. Assume now that voter groups can form form a lobbies and offer support to politicians prior to elections. After the politician announced his policy, members of the lobby can put effort in order to increase candidates probability of winning. The campaign effort comes at a cost, it generates a disutility of $h^J(C^i) = \alpha^J(C^i)^2/2$. The voter groups may differ in the cost of effort (captured by a group specific cost-parameter α^J. The campaign effort shifts the average bias of borrowers, so that the utility of voter i in group J associated with candidate A winning is given by: $U^{iJ}(A\ wins) = U^J(\bar{d}_A) + b^{iJ} + b + \sigma(C_A - C_B)$

The timing of the political game is as follows: (1) Politicans announce their platforms,

(2) Lobbies choose their campaign efforts, (3) Random bias is realized, (4) Elections take place and (5) The policy is implemented.

When voting in the majoritarian elections, agents evaluate the policy proposals of the two politicians and vote for the one whose policy offers them a higher utility accounting for their ideological biases. Lobbies choose their effort to support the politicians in order to maximize the probability of the politician with a favorable platform being elected.

With campaign efforts the ex-ante probability of winning by the politician A for a given policy of the competitor $\overline{d}_B$ and lobby efforts $C_K = \sum_J \theta^J C_A^J$

$$\pi_A = \frac{1}{2} + \frac{\Psi}{\bar{\psi}} \left[\sum_J \theta^J \psi^J [U^J(\overline{d}_A) - U^J(\overline{d}_B) + \sigma(C_A - C_B)] \right] \tag{2.24}$$

Where $\bar{\psi} = \sum_J \theta^J \psi^J$ is the average ideological concentration of the two groups. Each of the lobbies observes the policy announcement by the politicians and chooses its' campaign effort so that to maximize the expected utility of its members:

$$\max_{C_A^J, C_B^J} W^J = \pi_A U^J(\overline{d}_A) + (1 - \pi_A) U^J(\overline{d}_B) - \alpha^J \frac{(C_A^J + C_B^J)^2}{2}$$

When deciding on how much effort to put into supporting a candidate with a given policy lobby groups trade off the cost of that effort against it's marginal benefit: the expected increase in utility due to an increase the probability of winning of a candidate with a preferred policy. In equilibirum each lobby supports only one politician. The optimal campaign effort towards politician A for each agent in the lobby is:

$$C_A^J = C_A^J - C_B^J = \begin{cases} 0 & \text{if } U^J(\overline{d}_A) - U^J(\overline{d}_B) \le 0 \\ \frac{\sigma}{\alpha^J} \frac{\Psi}{\bar{\psi}} \left[U^J(\overline{d}_A) - U^J(\overline{d}_B) \right] & \text{otherwise} \end{cases}$$

The effort exerted by a lobby towards candidate A is proportional to utility gain from electing the politician with a favorable policy. The intensity of this relation is directly proportional to the impact of tha campaign efforts on voter bias (σ) and the aggregate sensitivity to economic policy of the population ($\frac{\Psi}{\bar{\psi}}$). It is inversely proportional to the cost of effort of a given group. The effort towards candidate B can be expressed analogously.

Given these expected campaign contributions, each politician chooses the policy platform so that to maximize his probability of winning. The resulting optimality condition of the problem of politician A is:

$$\frac{\partial \pi_A}{\partial \bar{d}_A} = \sum_J \theta^J \psi^J \left(1 + \frac{\sigma^2}{\alpha^J}\frac{\Psi}{\bar{\psi}}\right) \frac{\partial U^J(\bar{d}_A)}{\partial \bar{d}_A} = 0$$

Therefore, while maximizing his probability of winning the politician practically chooses a policy that maximizes a sum of weighted utilities of the two agents groups. The weight assigned to each of the groups in the politicians optimization reflects the concentration of their ideological biases and the strength of the lobby.

2.6.9 Solution with Taxes

Taxes on the initial debt rebated back to borrowers in the form of lump sum transfers are an alternative prudential tool that can restore constrained efficiency. In this section I discuss the planner problem and political equilibrium with taxes as the policy tool.

In the presence of taxes the $t = 0$ budget constraint of borrower reads:

$$c_0^B - (1-\tau)d_0^B - T = 0 \ \forall B \in \mathbb{B}$$

Where through balanced budget constraint, $\tau \sum_{B\in\mathbb{B}} \theta^B D_0^B = T$. The presence of taxes affects borrowers FOC, so that his choice of initial debt is pinned down by:

$$(1-\tau)\lambda_0^B - \lambda_1^B = 0$$

Thus, a higher tax rate drives down the amount of debt that the borrowers take on at $t = 0$. When choosing the optimal tax rate the social planner satisfies the following FOC:

$$\sum_{h\in\mathbb{B}} \chi^h \theta^h [-\lambda_0^h (d_0^h - \frac{\partial D_0^b}{\partial \tau}\tau - D_0^b) - \lambda_1^h (1-k_2^h)\frac{\partial p}{\partial \tau} + \kappa_1^h \phi k_2^h \frac{\partial p}{\partial \tau}] = 0$$

Since both types choose the same level of debt, we have $d_0^h = D_0^b$, $\lambda_t^h = \lambda_t^b$, and $\kappa_1^h = \kappa_1^b$ for all $h \in \mathbb{B}$. Thus, the optimal tax rate solves:

$$\tau = \frac{-\sum_{h\in\mathbb{B}} \chi^h \theta^h \lambda_1^b (1-k_2^h) + \kappa_1^b \phi k_2^h}{\lambda_0^b \sum_{h\in\mathbb{B}} \chi^h \theta^h} \frac{\partial p}{\partial D_0^b}$$

The optimal tax increases as the Pareto Weight of the low-income borrowers increases.

The reverse occurs if the Pareto Weight of high-income borrowers is increased. The tax is positive whenever the overall externality is negative, that is if the income inequality is not too large. The same intuition applies in the solutions to politician's problem. The equilibrium tax on debt weighs the preference of different income groups by the electoral power:

$$\tau = \frac{-\sum_{h\in\mathbb{B}} \psi^h \theta^h \lambda_1^b (1-k_2^h) + \kappa_1^b \phi k_2^h}{\lambda_0^b \sum_{h\in\mathbb{B}} \psi^h \theta^h} \frac{\partial p}{\partial D_0^b}$$

Like with the debt limit, a mean-preserving increase in inequality increases the disparity between the debt limit preferred by high- and low- income voters. If $\psi^r > \psi^p$ it results in laxer equilibrium policy. One way to analyze the setting with taxes under imperfect enforcement is to assume that the politically connected borrowers are exempt from the tax and do not receive the benefits associated with the transfers. In this case the total derivative of their utility with respect to tax is:

$$\lambda_1^c (1-k_2^c) \frac{\partial p}{\partial \tau} + \kappa_1^c \phi k_2^c \frac{\partial p}{\partial \tau} > 0$$

Which is strictly positive, so that connected prefer maximum tax rate $\tau = 1$ so that to limit the fire sale. The derivative of utility of non-connected with respect to tax pins down their most preferred policy is:

$$-\lambda_0^c (d_0^N - D_0^N - \frac{\partial D_0^N}{\partial \tau} \tau) + \lambda_1^N (1-k_2^N) \frac{\partial p}{\partial \tau} + \kappa_1^N \phi k_2^N \frac{\partial p}{\partial \tau} = 0$$

Which translates into the following preferred tax rate, which is lower than the one preferred by the connected.

$$\tau = -\frac{\lambda_1^N (1-k_2^N) \frac{\partial p}{\partial \tau} + \kappa_1^N \phi k_2^N \frac{\partial p}{\partial \tau} - \lambda_0^N (1-\theta^n) d_0^N}{\lambda_0^N \frac{\partial D_0^N}{\partial \tau}} < 1$$

An alternative way to study the problem of imperfect enforcement in the setting with taxes is to assume that connected are able to avoid taxes but share in the benefits. In this case, the policy benefits them through a direct transfer, on top of the benefits associated with limit the fire sale. Connected will choose a rate that maximizes these gains (which may be lower than one due to the considerations related to achieving a high transfer). For the non-connected, the transfer to non-connected consitutes an additional cost of tax and so their preferred policy rate is lower than the one in case without transfers to connected.

The total derivative of utility of connected borrowers with respect to tax is:

$$-\lambda_0^c(-D_0^N - \frac{\partial D_0^N}{\partial \tau}\tau) + \lambda_1^c(1-k_2^c)\frac{\partial p}{\partial \tau} + \kappa_1^c \phi k_2^c \frac{\partial p}{\partial \tau}$$

Which uses the fact that tax only applies to the non-connected ($D_0^N = \theta^n d_0^n$). This is strictly positive if $D_0^N + \frac{\partial D_0^N}{\partial \tau}\tau > 0$. Otherwise setting it equal to zero yields:

$$\tau = -\frac{\lambda_1^c(1-k_2^c)\frac{\partial p}{\partial \tau} + \kappa_1^c \phi k_2^c \frac{\partial p}{\partial \tau} + \lambda_0^c D_0^N}{\lambda_0^c \frac{\partial D_0^N}{\partial \tau}}$$

The derivative of utility of non-connected with respect to tax is:

$$-\lambda_0^c(d_0^N - D_0^N - \frac{\partial D_0^N}{\partial \tau}\tau) + \lambda_1^N(1-k_2^N)\frac{\partial p}{\partial \tau} + \kappa_1^N \phi k_2^N \frac{\partial p}{\partial \tau}$$

Which translates into the following preferred tax rate

$$\tau = -\frac{\lambda_1^N(1-k_2^N)\frac{\partial p}{\partial \tau} + \kappa_1^N \phi k_2^N \frac{\partial p}{\partial \tau} - \lambda_0^N(1-\theta^n)d_0^N}{\lambda_0^N \frac{\partial D_0^N}{\partial \tau}}$$

Chapter 3

To Be Bribed or Lobbied: Political Control or Regulation

3.1 Introduction

Models of political influence by interest groups often treat bribing and lobbying as equivalent (Persson and Tabellini, 2016). While they both entail a transfer towards the government in exchange for favors, in practice they differ across several dimensions. Critically, bribing aims at circumventing an existing policy, whereas lobbying seeks to change it (Harstad and Svensson, 2011). Moreover, bribing is illegal (Rose-Ackerman, 1975), while some form of lobbying is allowed in most jurisdictions and considered a legitimate form of advocacy.

This paper builds on earlier work by Perotti and Vorage included in Vorage (2011) to explore the implications of these differences for competition among interest groups under bribing and lobbying. The competitive structure determines both the policy and the size of political rents. We show how the quality of institutions such as political accountability and strength of the legal system affect politician's preference for being bribed or lobbied.

Bribing involves competition for an exclusive benefit of circumventing regulation, and therefore allows the politician to extract maximum political rents. Lobbying aims to alter universally applicable policy criteria. Rules generate non-excludable benefits for those who satisfy it, giving the corresponding lobby a bargaining power in the political game. This allows lobbyists to extract a share of rents at the expense of the politician. A key result is that when the political accountability is low and the legal system is weak the politician prefers to be bribed. As stronger institutions increase the risk of prosecution, they make bribing less attractive relative to lobbying.

The model considers a semi-benevolent politician who decides on the level of firm entry. She can choose to control market access directly or to regulate it by setting a minimum entry requirement based on some attribute. Citizens form competing interest groups in order to seek entry. They lobby for a favorable entry requirement if the politician opts for regulation or bribe to be granted market access if she chooses direct control. Since bribing is illegal, the politician setting entry via direct control faces the risk of costly prosecution.

As characteristics do not matter under bribing, perfect competition between bribing groups emerges. Each seeks to convince the politician to breach the rule in its' favor allowing her to extract maximal political rents. Lobbying aims to define the level of the entry requirement. Individuals endowed with a strong characteristic can satisfy the requirement more easily. They unite in an interest group (forming a "strong lobby") and win the lobbying game by outbidding any counteroffer. Since no rule can exclude entry by the strong lobby while allowing entry by weaker individuals, counter-lobbies stand to gain lower monopoly profits if they enter. They are thus unable to offer high transfers to a politician, weakening her bargaining power against the strong lobby. As a result the strong lobby retains some of the political rents. It can increase its' share of rents by admitting more members, thereby weakening the competition and further undermining politician's outside option. Such strategic enlargement under lobbying results in higher entry rates than under bribing (Vorage, 2011).

Governing via direct control and being bribed promises higher political rents to the politician, but comes with the risk of prosecution. Prosecution of a corrupt politician is more likely in economies with a stronger legal systems. Moreover, higher political accountability diminishes the difference in potential rents under the two regimes. Thus, the politician opts for direct control only if the institutional quality is not too high. With sufficiently high accountability the politician prefers to be lobbied, a result consistent with evidence of lobbying being more prevalent than bribing in states with stronger democracies and more independent media (Campos and Giovannoni, 2007).

An extension explores the outcomes when likelihood of prosecution depends on the number and identity of entrepreneurs. Customers support the legal inquiry against the politician and thereby increase the probability of prosecution. The effectiveness of these efforts depends on their total legal power, which can reflect the literacy, access to legal advice and representation or connections in the judiciary system of the opposing coalition. Thus, de facto strength of the legal system is determined endogenously by the interaction of exogenous distribution of power and politician's policy choice.

Higher entry lowers the de facto legal strength and the associated probability of prosecution, as it diminishes the total power of the coalition of customers. Thus, the more powerful the citizens the lower the optimal level of entry. When legal power is homogenous across all citizens, entry is set so that to maximize the expected rents of the politician, like in the baseline model. With heterogeneous power, the competitive structure of the bribing game changes. Powerful citizens form a bribing group with an advantage over others: the politician allowing entry by a less powerful group would face a higher risk of prosecution. This reduces politician's bargaining power vis-a-vis the most powerful bribing group, forcing her to surrender a share of the political rents. The result resembles the outcome in the case of lobbying, however the mechanisms differ. Here the bargaining power derives from citizens ability to influence the prosecution risk, while in the case of lobbying it is driven by non-excludability of strong citizens.

The distribution of legal power plays a key role in determining the equilibrium level of entry. If the inequality is not too large, entry is higher than in the case of homogenous power. The intuition is that powerful bribing group has an incentive to expand its' size so that to further undermine the outside option of the politician and extract higher share of the political surplus. If power is distributed very unevenly, entry level may be lower than in the homogenous setting. In this case the marginal expansion of the powerful bribing group does not affect the likelihood of prosecution (and thus the political rents accruing to the group) sufficiently to justify diluted profits.

3.2 Related Literature

This paper contributes to the extensive literature on the special interest politics, dating back to seminal work of Olson (1965). We study competition between interest groups in a setting in which the goal of regulation is to allow groups to extract rents in the spirit of Stigler (1971); Posner (1974) and Peltzman (1976).

Early contributions explore welfare implications of competition for political favors between exogenously determined interest groups (Krueger, 1974; Becker, 1983; Grossman and Helpman, 1996). Mitra (1999) studies the decision to form an interest group by modeling both the costs of association and the benefits of political influence. Abstracting from these costs Perotti and Volpin (2007) endogenize the size of a single interest group seeking preferential access to production. Our paper builds on this work and explores the differences that emerge between lobbying and bribing when multiple groups compete for market access.

Shleifer and Vishny (1993) show that, in weak states, lack of coordination between multiple agencies may lead to very high corruption levels as corrupt officials do not internalize the externality that their demands impose on other officials. Moreover, secrecy of bribery, necessary due to its' illegality, can make even well-coordinated corruption less efficient than taxation. Relatedly, our setting considers a single politician and focuses on the impact of competition between interest groups on the size of her rents and points to illegality as in important determinant of the choice between being bribed or lobbied.

Previous research explores the differences between lobbying and bribing and their welfare implications (Lambsdorff, 2002). Our distinction between the two is most closely related to that used by Harstad and Svensson (2011). We view lobbying as a means of changing the shape of a policy and bribing as a way to gain direct economic benefits. They explore the choice of a firm between these two modes of exerting political influence on a politician or a bureaucrat. We abstract from the agency conflict within the government and contribute by studying the incentives of a politician to design policy in a way that makes her susceptible to either lobbying or bribing. As in Damania et al. (2004) we assume bribery to be illegal. However, while their work investigates the possibility of lobbying that targets the reform of legal institutions, we treat these as sticky and analyze how their quality may affect the preference of politicians for regulation via rules or direct control.

Empirically, misuse of office appears to be constrained by the quality of institutions (Svensson, 2005). Campos and Giovannoni (2008) show that lobbying is more likely than bribing in democracies with independent media. Related evidence links bribing with low political accountability (Kaufmann and Vicente, 2011) and transparency (Bennedsen et al., 2011), in line with the predictions of our model. Pieroni and d'Agostino (2013) show that bribery is associated with lower levels of regulation. For us this relation is a direct consequence of the assumption that by choosing the mode of policy making the politician also chooses how she will be influenced by the interest groups.

Bribing firms tend to benefit from engaging in corruption (Zeume, 2017), but on a country level it reduces firm growth (Fisman and Svensson, 2007), investment and GDP growth (Mauro, 1995). Similarly, lobbying firms appear to exert negative externalities on their competitors through inducing politicians to pass legislation that favor their narrow interests (Neretina, 2019). In our framework, both bribing and lobbying lead to inefficiently low firm entry, however our analysis points to a clear normative ranking. Social welfare is higher under lobbying as strong lobby can weaken politician's bargaining position by expanding in size.

Our work explores the ability of special interest groups to influence politicians in the context of entry policy. Previous research points to an important relationship between corruption and market competition. Ades and Di Tella (1999) show that ability of firms to earn monopoly rents may stimulate corruption, though the relationship may be reversed if firms differ in their cost effectiveness (Bliss and Tella, 1997). In a related paper, Emerson (2006) shows that when detection of bribery depends on the number of firms and the size of the bribe, multiple equilibria may emerge: one characterized with a positive and one with a negative corruption-competition relationship. In our setting the politician trades-off social welfare against contributions by interest groups, so that size of transfers is negatively associated with the firm entry. In our model the political accountability shifts politician's preference towards social welfare, resulting in higher entry. In line with this intuition evidence suggests that competition is more limited when citizens have fewer democratic rights (Benmelech and Moskowitz, 2010).

3.3 Model Set Up

We study the choice of a politician to govern firm entry through direct control or minimum requirement regulation. Agents can form interest groups to seek entry into the market under either of the modes of governance, they bribe in case of the former or lobby in case of the latter. The politician can accept the contribution of one of the groups in exchange for granting it's members market access.

The baseline model is based on the earlier version of this paper (Vorage, 2011). It consist of one period, a unit mass of citizens and a single politician. In this section we first lay out the preferences and production technology of the citizens. Then we introduce the problem of a politician and discuss the formation of special interest groups.

3.3.1 Citizens

A unit mass of citizens indexed by i, derive utility from consuming the intermediate good (a numeraire) and a final good. The amount consumed of each good is denoted by x_i and y_i respectively and the utility function is given by:

$$U_i = x_i + ay_i - \frac{1}{2}y_i^2 \tag{3.1}$$

where $a > 1$ scales the utility of consuming the final good relative to the numeraire and ensures positive demand. Citizens receive a homogenous endowment of the numeraire equal to ω.

Each citizen has access to technology to invest one unit of numeraire in order to produce one unit of final good. We refer to those who do so as entrepreneurs $i = e$. The number of entrepreneurs who can enter the product market, n, is determined by the politician who either grants permission directly to specific agents or sets a regulatory requirement. Once allowed to enter they can sell the final good at endogenously determined competitive price $p(n)$ and earn a profit $\pi_e(n) = p(n) - 1$. Citizens who are denied entry cannot sell the final good therefore choose not to produce. They are referred to as consumers, $i = c$, and earn no profits, $\pi_c = 0$.

We define m as the entry level at which entrepreneurs make zero profits, $\pi_e(m) = 0$, and assume that $m \leq \frac{1}{2}$, so that even without politician's restrictions on entry consumers are in the majority.

Citizens are heterogeneous with respect to some observable characteristic $\delta_i \sim F(\delta)$ describing its' distribution in the population. For tractability, we assume that the characteristic is not correlated with agent's productivity nor preferences. It is however a criterion that the politician can use in setting the entry requirements. This assumption allows us to focus on the environment in which any policy limiting entry or selecting the identity of entrepreneurs is aimed solely at rent extraction and brings no social benefits.

Some of the citizens are also endowed with organizational talent, which allows them to solve the collective action problem in order to form interest groups and influence the policy. We refer to them as representatives. Their role and objective is discussed in section 3.3.3.

3.3.2 Politician

In the tradition of Grossman and Helpman (1996), we assume a semi-benevolent politician. We study her choice of a form of governance, g, and the level of entry that she allows, n.

Form of Governance

The politician can control entry directly or regulate it through a minimum requirement for market access. Under direct control the politician can be bribed by interest groups for preferential access. When entry is regulated through requirements lobbying groups are formed to advocate a favorable rule. Since each form of governance corresponds to a different mode of influence by the interest groups, we sometimes refer to governance by direct control as "being bribed" (and denote it as $g = B$), and to setting regulation as "being lobbied" (denoted as $g = L$).

When governing through direct control, the politician selects the citizens who will be allowed to sell the final good in the market. As positive monopoly rents can be earned, citizens have an incentive to offer bribes to the politician in return for being allowed exclusive entry. This type of outright corruption, or quid-pro-quo is generally illegal and thus results in prosecution of the politician. The prosecution succeeds with probability $\rho(g = B) = \phi$, where ϕ measures the strength and independence of legal institutions. If it does the he politician is forced to give up the contributions through fines and is not allowed to compete for reelection which brings her utility to zero. For tractability we assume that the politician faces the risk of prosecution whenever she chooses to govern by direct control. In Appendix 3.7.3 we show that it does not affect the main result of the analysis.

Alternatively, the politician can regulate entry by imposing a minimum entry requirement. Regulation entails setting a threshold $\hat{\delta}$, such that only citizens with a characteristic above the threshold can enter the market (resulting in entry equal to $n(\hat{\delta})$. The requirement can represent a regulatory barrier to entry. This can be a criterion based on personal attributes such as minimum level of education or age. Alternatively technological standards, safety requirements or accounting and taxation rules can imply an entry limit dependent on agent's access to finance. Critically, regulation implies that those who satisfy the requirement cannot be excluded from the market, and that rules are implemented as legislation and thus legal. The risk of successful prosecution of a politician using regulation is zero $\rho(g = L) = 0$

Politician's Utility

Because of re-election concerns the politician values social welfare $S(n) = nU_e(n) + (1 - n)U_c(n)$. She also derives utility from contributions paid by interest groups, $K(n)$, because these can be consumed in the future or help finance campaign spending. The utility function weighs welfare and contributions by β and $1 - \beta$ respectively, where $\beta \in [0, 1]$ measures public accountability. Taking into account the risk of successful prosecution the expected utility of the politician can be expressed as:

$$U_p(n) = (1 - \rho(g)) \left[\beta S(n) + (1 - \beta)K(n)\right] \tag{3.2}$$

We view both the accountability, β, and the quality of the legal system, ϕ, as persistent institutions that cannot be directly affected by the government.

3.3.3 Interest groups

There are J representatives indexed by j. Each representative can form a coalition consisting of q_j citizens and offer the politician a contribution K_j in return for market entry for the members of the group. The role of the representative is to solve the coordination problem, formulate the offer and collect the contributions from all of group's members. Representatives enter sequentially and can offer membership to any citizen not yet associated with another interest group.

Each group can commit to pay its' promised contributions after its' offer has been accepted, the corresponding policy implemented and the profits were realized. This group can refuse to pay the contributions if the politician does not implement its' preferred policy. This threat ensures that the politician can only accept an offer of one interest group. However, under lobbying a subset of agents with high characteristic q'_j may be granted entry rights by free-riding on the offer of another group that advocates for a lax minimum requirement.

The representative charges a fee that represents an infinitesimal fraction of the coalitions profit Π_j i.e., total profits of entrepreneurs in the coalition net of paid contribution. Therefore, he maximizes:

$$\Pi_j = \begin{cases} q_j(p-1) - K_j & \text{if } j \text{ wins} \\ q'_j(p-1) & \text{if } j \text{ looses but } q'_j \text{ get access} \\ 0 & \text{otherwise} \end{cases} \tag{3.3}$$

If the politician governs via direct control interest group j bribes the politician for exclusive access to the market by its' members to ensure that $n(B) = q_j$. In case of regulation through minimum entry requirements, group j lobbies for the requirement to be set so that all agents in coalition q_j satisfy it. Let $\underline{\delta_j}$ be the characteristic of the lowest ranked member of coalition j, then the requirement that the group lobbies for is $\hat{\delta} = \underline{\delta_j}$.

3.3.4 Timeline

The timing of actions by different agents in the economy is the following:

1. Citizens receive their endowments ω
2. Politician chooses governance structure g

3. Representatives $j = 1, 2, ..J$ enter sequentially to form interest groups and make an offer to a politician (n_j, K_j)

4. The politician chooses one of the offers or decides on entry policy independently forgoing contributions

5. Entrepreneurs produce and sell their good to consumers

6. Interest group whose offer was accepted pays the contribution K_j

7. Citizens consume x_i and y_i

8. The uncertainty about the success of prosecution is realized

3.3.5 Social welfare and Laissez-Faire

The utility maximization by citizens yields the individual demand function for the final good: $y_i^d = a - p$. The total supply of the final good corresponds to the number of active entrepreneurs $y^s = n$. Aggregating the individual demand and equating with the supply gives an expression for the equilibrium price $p = a - n$. Since $n = m$ is the maximum size of the market, entrepreneurs' profits can be expressed as:

$$\pi_e = m - n$$

Using that in indirect utilities of entrepreneurs $V_e(n)$ and consumers $V_c(n)$, gives the social welfare:

$$S(n) = n\left(m - \frac{1}{2}n\right) \tag{3.4}$$

Corollary 3.1. *Under free entry entrepreneurs enter the market until no more profits can be earned, $n = m$, and the social welfare is maximized, $m = argmax_n S(n)$.*

3.4 Political Equilibrium

In this section we study the outcomes of competition among interest groups under direct control and regulation: political offers made, resulting policy and distribution of political rents. We show how these depend on the institutional quality and ultimately determine politician's preferred form of governance.

Under both governance structures interest groups have incentives to offer contributions in return for preferential entry. For the politician to accept the offer of interest group j, the level of entry and the contribution it proposes must be such that she is better of accepting the offer than not accepting any and the offer made by group j cannot be dominated by an offer from another group $k \neq j$. If the politician does not accept any offer she chooses the level of entry that maximizes her utility conditional on receiving no contributions: $n = m$. In this case the policy is implemented by allowing entry by the first m firms. The resulting participation and incentive constraints of the politician considering an offer by group j are:

$$\beta S(n_j) + (1-\beta)K_j \geq \beta S(m) \tag{PC-P}$$

$$\beta S(n_j) + (1-\beta)K_j \geq \beta S(n_k) + (1-\beta)K_k \ \forall k \neq j \tag{IC-P}$$

3.4.1 Direct Control and Bribing

If market access is determined by direct control, special interest groups can bribe the politician in order to seek exclusive entry. Since the representative can only charge a fee based on the profits of its' members, under bribing he will never seek an entry policy that is broader than its' member base. The profits of each bribing group are:

$$\Pi_j^B = \begin{cases} n_j(m-n_j) & \text{if group } j \text{ wins} \\ 0 & \text{otherwise} \end{cases}$$

The level of entry that maximizes the total profit of the bribing group is $n^* = \frac{m}{2}$. Any offer made by the group needs to satisfy its' participation constraint:

$$n_j(m-n_j) - K_j \geq 0 \tag{3.5}$$

Presence of multiple representatives induces competition among bribing groups. Any offer by group j that leaves it's participation constraint slack, thereby allowing the members to earn positive rents, can be outperformed by a counter offer by briber k. The counter offer can provide the politician with higher utility by either increasing the size of the contribution or requesting higher entry. Consequently, a bribing group j finds it optimal to offer (n_j, K_j) that maximizes politicians utility while satisfying the group's participation constraint.

Proposition 3.1. *Under direct control the first $l = \lfloor \frac{1}{n^B} \rfloor$ representatives form bribing* *groups of equal size n^B. Each bribing group makes an offer (n^B, K^B):*

$$n^B = \frac{m}{2-\beta} \tag{3.6}$$

$$K^B = n^B(m - n^B) \tag{3.7}$$

and has an equal chance of being granted market access.

Proof. In Appendix 3.7.1 □

The political game between the interest groups and the politician can generate rents for both parties. However, competition forces bribing groups to forgo all the rents associated with exclusive entry to the product market and make an offer that maximizes politician's rents. They pledge all of the profits as contributions and seek entry above the profit maximizing level, $n^B > n^* = \frac{m}{2}$. The expected rents that accrue to the politician are:

$$\Omega_P^B(n^B, \phi) = (1-\phi)\left[\beta S(n^B) + (1-\beta)n^B(m - n^B)\right] \tag{3.8}$$

Lemma 3.1. *Under direct control:*

- *the level of entry increases in political accountability, $\frac{dn^B}{d\beta} > 0$,*
- *the size of the political contribution decreases in political accountability, $\frac{dK^B}{d\beta} < 0$.*

Proof. In Appendix 3.7.1 □

With higher political accountability the politician favors social welfare relative to transfers. Consequently, bribing groups seeking to maximize politician's rents make offers that involve a higher entry level and a lower contribution.

3.4.2 Regulation and Lobbying

If the politician decides to regulate entry by setting a minimum requirement any citizen with a characteristic high enough to satisfy it can sell the product in the market. When choosing whether to lobby for entry, an agent with a given δ_i needs to consider that if he is allowed entry, so is anyone with a higher characteristic. As a consequence representatives sequentially form lobbying groups composed of citizens with highest characteristics among those who are not yet associated in another group.

The offer made by each lobby can be expressed in terms of the contribution offered and the preferred minimum requirement, $\hat{\delta}_j$, or equivalently the total entry that it permits, n_j.

Given the sequential entry, the size of each lobby is given by $q_j = (n_j - n_{j-1})$, where $n_0 = 0$. Using this notation, the total profits of successive lobbying groups can be expressed as:

$$\Pi_j^L = \begin{cases} (n_j - n_{j-1})(m - n_k) & \text{if lobby } k > j \text{ wins} \\ (n_j - n_{j-1})(m - n_j) - K_j & \text{if lobby } j \text{ wins} \\ 0 & \text{if lobby } k < j \text{ wins} \end{cases}$$

Thus, the participation constraint for a lobbying group to offer a positive contribution to the politician is:

$$(n_j - n_{j-1})(m - n_j) - K_j \geq 0 \tag{3.9}$$

Critical feature of regulation is that only the lobby formed by the first representative, composed of the highest ranked citizens (thereafter referred to as the strong lobby), can enjoy exclusive market access upon winning the lobbying game. Victory by any subsequent lobby would enable entry by its' members as well as entrepreneurs associated in the previously formed lobbies. The non-excludability of the strong lobby gives it a competitive advantage over other groups in the lobbying game. The intuition is that any subsequent lobby shares the monopoly rents with the strong lobby. The lower profits earned by these groups imply a tighter participation constraint, limiting the size of contributions that they can offer to the politician. This weakened competition enables the strong lobby to secure exclusive access at a lower cost.

Proposition 3.2. *Under regulation two lobbying groups are formed: the strong lobby composed of n_1^L citizens with highest characteristic, and the counter-lobby composed of the next $n_2^L - n_1^L$ citizens. The strong lobby makes a winning offer (n_1^L, K_1^L):*

$$n_1^L = \frac{1 + (2-\beta)(1-\beta)}{1 + 2(1-\beta)(2-\beta)} m \tag{3.10}$$

$$K_1^L = \frac{\beta}{1-\beta}(S(n_2) - S(n^L)) + (n_2^L - n^L)(m - n_2) \tag{3.11}$$

where $n_2^L = \frac{m + (1-\beta) n_1^L}{2-\beta}$ $K_2^L = (n_2^L - n_1^L)(m - n_2^L)$ is the best offer of the counter-lobby. The minimum entry requirement $\hat{\delta}$ satisfies $F(\delta > \hat{\delta}) = n_1^L$.

Proof. In Appendix 3.7.2 □

In order to win the lobbying game the strong lobby needs to outbid its' fiercest competitor. Due to non-excludability of the stronger lobbies, the group formed around the second representative (composed of highest characteristic citizens among those not associated in the strong lobby) can make the most attractive counter-offer to the politician. Subsequent group can offer only a lower political contribution as higher entry results in lower monopoly rents. The best offer of the second lobbying group, also referred to as the counter-lobby, allocates all of the group's profits as contribution $(n_2^L - n^L)(m - n_2^L) = K_2^L$ and sets entry level that maximizes politician's utility.

Given the best counter-offer, the strong lobby's can win if it's offer satisfies politician's participation constraint:

$$U_p(n_2^L, K_2^L) \geq U_p(n_1^L, K_1^L) \tag{PC-P-L1}$$

As long as this holds, the strong lobby can choose its' size n_1^L so that to maximize own profits. The resulting entry and contribution are given by (3.10) and (3.11) in Proposition 3.2.

Inability of the counter-lobby to offer as high contributions to the politician, gives bargaining power to the strong group in the game against the politician. The strong lobby offers just enough of its' profits to compensate the politician for not choosing the offer of the counter-lobby and reaps the remainder of the rents generated by the policy. The total rents that accrue to the politician and the winning lobby are:

$$\Omega_P^L(n_1^L, n_2^L) = \beta S(n_2^L) + (1-\beta)(n_2^L - n_1^L)(m - n_2^L) \tag{3.12}$$

$$\Omega_L^L(n_1^L, n_2^L) = \frac{1}{1-\beta}\left[\beta S(n_1^L) + (1-\beta)n^L(m - n_1^L) - \Omega_P^L(n_1^L, n_2^L)\right] \tag{3.13}$$

An alternative strategy by the strong lobby could be to free-ride on the offer by other lobbies. In that case the level of entry would reflect the offer of the counter-lobby, which would choose it so that to maximize own rents while ensuring that it outbids the subsequent group. The counter-lobby does not internalize the impact of its offer on the rents accruing to the strong lobby. As a consequence the total rents earned by the entrepreneurs are lower than in case of the strong lobby making the winning offer. Therefore free-riding on the offer of the second lobby is sub-optimal for the strong.

Lemma 3.2. *Under minimum entry requirement:*

- *the level of entry increases in political accountability,* $\frac{dn^L}{d\beta} > 0$,
- *the rents accruing to the strong lobby decrease in political accountability,* $\frac{d\Omega_L}{d\beta} < 0$.

Proof. In Appendix 3.7.2 □

As in the case of bribing, higher political accountability implies that importance of the social welfare in politician's utility increases. This increases the marginal costs of lobbying for low entry resulting in a lower equilibrium size of the strong lobby and entry level. Moreover, since with high accountability the politician cares more about the level of entry than contributions, the offer by the counter-lobby (which entails higher entry) becomes relatively more attractive. This weakens the bargaining power of the strong lobby, leaving it with fewer rents.

3.4.3 Choice of the Form of Governance

The structure of competition among the interest groups is one of the two key differences between direct control and regulation. It drives the equilibrium entry level and the distribution of political rents under the two governance structures. The other distinction is in terms of the risk of successful prosecution of the politician. The politician chooses the governance that maximizes her expected political rents. In this section we compare the equilibrium outcomes under direct control (bribing) and regulation (lobbying) and show how political accountability and legality shape politician's preference for one over the other.

The level of entry into the product market determines social welfare in this framework: higher entry implies higher citizens' utility. The profits earned by the entrants in the restricted market improve the utility of entrepreneurs at the expense of the consumers. The lemma below compares the level of entry and welfare under direct control and minimum requirement regulation .

Lemma 3.3. *The level of entry and social welfare is lower under direct control than under minimum requirement policy.*

$$n^B > n^L$$
$$S(n^B) > S(n^L)$$

Proof. In Appendix 3.7.3 □

Under direct control competition between interest groups results in each of them choosing its' size and the corresponding level of entry so that to maximize politician's rents. Weighing the social welfare benefits and the political contributions yields n^B as the optimal level of entry. Under regulation, the strong lobby chooses its' offer so that to maximize own rents. Increasing the level of entry (and the size of the lobby) has two effects on the rents. On one hand, increasing the number of firms operating decreases the profits that can be earned by the entrepreneurs. This mechanism is at play in the context of both bribing and lobbying. On the other hand, increasing the size of the lobby weakens the counter-lobby, thereby undermining the bargaining position of the politician. This lowers the rents accruing to the politician, $\Omega_P(L, n^L)$, leaving more available to the strong lobby. The group accounts for these additional benefits, that do not occur in the context of bribing, and therefore chooses a higher entry level (and the corresponding group size).

Corollary 3.2. *If the politician is not prosecuted, the rents she earns under direct control are higher than under regulation.*

$$\Omega_P^B(n^B, 0) > \Omega_P^L(n_1^L, n_2^L)$$

Under regulation the level of entry is set to maximize rent's accruing to the strong lobby, while under direct control it is set to maximize politician's rents. Consequently, without prosecution the politician could earn higher rents while being bribed than if she was lobbied. However, since direct control makes the politician exposed to the risk of prosecutions, the expected rents may be higher under regulation. The choice of the form of governance depends on the strength of the legal system and the level of political accountability.

Proposition 3.3. *There exists a threshold quality of the legal system $\hat{\phi}$ at which the politician is indifferent between governing through direct control and regulation. If the quality of the legal system is below the threshold, the politician prefers direct control (being bribed), if it is above she prefers regulation (being lobbied). The threshold decreases in political accountability:*

$$\frac{d\hat{\phi}}{d\beta} < 0 \tag{3.14}$$

Proof. In Appendix 3.7.3 □

When choosing the governance structure, the politician trades off the size of political rents against the likelihood of earning them. Under direct control competition between bribing groups maximizes the surplus accruing to the politician, however the threat of prosecution implies that she may not be able to benefit from it. The lower the quality of the legal system, the lower the threat of prosecution. This results in a higher expected utility of the politician under bribing. The level of political accountability affects the trade-off indirectly. An increase in β implies that the politician cares more about social welfare and less about the financial gains. Since under lobbying the politician receives lower contributions and implements a higher entry than under bribing, higher political accountability makes governing via regulation relatively more attractive. In this case lower quality of legal system is sufficient to deter the politician from choosing to be bribed.

3.5 Legal Power

In this section we extend the framework by allowing the probability of prosecution to depend on the number and the identity of citizens granted entry. We explore it's effect on the equilibrium level of entry and the size of rents earned by the bribers and the politician.

Each citizen is assumed to have some legal power ψ_i, which can be used to increase the likelihood of prosecuting a politician. It can reflect citizen's legal literacy, access to advice and representation, or connections to the judiciary system. The citizen can commit to not contribute to the prosecution efforts if he is allowed to enter the product market. Therefore, the probability of prosecution is determined by the total legal power of the consumers $\rho(B) = \bar{\psi}_c$.

In the current setting the de facto strength of the legal system is no longer exogenous. It is endogenous and depends on the entry policy of the politician. What can be viewed as an underlying stable institutional characteristic is now the distribution of legal power in the society. In this context we consider two cases.

First the legal power is assumed to be homogenous $\psi_i = \psi < 1$, which allows us to isolate the impact of the prosecution considerations on the level of entry under bribing.

Next, we allow for heterogeneous distribution of power, $\psi_i \sim G(\psi)$. In this context legal power affects the bargaining position of the bribing groups. We analyze the impact on the distribution of rents and study how the degree of inequality in power affects the level of entry.

3.5.1 Homogenous Legal Power

When citizens are homogenous with respect to their legal power, there is no natural ranking of the most preferred members of a bribing group. Thus, as in the baseline setting the representative j forms a group of size n_j composed of any citizens not yet associated elsewhere. Competition induces these identical bribing groups to maximize politician's utility by offering all of their future profits as contributions.

The difference relative to the no-legal-power-case is that now, tighter entry restrictions come at a cost of higher risk of prosecution for the politician, specifically:

$$\rho(B, n^B) = \phi + (1 - n^B)\psi \tag{3.15}$$

Lemma 3.4. *The level of entry under direct control increases in the legal power of the citizens.*

Proof. In Appendix 3.7.4 □

Higher legal power of citizens implies a higher sensitivity of the probability of prosecution to the level of entry. This increases the cost of limiting entry for the politician. As bribing groups competing to win exclusive access maximize politician's utility, they choose their size and propose the level of entry that accounts for this additional effect.

3.5.2 Heterogenous Legal Power

If citizens differ in their legal power, the identity of entrepreneurs matters for the likelihood of prosecution. Thus, bribing groups composed of citizens with high legal power are able to make more attractive offers, by ensuring that their power does not contribute to the prosecution efforts.

The first representative finds it optimal to form a group composed of n_1^B citizens with highest legal power, $n_1^B = G(\psi > \psi_1)$. Each following representative j associates the group of next most powerful citizens, with the group size given by $n_j^B = G(\psi_{j-1} > \psi > \psi_j)$. If market access is granted to a bribing group j, the total power of the consumers is $\Psi(n_j, n_{j-1}) = \int_{-\infty}^{\psi_j(n_j)} \psi g(\psi) d\psi + \int_{\psi_{j-1}(n_{j-1})}^{+\infty} \psi g(\psi) d\psi$, with $n_0 = 0$.

Assumption 3.1. *The distribution of legal power is such that*

- *The probability of prosecution increases in the size of the group granted entry,* $\Psi'_{n_j}(n_j, n_{j-1}) < 0$*, for all* $n_j < \frac{2m}{2-\beta}$*;*
- *The probability of prosecution if group* j *wins increases in the size of the group formed previously,* $\Psi'_{n_{j-1}}(n_j, n_{j-1}) > 0$ *for all* $n_{j-1} \in (0, \frac{2m}{2-\beta})$
- *The probability of prosecution is between zero and one,* $\Psi(n_j, n_{j-1}) \in (0, 1)$ *for all* $n_j \in (0, \frac{2m}{2-\beta})$

The sequential group formation is based on a ranking of citizens. As in the case of lobbying, it emerges because associating highly ranked citizens in a group earns the group a competitive advantage over the subsequent ones. By committing to not engage in prosecution efforts, the first bribing group (referred to as a powerful bribing group) can make an equally attractive offer as the following group while giving up fewer rents. Thus, the powerful bribing group can maximize own profits as long as it makes an offer that outbids any offer by the competitors.

Lemma 3.5. *Under direct control of entry if legal power is heterogeneous rents are shared by the politician and the powerful bribers:*

$$\Omega_P^{BP}(n_1^B, n_2^B) = (1 - \Psi(n_2^B, n_1^B)) \left[\beta S(n_2^B) + (1-\beta) n_2^B (m - n_2^B)\right] \tag{3.16}$$

$$\Omega_B^{BP}(n_1^B, n_2^B) = \frac{1}{1-\beta}\left[\beta S(n_1^B) + (1-\beta)(n_1^B)(m - n_1^B) - \frac{\Omega_P^{BP}(n_1^B, n_2^B)}{1 - \Psi(n_1^B, 0)}\right] \tag{3.17}$$

Where $n_2^B = argmax_{n_2} \Omega_P^{BP}(n_1^B, n_2^B)$ *and* $n_1^B = argmax_{n_1} \Omega_B^{BP}(n_1^B, n_2^B)$.

Proof. In Appendix 3.7.4 □

The problem of the powerful bribing group resembles that of the strong lobby. The inequality in terms of legal power ensures a superior bargaining position to the most powerful citizens. If the powerful group is not allowed to enter it will strengthen the coalition of citizens who wish to prosecute the politician. Its' superior legal power implies that the outside option of the politician is to accept higher risk of prosecution and lower expected rents. Thus, the politician can only earn as much as would be available to her if the second group was granted entry and all the remaining gains accrue to the bribing group. High legal power of the first bribing group .

Lemma 3.6. *If citizens are heterogeneous with respect to legal power, the level of entry under direct control:*

- *is higher than in the case of homogenous legal power if* $-\Psi_n'(n,0)|_{n=\frac{2m}{2-\beta}} \geq \psi$ *and* $\Psi(\frac{2m}{2-\beta}, 0) \geq \psi(1 - \frac{2m}{2-\beta})$

- *is lower than in the case of homogenous legal power if* $-\Psi_n'(n,0)|_{n=\frac{m}{2-\beta}} \ll \psi$, $\Psi(\frac{m}{2-\beta}, 0) \ll \psi(1 - \frac{m}{2-\beta})$ *and* $\Psi_{n_1}(n_2, n_1)$ *is low,*

Proof. In Appendix 3.7.4 □

The entry level in the case of heterogeneous legal power, n_1^B solves:

$$\underbrace{-\Psi'_{n_1^B}(n_1^B,0)\left[\beta S(n_1^B)+(1-\beta)n_1^B(m-n_1^B)\right]}_{PR}+$$
$$\underbrace{(1-\Psi(n_1^B,0))\left[\beta S'(n_1^B)+(1-\beta)(m-2n_1^B)\right]}_{BP}+$$
$$\underbrace{\Psi'_{n_1^B}(n_2^B,n_1^B)n_2^B(\left[\beta S(n_2^B)+(1-\beta)n_2^B(m-n_2^B)\right]}_{OO}=0 \quad (3.18)$$

Change in the level of entry and the size of the powerful bribing group affects their rents via three channels. First, increasing the level of entry lowers the likelihood of prosecution by the politician and thus increases the available political rents. This is referred to as the political rents channel and is captured by term PR in (3.18). Second, a higher entry lowers profits earned by the bribers. This is a briber profits channel and is represented by term BP. Third, larger size of the powerful group weakens the competing bribers. This impairs politician's outside option and thereby drives down her share of the political rents. We call this an outside option channel, captured by term OO. The equilibrium n_1^L, depends on the relative importance of the three channels and is determined by the shape of the distribution $G(\psi)$.

If inequality in legal power is not too high (ie. $-\Psi'_n(n,0)|_{n=\frac{2m}{2-\beta}}$ and $\Psi(\frac{2m}{2-\beta},0)$ are not too low), the effect of increasing entry on likelihood of prosecution is sufficiently high for the political rents and the outside option channels to dominate. In this case the entry level is higher than with homogenous legal power. Key to this results is that now the powerful bribing group can increase the share of political rents that it earns by increasing its size, thereby weakening the second group and lowering the outside option of the politician. The effect resembles the one that emerges in the case of lobbying, only now the lower utility of politician is achieved by increasing the likelihood of prosecution and not by lowering the profitability of the competition.

If inequality in legal power is sufficiently high ($-\Psi'_n(n,0)|_{n=\frac{m}{2-\beta}}$ is low) and the total legal power is not too high ($\Psi(\frac{m}{2-\beta},0)$ is low), only a few very powerful citizens have substantial impact on the likelihood of prosecution. Once their participation is secured, the marginal effect of increasing the size of the bribing group is low. This dampens the political rents and the outside-option channels, so that the briber profits channel dominates. As a result the powerful bribers may prefer the entry level lower than in the case of homogenous legal power. Key to this result is the low sensitivity of rents to changes in the level of entry at a higher n.

In the case of lobbying the distribution of the characteristic, δ_i, does not play a role. The heterogeneity only affects the equilibrium outcomes by creating a natural ranking that governs the non-excludability of entry under regulation. Under bribing in the context of citizens' legal power, distribution plays a key role in affecting the division of rents and the policy that follows from the political bargain.

3.6 Conclusions

We explore how different governance and the associated forms of influence gives rise to a different structure of competition among interest groups. Direct control of entry makes the politician prone to illegal bribery in return for market access. Regulation through minimum requirements lends itself to lobbying for favorable rules.

When the risk of prosecution under direct control does not depend on the identity of entrants (i.e., is either affected only by their number or determined altogether by exogenous institutional quality) competition among bribers drives down their bargaining power against the politician. The outcome is full appropriation of rents by the politician and a highly restricted level of entry.

Since regulation generates a non-excludable benefit for agents endowed with strong attributes, competition between lobbies is uneven. The strong lobby is able to offer more to the politician than any following group, giving it bargaining power in the game with the politician. As a result lobbyists earn some of the rents generated by the policy eating into the share extracted by the politician.

While being bribed promises higher political rents, these benefits are only realized if the politician manages to avoid prosecution. As higher quality of the legal system or legal power of the citizens increase the risk of a successful prosecution, the politician prefers direct control only when the quality of institutions is low. With better institutions regulation is the optimal form of governance.

We show that homogeneity in bribing is key for the politician's ability to extract full rents under direct control. When the risk of prosecution is influenced by the identity of entrants, bribing groups composed of powerful agents gain a competitive advantage over others. In this case rent sharing may occur also under direct control. Moreover the distribution of legal power among citizens has important consequences for the resulting level of entry: market access is particularly limited when legal power is distributed very unevenly.

Forms of governance imply different competitive structures in political influence with critical consequences for the division of rents and the overall social welfare. In a more homogenous economy with low quality of institutions the politician governs by direct control earning full rents, leaving none to the entrepreneurs. In as far as financial wealth can help in acquiring legal power or improving institutions in the long run, these competition differences could have important dynamic implications.

3.7 Appendix

3.7.1 Direct control

Proof of Proposition 3.1

Each bribing group j seeks to maximize its' expected profits net of contributions taking as given the offers made by other groups. Let an offer of group k, (n_k, K_k), be the one among the competing offers that gives highest utility to the politician. It is optimal for bribery j to make an offer that gives the politician a marginally higher utility, so that to ensure victory in the bargaining game. As the same holds for all bribing groups, the optimal offer by j maximizes politician's utility while satisfying bribery's participation constraints. The problem is given by:

$$max_{n_j,K_k} S(n_j) + (1-\beta)K_j$$
$$\text{subject to:} K_j \leq n_j(m-n_j)$$

It follows that politician's utility is maximized when bribery's participation constraint is binding $K_j = n_j(m-n_j)$ and the level of entry is set at $n_j = \frac{m}{2-\beta}$. All bribing groups find it optimal to make the same offer. New bribing groups are formed as long as there are sufficiently many non-associated citizens to form a group of size $q_j = n^B$

Proof of Lemma 3.1

Taking first order derivative of (3.6) with respect to β yields:

$$\frac{dn^B}{d\beta} = \frac{m}{(2-\beta)^2} < 0$$

Taking first order derivative of (3.7) with respect to β yields:

$$\frac{dK^B}{d\beta} = (m - 2n^B)\frac{m}{(2-\beta)^2}$$

Since $n^B > \frac{m}{2}$, $\frac{dK^B}{d\beta} < 0$.

3.7.2 Minimum requirment regulation

Proof of Proposition 3.2

The strong lobby can either make a winning offer or free-ride on the offer of the competitors.

If it chooses to make a winning offer, it can set the entry level and contribution so that to maximize own profits as long as it ensures that politician's participation constraint is satisfied. The politician chooses the offer of the strong lobby if the utility she obtains from her offer is as high as that under the best alternative offer.

The best offer by any lobby maximizes politician's utility while satisfying own participation constraint $(n_k - n_{k-1})(m - n_k) = K_k$. Thus the utility of the politician is given by:

$$\max_{n_k} U_p(n_k, n_{k-1}) = \beta S(n_k) + (1-\beta)(n_k - n_{k-1})(m - n_k) \quad (3.19)$$

The utility of the politician decreases in the size of the lobby that was formed just prior to the counter lobby: $\frac{\partial U_p(n_k, n_{k-1})}{\partial n_{k-1}} = -(1-\beta)(m - n_k) < 0$. Thus, each subsequent lobby can make a less attractive offer to the politician. So the strong lobby needs to make an offer that outbids the lobby formed around the second representative (the counter-lobby). Solving (3.19) for $k = 2$ yields:

$$n_2 = \frac{m + (1-\beta)n_1}{2-\beta} \quad (3.20)$$

The problem of a strong lobby is thus:

$$\max_{n_1} \frac{1}{1-\beta}\left[\beta S(n_1) + (1-\beta)n_1(m - n_1) - (\beta S(n_2) + (1-\beta)(n_2 - n_1)(m - n_2))\right] \quad (3.21)$$

Solving that yields (3.10) and (3.11). As a result the strong lobby extracts rents equal to 3.13.

If the strong lobby free-rides on the offer of another, the second lobby does not need to sacrifice all of its' profits and may still win the lobbying game. It needs to strategically outbid the fiercest competitor, the third representative. The offer by the third lobby (n_3, K_3) solves (3.19), where $k = 3$. The problem of the second lobby would then be:

$$\max_{n_2} \frac{1}{1-\beta} \left[\beta S(n_2) + (1-\beta)(n_2 - n_1)(m - n_2) - (\beta S(n_3) + (1-\beta)(n_3 - n_2)(m - n_3))\right]$$

In this case the strong lobby chooses its size so that to maximize own profits, under the entry lobbied for by the second group:

$$\max_{n_1} n_1(m - n_2)$$

Under free-riding, the total rents available to entrepreneurs are:

$$\max_{n_2} \frac{1}{1-\beta} \left[\beta S(n_2) + (1-\beta)n_2(m - n_2) - (\beta S(n_3) + (1-\beta)(n_3 - n_2)(m - n_3))\right]$$

If the second lobby was choosing n_2 so that to maximize the total surplus, the problem would be equivalent to that of a strong lobby trying to win given in (3.21). However, when strong lobby free-rides the second lobby chooses n_2 so that to maximize own surplus. The resulting n_2 differs from the one that would maximize the surplus of both lobbies whenever $n_1 > 0$. When free-riding it is optimal for the strong lobby to choose a positive size of a group. Thus, the surplus available to the two lobbies under free-riding by the strong lobby is lower than the surplus available to the strong lobby when it lobbies to win.

Proof of Lemma 3.2

Taking the first order derivative of n^L with respect to β yields:

$$\frac{dn^L}{d\beta} = \frac{3 - 2\beta}{[1 + 2(1-\beta)(2-\beta)]^2} > 0$$

Using (3.21) we take the derivative of the total rents of the strong lobby with respect to β and apply envelope theorem to get:

$$\frac{d\Omega_L(L, n^L)}{d\beta} = \frac{1}{(1-\beta)^2} \left[S\left(n^L\right) - S\left(n_2^L\right)\right] < 0$$

3.7.3 Equilibrium

Proof of Lemma 3.3

Comparing the levels of entry:

$$\begin{aligned}
\frac{m}{2-\beta} &< \frac{1+(1-\beta)(2-\beta)}{1+2(1-\beta)(2-\beta)}m \\
1+2(1-\beta)(2-\beta) &< (2-\beta)+(1-\beta)(2-\beta)^2 \\
(1-\beta)(1-2(2-\beta)+(2-\beta)^2) &> 0 \\
(1-\beta)(1-(2-\beta))^2 &> 0
\end{aligned}$$

So entry is lower under bribing than under lobbying.

Proof of Proposition 3.3

Proof. The existence of the threshold follows from comparing the utilities under the two strategies at $\phi = 0$ and $\phi = 1$ and observing that politician's expected utility under bribing increases as ϕ rises. The threshold is implicitly defined in:

$$\Omega_P^B(n^B, \hat{\phi}) = \Omega_P^L(n_1^L, n_2^L) \tag{3.22}$$

To show that increase in political accountability lowers that threshold, we take a derivative of politician's utility under bribing and lobbying with respect to β. Using envelope theorem these simplify to

$$\begin{aligned}
\frac{dU_p(n^B)}{d\beta} =& (1-\phi)(S(n^B) - n^B(m-n^B)) = (1-\phi)\frac{m^2}{2(2-\beta)} \\
\frac{dU_p(n^L)}{d\beta} =& S(n_2^*) - (n_2^* - n^L)(m - n_2^*) + (1-\beta)n_2\frac{dn^L}{d\beta}
\end{aligned}$$

Since $n_2^* > n^L > n^B$, $n_2^* - n^L = \frac{m-n^L}{2-\beta} < \frac{m}{2-\beta}$ and $\frac{dn^L}{d\beta} > 0$, $\frac{dU_p(n^B)}{d\beta} < \frac{dU_p(n^L)}{d\beta}$ for all ϕ. For a given quality of legal institutions increasing political accountability increases politicians utility under minimum requirement policy more than under direct control. Therefore with high β a lower level of legality is sufficient to make politician indifferent between the two. $\square$

Discussion: Risk of prosecution only if bribes are accepted

If the politician choosing direct control only faces a positive risk of prosecution if she accepts positive contributions, her participation constraint for accepting the offer of a bribing group j reads:

$$(1-\phi)(\beta S(n_j) + (1-\beta)K_j \geq \beta S(m)$$

The structure of competition among bribers is not affected and the optimal offer remains $n^B = \frac{m}{2-\beta}$ and $K^B = n^B(m - n^B)$. Using the participation constraint of the politician we can show that the offer is accepted only if:

$$\phi < (1-\beta)^2$$

Otherwise, the politician does not accept bribes $K^B = 0$ and sets entry at $n^B - m$. The politician choosing $n^L = m$ under lobbying would earn the same utility, however she finds it optimal to accept an offer with lower entry and positive contributions (n_1^L, K_1^L). Which implies that $\phi > (1-\beta)^2$ the politician prefers lobbying over direct control.

Therefore with the risk of prosecution depending on the acceptance of bribes the threshold strength of the legal system below which the politician prefers direct control over regulation is given by $\tilde{\phi} = \min[\hat{\phi}, (1-\beta)^2]$ and decreases in β.

3.7.4 Legal Power

Proof of Lemma 3.4

Each bribing group j is solving the following problem: The problem can be expressed as:

$$\max_{n_j} \, (1 - \rho(B, n_j)) \left[\beta S(n_j) + (1-\beta) n_j (m - n_j)\right] \tag{3.23}$$

The first order condition reads:

$$\psi \Omega_P(B, n_j) + (1 - (1 - n_j)\psi)\Omega_P'(B, n_j) = 0 \tag{3.24}$$

Since $\Omega_P'(B, n_j) = 0$ at $n_j = \frac{m}{2-\beta}$ and $\Omega_P(B, \frac{m}{2-\beta}) > 0$, it must be that $n_j^* > \frac{m}{2-\beta}$. Since $\Omega_P(B, n_j) = 0$ at $n_j = 0$ and $n_j = \frac{2m}{2-\beta}$ it must be that $n_j^* < \frac{2m}{2-\beta}$. Implicit differentiation of (3.24) with respect to ψ yields:

$$\frac{\partial n_j^*}{\partial \psi} = \frac{n(m - \frac{2-\beta}{2}n) - (1-n)(m-(2-\beta)n)}{(1-\psi(1-n_j^*))(2-\beta) - (m-(2-\beta)n)}$$

Since $n_j* \in (\frac{m}{2-\beta}, \frac{2m}{2-\beta})$, we have that $\frac{\partial n_j^*}{\partial \psi} > 0$.

Proof of Lemma 3.5

The powerful bribing group aims to maximize own profits net of contributions while outbidding the strongest competitor. As the second bribing group can offer the next lowest risk of prosecution to the politician it has the potential to make the most attractive alternative offer. The highest offer of the second bribing group maximizes politician's utility while forgoing all profits as political contribution. The level of entry proposed by that group, n_2^B, solves:

$$\max_{n_2^B} (1 - \Psi(n_2^B, n_1^B)) \left[\beta S(n_2^B) + (1-\beta)n_2^B(m - n_2^B)\right] \tag{3.25}$$

To ensure that it wins, the powerful bribery must provide the politician with at least as high utility as what she could get with the second bribing group. Therefore the problem of the powerful bribery can be expressed as:

$$\max_{n_1^B} \frac{1}{1-\beta}\left[\beta S(n_1^B) + (1-\beta)n_1^B(m-n_1^B) - \frac{1-\Psi(n_2^B, n_1^B)}{1-\Psi(n_1^B, n_0^B)}\left[\beta S(n_2^B) + (1-\beta)n_2^B(m-n_2^B)\right]\right] \tag{3.26}$$

Therefore the rents accruing are the solution of problem (3.25) and those earned by the powerful bribery are given by (3.26).

Proof of Lemma 3.6

The level of entry in the case of homogenous legal power, n^B solves:

$$\underbrace{\psi(m - \frac{(2-\beta)}{2}n^B)n^B}_{A} + \underbrace{(1-\psi(1-n^B))(m-(2-\beta)n^B)}_{B} = 0 \tag{3.27}$$

Graphically (3.27) is a sum of two parabolas. Function A takes value of zero at $n^* = 0$ and $n^* = \frac{2m}{2-\beta}$ and achieves its' maximum value of $\psi\frac{m^2}{2(2-\beta)}$ at $n = \frac{m}{2-\beta}$. Function B has two zeros at: $n^* = \frac{\psi-1}{\psi} < 0$ the other one at $n^* = \frac{m}{2-\beta}$. Thus the positive solution of (3.27) lies in the set $n^B \in (\frac{m}{2-\beta}; \frac{2m}{2-\beta})$.

The level of entry in the case of heterogenous legal power, n_1^B solves:

$$\underbrace{-\Psi'_{n_1^B}(n_1^B,0)(m-\frac{(2-\beta)}{2}n_1^B)n_1^B}_{PR}+\underbrace{(1-\Psi(n_1^B,0))(m-(2-\beta)n_1^B)}_{BP} \tag{3.28}$$

$$+\underbrace{\Psi'_{n_1^B}(n_2^B,n_1^B)n_2^B(m-\frac{2-\beta}{2}n_2^B)}_{OO}=0 \tag{3.29}$$

The equation is a sum of three components: PR, BP and OO. First note that n_2^B solves:

$$-\Psi'_{n_2^B}(n_2^B,n_1^B)(m-\frac{(2-\beta)}{2}n_2^B)n_2^B+(1-\Psi(n_2^B,n_1^B))(m-(2-\beta)n_2^B)=0 \tag{3.30}$$

Since $\Psi'_{n_j}(n_j,n_{j-1})<0$ for all $n_j<\frac{2m}{2-\beta}$ and $1-\Psi(n_j,n_{j-1})\in(0,1)$ for all $n_j\in(0,\frac{2m}{2-\beta})$, the positive solution to (3.30) is $n_2^B\in(\frac{m}{2-\beta};\frac{2m}{2-\beta})$. Combining this with the fact that $\Psi'_{n_{j-1}}(n_j,n_{j-1})>0$ for all $n_{j-1}\in(0,\frac{2m}{2-\beta})$, term OO is strictly positive for all $n_1^B\in(0,\frac{2m}{2-\beta})$.

Term PR and BP correspond to terms A and B in the homogenous case.

Conditions for $n_1^B > n^B$:

The groups are formed sequentially and include citizens with the highest legal power of those not yet associated. This means that an increase in n_j at low levels of n_j has at least as strong impact on the probability of prosecution as at high levels of n_j, $\Psi''_{n_j}(n_j,n_{j-1})\geq 0$.

Consequently, if $-\Psi'_n(n,0)|_{n=\frac{2m}{2-\beta}}\geq\psi$ then $-\Psi'_n(n,0)|_{n<\frac{2m}{2-\beta}}\geq\psi$. Under this condition, function PR takes weakly higher values than function A for all $n\in(\frac{m}{2-\beta},\frac{2m}{2-\beta})$. Both are equal to zero at $n=\frac{2m}{2-\beta}$.

Functions BP and B are both equal to zero at $n=\frac{m}{2-\beta}$. The ordering of the values they take for larger n depends on their relative steepness. The derivatives are:

$$\frac{dB}{dn}=\psi(m-(2-\beta)n)-(2-\beta)(1-\psi+\psi n)$$
$$\frac{dBP}{dn}=-\Psi_n(n,0)(m-(2-\beta)n)-(2-\beta)(1-\Psi(n,0))$$

The function BP decreases in n less steeply than function B if the $\frac{dBP}{dn}>\frac{dB}{dn}$. Since $-\Psi'_n(n,0)|_{n=\frac{2m}{2-\beta}}\geq\psi$, the sufficient condition is $(1-\psi+\psi n)>1-\Psi(n,0))$ For the decrease to be less steep for any $n\in(\frac{m}{2-\beta},\frac{2m}{2-\beta})$ we need $\Psi(\frac{2m}{2-\beta},0)\geq\psi(1-\frac{2m}{2-\beta})$.

Thus, if $-\Psi'_n(n,0)|_{n=\frac{2m}{2-\beta}}\geq\psi$ and $\Psi(\frac{2m}{2-\beta},0)\geq\psi(1-\frac{2m}{2-\beta})$ functions PR and BP take lower values than functions A and B for $n\in(\frac{m}{2-\beta}),\frac{2m}{2-\beta})$

Equation (3.29) sums term PR, BP and OO. Since for all $n \in (\frac{m}{2-\beta}), \frac{2m}{2-\beta})$ both PR and BP take higher values than A and B respectively and since OO is positive, the positive solution of (3.29) has to larger than the positive solution of (3.27), $n_1^B > n^B$.

Conditions for $n_1^B < n^B$:
Since $\Psi''_{n_j}(n_j, n_{j-1}) \geq 0$, if $-\Psi'_n(n,0)|_{n=\frac{m}{2-\beta}} < \psi$, then $-\Psi'_n(n,0)|_{n>\frac{2m}{2-\beta}} < \psi$. Thus, if $-\Psi'_n(n,0)|_{n=\frac{m}{2-\beta}} < \psi$ function PR takes lower values than function A for all $n \in (\frac{m}{2-\beta}, \frac{2m}{2-\beta})$. Both are equal to zero at $n = \frac{2m}{2-\beta}$.

If $\Psi(\frac{m}{2-\beta}, 0) < \psi(1 - \frac{m}{2-\beta})$, then function BP decreases in n more steeply than function B for all values of $n \in (\frac{m}{2-\beta}), \frac{2m}{2-\beta})$. Thus in this domain function BP takes lower values than function BP.

If $\Psi_{n_1}(n_2, n_1)$ is low, $-\Psi'_n(n,0)|_{n=\frac{m}{2-\beta}} \ll \psi$ and $\Psi(\frac{m}{2-\beta}, 0) \ll \psi(1 - \frac{m}{2-\beta})$, then the entry that solves the heterogenous problem is lower than the one that solves the homogenous case, $n_1^B < n^B$.

Summary

This thesis consists of three chapters which cover topics in financial economics and political economy.

The first chapter explores how bank balance sheet opacity can amplify credit cycles. It develops a theoretical model in which global banks have superior information about the aggregate productivity but may have incentives to risk-shift by taking excessive exposure in the risky asset. Other agents try to infer the productivity from banks actions. They may be unable to estimate it precisely because the opacity of bank balance sheet obscures banks' portfolio choices and incentives, making the prices observed in the market imperfectly informative. As a result these less informed agents make mistakes from the ex-post perspective: they over-invest when global banks risk-shift and under-invest when global banks invest prudently. If these agents are levered, such as local banks, this uncertainty about the productivity may induce them to risk-shift by betting on the more optimistic estimate of the aggregate state. A consequence is an amplification of investment and risk in the states when global banks risk-shift.

The second chapter studies how political factors shape prudential regulation, by incorporating a probabilistic voting model into a setting with negative externalities of borrowing. In the absence of regulation atomistic agents overborrow because they do not internalize how high aggregate level of debt today limits their ability to borrow in the future by depressing the value of collateral. Voting for a politician who commits to implement a universal debt limit solves this coordination problem, so agents support a binding debt limit through elections. However, as curbing over-borrowing limits future declines in asset prices, it distributes wealth from high- to low-income borrowers. As a consequence, the high-income borrowers support lax regulation while low-income borrowers vote for strict policy. If the politician cannot commit to universal enforcement and instead provides exemptions from regulation to politically connected borrowers, voter preferences are altered. Connected agents support excessively strict policy as they do not bear its' costs.

Borrowers without connections may prefer an overly lax debt limit as its' effectiveness is decreased. Consequently, in the presence of regulatory capture equilibrium regulation is generally inefficient. It may be too strict or too lax depending on which of the groups dominates in the elections.

The third chapter explores the role of competition among special interest groups in shaping politician's choice of the form of governance. The politician chooses between minimum requirement regulation and direct control of firm access. Under minimum requirement regulation interest groups lobby the politician to set the requirement at the preferred level. Direct control of entry makes the politician susceptible to illegal bribing as interest groups try to secure access to the market. As direct control allows the politician to grant exclusive access, she is able to extract higher political contributions than under lobbying. In equilibrium the politician chooses the form of governance by trading off lower political contributions under lobbying against the risk of prosecution under bribing. She prefers the former whenever legal institutions are sufficiently strong to make bribing too risky. If the probability of prosecution is endogenous to the number and the identity of agents excluded from market access, politician ability to extract high contributions under bribing may be limited. As a result the preference for direct control depends on both the quality of institutions and distribution of legal power in the economy.

Samenvatting

Dit proefschrift bestaat uit drie hoofdstukken die onderwerpen behandelen in financiële economie en politieke economie.

In het eerste hoofdstuk wordt onderzocht hoe ondoorzichtigheid van bankbalansen kredietcycli kan versterken. Het ontwikkelt een theoretisch model waarin mondiale banken superieure informatie hebben over de algehele productiviteit, maar mogelijk worden gestimuleerd om risico's te verschuiven door overmatige blootstelling aan het risicovolle activum te nemen. Andere agenten proberen de productiviteit af te leiden uit de acties van banken. Ze kunnen het misschien niet precies inschatten omdat de ondoorzichtigheid van de bankbalans de portefeuillekeuzes en prikkels van banken vertroebelt, waardoor de prijzen die op de markt worden waargenomen niet perfect informatief zijn. Het resultaat is dat deze minder geïnformeerde agenten achteraf gezien fouten maken: ze investeren te veel wanneer mondiale banken risico's verschuiven het risico van mondiale banken verschuift en onderinvesteren wanneer mondiale banken verstandig investeren. Als de financiën van deze agenten gehefboomd zijn, zoals bij lokale banken, kan deze onzekerheid over de productiviteit hen ertoe aanzetten om risico's te verschuiven door te wedden op de meer optimistische schatting van de gezamenlijke staat. Een gevolg is een toename van investeringen en risico's in de staten wanneer de mondiale banken risico's verschuiven.

Het tweede hoofdstuk bestudeert hoe politieke factoren prudentiële regulering bepalen, door een probabilistisch stemmodel op te nemen in een omgeving met negatieve externe effecten van lenen. Bij gebrek aan regulering nemen atomistische agenten te veel krediet op omdat ze niet internaliseren hoe hun vermogen om in de toekomst te lenen beperkt wordt door een hoog geaggregeerd schuldniveau dat de waarde van onderpand verlaagt. Stemmen voor een politicus die zich ertoe verbindt een universeel schuldlimiet in te voeren, lost dit coördinatieprobleem op, dus agenten steunen een bindend schuldlimiet door middel van verkiezingen. Echter, aangezien het beteugelen van overlening toekomstige dalingen

van activaprijzen beperkt, verdeelt het vermogen van hoge naar lage inkomens. Als gevolg hiervan steunen de kredietnemers met een hoog inkomen lakse regelgeving, terwijl kredietnemers met een laag inkomen voor een strikt beleid stemmen. Als de politicus zich niet kan committeren aan universele handhaving en in plaats daarvan vrijstellingen van regulering verleent aan politiek verbonden leners, veranderen de voorkeuren van de kiezers. Verbonden agenten ondersteunen een buitensporig strikt beleid omdat ze de kosten ervan niet dragen. Kredietnemers zonder connecties geven misschien de voorkeur aan een al te laks schuldlimiet omdat de effectiviteit ervan afneemt. In de aanwezigheid van dergelijke regulatory capture zal de regulering over het algemeen inefficiënt zijn. Het kan te streng of te laks zijn, afhankelijk van welke groep de verkiezingen domineert.

Het derde hoofdstuk onderzoekt de rol van concurrentie tussen belangengroepen bij het vormgeven van de keuze van politici over de vorm van bestuur. De politicus maakt een keuze tussen regulering van minimumvereisten en directe controle van de toegang van bedrijven. Onder regelgeving inzake minimumvereisten lobbyen belangengroepen bij de politicus om het vereiste op het gewenste niveau te stellen. Directe controle op de toegang maakt de politicus vatbaar voor illegale omkoping, aangezien belangengroepen proberen de toegang tot de markt veilig te stellen. Omdat directe controle de politicus in staat stelt exclusieve toegang te verlenen, is ze in staat hogere politieke bijdragen te ontvangen dan onder lobby. In het evenwicht kiest de politicus de vorm van bestuur door lagere politieke bijdragen onder lobby af te wegen tegen het risico van vervolging onder omkoping. Ze geeft de voorkeur aan het eerste wanneer juridische instellingen sterk genoeg zijn om omkoping te riskant te maken. Als de kans op vervolging afhangt van het aantal en de identiteit van agenten die van markttoegang zijn uitgesloten, kan het vermogen van politici om hoge bijdragen uit omkoping te ontvangen beperkt zijn. Als gevolg hiervan wordt de voorkeur voor directe controle beïnvloed door zowel de kwaliteit van instituties als de verdeling van de juridische macht in de economie.

List of Co-Authors

Chapter 1 is based on Perotti and Rola-Janicka (2020), which I worked on in collaboration with Prof. Dr. Enrico Perotti, whose idea initiated the project. We both contributed to defining the research question, deciding on the direction and the message of this paper and drafting. I developed and solved the economic model studied in this chapter.

Chapter 2 is based on Rola-Janicka (2020), which is my independent work.

Chapter 3 is based on Perotti et al. (2020), which is joint work of Prof. Dr. Enrico Perotti, Dr. Marcel Vorage and myself. The working paper used in this chapter builds on the earlier work by Enrico Perotti and Marcel Vorage which was included in Vorage (2011). The baseline model discussed in the chapter was developed in this earlier work. I contributed by extending the analysis to consider endogenous legal power, restructuring the presentation and discussion of the model and re-drafting the paper so that to highlight its' contribution and relation to literature.

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