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Author
Agarwal, Samanvaya

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Essays on Frictions in Financial Intermediation

by

Samanvaya Agarwal

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Committee in charge:

Professor Christine Parlour, Chair
Professor Terrence Hendershott
Associate Professor Dmitry Livdan
Professor Yuriy Gorodnichenko

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Abstract

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Financial intermediaries are arguably the backbone of every economy, engaged in a multitude of activities, for instance, capital allocation, liquidity provision, insurance and information production and dissemination. Frictionless financial intermediation is the key to developing an efficient and robust financial system. However, frictions exist and identifying and carefully assessing their potential remedies is critical in preventing market failures. This dissertation aims to further the understanding of frictions in financial intermediation performed by banking organisations and their affiliates while channeling savings of households and businesses to fund profitable opportunities.

Chapters 1 and 2 focus on the interactions of hedge funds and prime brokers in short-term debt markets where the former rely on prime brokerages for leverage. In **Chapter 1, "Hedge Fund Leverage: The Role of Moral Hazard and Liquidity Insurance"**, we build a model of hedge fund securing financing from a prime broker to invest in hard-to-value assets. We introduce a novel form of moral hazard - "fraudulent transfers", whereby a distressed fund may utilize its discretion in valuation of hard-to-value assets to transfer them to affiliates to avoid repaying its obligations. These actions may exacerbate liquidity risk for the prime broker and may also lead to a costly legal recourse to enforce contracts. The model provides several new insights. First, it uncovers a new channel for funding liquidity that can explain why illiquid funds fare worse in times of stress and why better governed funds fared better during the financial crisis. Second, the model provides a new testable hypothesis that systematic or idiosyncratic shocks to fundamentals of bank holding companies may spillover to connected hedge funds through internal capital markets. It also offers an identification strategy to distinguish between possible competing hypotheses. Third, strong governance at hedge funds may reduce incentives to invest in profitable opportunities. Fourth, banking reforms such as Supplementary Leverage Ratio, Liquidity Coverage Ratio and Standing Repo Facility intended to improve resilience of banks may also make hedge funds less vulnerable to shocks in the banking sector. Fifth, the model offers a possible reconciliation for the mixed

evidence on the impact of leverage on hedge fund survival documented in the literature.

In **Chapter 2, "Multi-Prime Financing by Hedge Funds: A Common Agency Perspective"**, we extend the model studied in Chapter 1 to a model of nonexclusive contracting with a hedge fund raising secured debt from multiple prime brokers for investment in hard-to-value assets. Multi-prime financing makes it harder for prime brokers to manage counterparty risk due to lack of position transparency of the client. In our model, fund positions are transparent. However, as before, the fund may utilize discretion in valuation of these assets to avoid repaying its obligations. The model highlights that "high-quality" funds in the sense of low probability of default may suffer a loss in aggregate funding in comparison to single-prime level. "Low-quality" funds may also suffer a loss in funding, unless they decrease investment in hard-to-value assets thus constraining investment strategy. Together, these results highlight that multi-prime financing in the presence of position transparency may result in reduced investment in illiquid, hard-to-value assets which arguably also have a high rate of return. This provides a new rationale for why funds are reluctant in improving position transparency among their prime brokers. Furthermore, prime brokers may also be worse-off, highlighting that while improving position transparency may ease counterparty risk management for prime brokers, it may not necessarily make them better-off.

In contrast to our focus on inefficient actions on part of the borrower in the first two chapters, **Chapter 3, "Board Conduct in Banks"** (co-authored with Krishnamurthy Subramanian, Saipriya Kamath and Prasanna Tantri) focuses on inefficient actions that may be taken within banking organizations themselves. Specifically, motivated by several multinational and national reports on the failure of boards of banks in providing risk oversight preceding the financial crisis of 2008, we examine the minutes of Indian banks' board meetings and offer insights on board conduct on the kind of issues tabled and discussed in bank boards. We find that risk issues account for only 10% of the issues tabled with regulation and compliance accounting for the most (41%), followed by business strategy (31%). Majority of the issues are not deliberated in detail. We interpret the evidence as suggestive of under-investment in risk and over-investment in regulation and compliance by bank boards.

This dissertation is dedicated to my family, for their immeasurable love and support.

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Co-author Information: Chapter 3 of this dissertation has been co-authored with Krishnamurthy Subramanian, Professor of Finance, Indian School of Business, Hyderabad, India, Saipriya Kamath, Assistant Professor of Accounting, London School of Economics, and Prasanna Tantri, Associate Professor of Finance, Indian School of Business, Hyderabad.

Chapter 1

Hedge Fund Leverage: The Role of Moral Hazard and Liquidity Insurance

1.1 Introduction

Hedge funds often rely on leverage in their strategies with prime brokers as the primary suppliers. Deleveraging by hedge funds has the potential to disrupt smooth functioning of financial markets and may even pose a threat to financial stability.[1] Consequently, there has been significant academic and regulatory interest in understanding the determinants of changes in hedge fund leverage.[2] For instance, Brunnermeier and Petersen (2009), Dang et al. (2013) highlight the role of collateral liquidity, Mitchell and Pulvino (2012), Eren (2015) and Infante (2019) study prime broker funding liquidity, while Lan et al. (2013) and Drechsler (2014) focus on compensation contracts of fund managers.

In this chapter, we argue that the composition of *unencumbered* assets of a fund may also matter for leverage in that it can expose prime brokers to strategic actions by the fund exacerbating both counterparty and liquidity risk for prime brokers. Specifically, hedge funds may invest in illiquid securities for which market prices are not readily available. This gives significant discretion to the fund over their valuation which can be exploited during times of stress to the detriment of prime brokers. We study a novel form of moral hazard, termed "fraudulent transfers" in legal parlance, in that a distressed fund may renege on their obligations by transferring unencumbered assets to affiliated third parties.[3] This imposes

[1]See Agarwal et al. (2015) (section 5) for a review of the role of hedge funds in the financial system.

[2]The Dodd-Frank Act enacted in 2011 mandated hedge funds to file confidential Form-PF that elicits information about assets, counterparty exposures and financing etc. for the purposes of monitoring systemic risk in the U.S. financial system. See, SEC Approves Confidential Private Fund Risk Reporting.

[3]Another possibility is misreporting performance in the presence of asymmetric information, (Townsend, 1979; Lacker, 2001; Parlatore, 2019). While firms may be able to misreport performance without transferring assets, say by manipulating revenues or costs, hedge funds may not. This is because prime brokers by virtue of their involvement in trade execution, clearing and settlement gain information about performance of their clients. Even if hedge funds trade through multiple prime brokers, post-default information sharing among

two types of costs on prime brokers.

First, it exacerbates liquidity risk because prime brokers themselves rely on short-term funding for their operations and this form of moral hazard may arise precisely when a portion of portfolio pledged as collateral has fundamentally deteriorated. Second, prime brokers may incur additional costs to enforce contracts in a court of law. When assets can be transferred to third parties, the central issue is *asset recovery from transferees*. This is because absent explicit pre-existing contractual requirements, transferees are not obligated to return assets to satisfy transferrors obligations to her creditors. To make matters more complicated, it is only when transfers are deemed "unfair" can the assets be recovered.

To capture these possibilities, we model a matched-book repo between a hedge fund (HF), a prime broker (PB) and a money market fund (MMF). To focus on the agency problem between HF and PB, we abstract from agency issues between managers and investors. In other words, interests of managers and investors are perfectly aligned. HF pledges collateral to PB in return for funds to invest in risky assets and is privately informed about their value at maturity. The interpretation is that an "active" market for risky assets does not exist thus giving HF discretion over their valuation. HF can contact the PB to realize the true value, thus revealing it to the PB. Alternatively, he may circumvent the PB by transferring these assets to an affiliate and claim default to the PB. The affiliate can also realize the true value and we assume the affiliate's transactions are not observable to the PB in real-time.

Conditional on default, the PB has an option to conduct imperfect, costly state verification (audit hereafter) of the client. The process requires PB to detect the transfer, establish the transfer was "unfair" in that the value received by HF in exchange was not the true value and then recover the true value from the affiliate. The interpretation is that federal bankruptcy and state laws, collectively, "fraudulent transfer laws" are designed to provide recourse to creditors against "fraudulent transfers" by debtors. However, this is costly and successful recovery is not guaranteed. As we will argue later, internal governance and ease of valuation of transferred assets are key to a successful claim.[4] Finally, we assume PB is committed to repayment of debt to the MMF and utilizes costly liquidity insurance in the event of HF default. This captures liquidity costs for the PB in the simplest possible manner.

Our first main result concerns the supply of leverage. First, if cost of liquidity insurance is below a certain threshold, termed the haircut hurdle rate (HHR), the PB optimally supplies maximum leverage to clients. Second, as cost increases above HHR, (i) "low quality" funds in the sense of relatively higher risk of fraud experience a positive haircut. In other words, they are "tapped" for liquidity, (ii) among the low quality funds who borrow, funds with

prime brokers may prevent hedge funds from misreporting performance either selectively or to all prime brokers. For instance, prior to the collapse of Archegos in March 2021, prime brokers met to coordinate liquidation of the fund's position in an orderly manner, see, Archegos banks discussed co-operation to head off selling frenzy.

[4]The crucial feature that allows for strategic default by HF and justifies costly state verification in the presence of collateral is that the debt contract is incentive-incompatible in that repayment amount cannot be made contingent on future realization of collateral value. If this were possible, contract can be designed to disincentivize asset transfers to the affiliate, similar to Lacker (2001) and Parlatore (2019).

weak governance and higher fraction of hard-to-value assets experience larger haircuts and (iii) an increasing proportion of funds get tapped. This result has several implications.

One, existing literature has shown quality of collateral in margin accounts or repos to be an important determinant of funding liquidity of hedge funds as in Brunnermeier and Pedersen (2009) and Dang et al. (2013). Our model shows that, in addition to collateral quality, *unencumbered* part of a fund's portfolio funded either by cash or repos also matter for funding liquidity during times of stress. This provides an additional channel that can explain the relatively worse performance of illiquid funds in times of stress. Two, Clifford et al. (2018) finds that among the funds that established discretionary liquidity restrictions (DLRs) such as gates and side pockets during the financial crisis, better governed funds outperformed other funds. The authors argue that better governance results in better monitoring of managers which reduces potential abuses of DLRs for personal gain. Our model provides another explanation in that better governed funds may enjoy better funding liquidity because they represent a lower risk of fraud for the PB which can lead to reduced fire-sales and hence better performance compared to other funds.

Three, a testable hypothesis is that adverse systematic or idiosyncratic shocks to fundamentals of bank holding companies may spillover to connected hedge funds in the form of reduced credit supply. Competing explanations include changes in funding costs for banks in response to changing fundamentals are passed on hedge funds who optimally decide the amount of leverage to employ and that facing a prime broker with deteriorating financial conditions, hedge funds withdraw collateral to avoid losing it in the event of default by the prime broker leading to a collateral run as in Infante and Vardoulakis (2021). The model suggests exploiting cross-section variation across fund characteristics such as governance and fraction of hard-to-value assets to study the impact of changes in banking sector fundamentals on hedge fund leverage since these characteristics are directly related to the risk of fraud and thus the likelihood of the prime broker needing liquidity assistance.

Our second main result highlights the impact of governance on incentives to invest in profitable opportunities. Specifically, funds with strong governance may not invest in certain profitable opportunities. This is because part of the attractiveness of an opportunity stems from the option to defraud. The likelihood of an opportunity paying off and then getting away with fraudulent actions jointly determine the value of option. The double whammy of low chances of payoff and strong governance make the option out-of-money which reduces incentives to invest in the first place. This leads to reduced demand for leverage. Admittedly, this possibility should be more interesting to explore in a model with agency issues between investors and managers which the model abstracts from. While benefits of better governance in reducing agency problems between investors and managers have been documented in the literature (Clifford et al., 2018; Honigsberg, 2019), the result suggests strong governance may come at a cost of reduced incentives for investment that has hitherto been unrecognized in the literature. If this is indeed costly for investors, they may be willing to pay higher fee to restore incentives. This argument is consistent with the findings of positive correlation between strong internal governance and higher incentive fee in Cassar and Gerakos (2010). They argue better governance reduces agency costs, making reported performance more reliable thus allowing managers to charge a higher fee. However, our model suggests another possible explanation.

Our third result discusses the implications of Basel III reforms such as Supplementary Leverage Ratio, Liquidity Coverage Ratio and the recently established Standing Repo Facility intended for a resilient banking and financial system on hedge fund leverage. We show that to the extent the cost of liquidity insurance was not a binding concern prior to these reforms, their passage lowers the vulnerability of hedge funds to adverse shocks to the banking sector. In other words, safer banks imply safer hedge funds.

Finally, the model provides a possible reconciliation of the disparate results documented in the literature on the impact of leverage on hedge fund survival. For instance, Baba and Goko (2009), Liang and Park (2010) report an insignificant relationship while Lee and Kim (2014) report a significant negative relationship. Our model highlights two opposing effects of leverage on the probability of default. On the one hand, higher leverage increases the likelihood that the PB will have unsecured claims outstanding thus exposing her to HF default. On the other hand, higher leverage also increases incentives to audit which in turn induces HF to repay more often. The net impact is therefore ambiguous.

The chapter proceeds as follows. Section 1.2 discusses the related literature. Section 1.3 briefly describes the various moral hazard issues in hedge funds followed by a detailed discussion of the issue of fraudulent transfers along with an example. Section 1.4 contains the model. Section 1.5 discusses implications of some post-crisis banking reforms. Section 1.6 concludes.

1.2 Related Literature

This chapter is related to the literature of supply and demand side determinants of hedge fund leverage. Papers studying supply side factors include Brunnermeier and Pedersen (2009) on margin constraints, Dang et al. (2013), Eren (2015), Infante (2019) on collateral quality, default risk and funding liqudity of prime brokers. Papers on demand for leverage link features in compensation contracts such as high water marks and personal stake to risk-taking by hedge fund managers, for instance, Lan et al. (2013), Buraschi et al. (2014) and Drechsler (2014). We add to this literature by examining how prime brokers' liquidity insurance and legal recourse against possible fraudulent actions by hedge funds affect the supply and demand of leverage for hedge funds which have received little attention in the literature.

Our work is also related to the literature on internal governance of hedge funds which has mainly focused on agency issues between managers and investors. Papers have documented funds with weak governance strategically delay performance reporting in public databases, Aragon and Nanda (2017), exhibit smoother observed returns, Cassar and Gerakos (2011), have a higher likelihood of committing legal or regulatory violations in the future, Bollen and Pool (2012), abuse discretionary liquidity restrictions, exhibit performance-based risk shifting, Clifford et al. (2018), misreport performance, Honigsberg (2019), charge lower incentive fee, Cassar and Gerakos (2010), and are more likely to fail, Brown et al. (2012). We show that governance may also matter for funding liquidity from prime brokers and also highlight the idea that it may also impact investment incentives of managers. We also offer a rationalization of the mixed evidence of the impact of leverage on hedge fund survival documented in the literature, for instance, Baba and Goko (2009), Liang and Park (2010) and Lee and Kim (2014).

Internal capital markets of bank holding companies (BHCs) have been shown to be an important source of liquidity for subsidiaries in times of need. Ashcraft (2008) studies two reforms in BHC regulations to show that banks affiliated with multi-bank holding companies are more likely to receive injections of capital when distressed, recover from financial distress more quickly, and are less likely to fail from distress in the next year. Further, the benefit of holding company affiliation comes through access to resources in other bank and non-bank subsidiaries, as well as greater access to external funds through access that the parent has to the public equity market. Correa et al. (2020) study short-term dollar liquidity provision by U.S. GSIBs during periods of increased dollar shortages in FX swap and repo markets. They document "reserve-draining" intermediation as the main mechanism used for providing liquidity. Specifically, excess reserves at the Federal Reserves are channelled to money markets by depository institutions via reverse repos to broker-dealer affiliates.

Caglio et al. (2021) compare shifts in U.S. Treasury holdings and repo trading of BHC affiliated and independent broker-dealers in response to liquidity shocks during the financial crisis. They document flight to liquidity in independent broker-dealers in that share of repo in total liabilities increased while it decreased for the other group. Moreover, consistent with flight to safety, independent broker-dealers increased the share of government securities in the long inventory while BHC-affiliated dealers decreased. The authors attribute these results to BHC-affiliated dealers being less constrained for liquidity due to access to internal capital markets of the parent company. Finally, they also show that parent BHCs provided support to both bank and non-bank subsidiaries in the form of subsidies. Motivated by this literature, we conjecture that adverse shocks to overall fundamentals of a BHC may reduce funding to hedge fund clients of its prime brokerage due to reduced ability to provide liquidity insurance through internal capital markets.

We add to the literature on the impact of post-crisis banking reforms on leverage supply for hedge funds. Boyarchenko et al. (2020) show that supplementary leverage ratio has increased diversification of prime brokers by hedge funds and constrains the ability to GSIB-affiliated prime brokers to supply leverage resulting in limits to arbitrage in basis trades. We argue that post-crisis banking reforms plausibly reduce costs incurred by a BHC in providing liquidity assistance to affiliated prime brokers. As a consequence of such reforms, hedge funds may be less vulnerable to adverse shocks in the banking sector.

Finally, the specific agency problem we study, in legal parlance, fraudulent transfers, has received little attention in the finance literature. Erashin et al. (2021) study the impact of improved creditor rights on entrepreneurial activity using staggered adoption of fraudulent transfer laws in the U.S. They document declines in startup entry, closure of existing firms after law adoption and reduced demand for leverage by entrepreneurs. Heaton (2000) present a theoretical analysis of how fraudulent transfer laws improve debt capacity. In their model, transfer of assets is public knowledge and recovery is costless. Transfers are feasible only if the borrower is left solvent to repay debts. In contrast, in our model, borrower is privately informed about the value of assets transferred. Creditor has the option to conduct costly state verification post default and successful recovery of fraudulent transfers depend on the verifiability of manager's actions and value of assets. Thus, our model is also related to costly state verification models of Townsend (1979) and Gale and Hellwig (1985). While these papers derive the optimality of debt contracts, we take as given the (secured) debt contract and consider the possibility of strategic default by the borrower.

1.3 Moral Hazard in Hedge Funds

Moral hazard in hedge funds can be broadly divided according to the primary stakeholder affected by it - investors, creditors or other participants in the financial system. Table 1.1 highlights some examples under each of these buckets. This list was compiled using Castle Hall (2009), Baker and Filbeck (2017) and observations from SEC examinations of private funds.[5] Fraudulent transfers has been added by the author.

For instance, by concealing losses or deviating from the advertised strategy, a fund can impact the overall risk-return profile of an investor's portfolio. Inflated net asset value will lead to higher fees charges. Inadequate risk management can not only impact a fund's performance but also other participants in the overall financial system. Cassar and Gerakos (2016) find that funds that used formal models of portfolio risks such as VaR, stress testing or scenario analysis fared relatively better during the financial crisis. Jorion (2000) argues the failure of LTCM was a failure of risk management at the fund. Employees at hedge funds may gain material, nonpublic information through interactions with corporate insiders or "expert-network" firms. This information can be used for personal gain at the expense of fund's investors.[6] In this chapter, however, we study the issue of fraudulent transfers that primarily affects creditors of a firm in general and has received little attention in the literature. The following section describes the concept, related regulations and a recent high profile case involving the now bankrupt asset manager Highland Capital Management and investment bank UBS Securities.

Fraudulent Transfers

Borrowers may transfer assets to third parties for personal gain, especially during financial distress to avoid debt payments. Absent explicit restrictions in a debt contract on transferees to be a party to transfers, creditors have no recourse to recover such fraudulent transfers from transferees to satisfy their claims in the event of borrower bankruptcy. A complete debt

[5] See Observations from Examinations of Investment Advisers Managing Private Funds, 2020.

[6] Even when investors benefit, illegal insider trading can lead to enforcement actions for violation of rule 10b-5 under the Exchange Act.

contract would require to establish acceptable (or unacceptable) transfers in every future state of world, anticipating all possible third parties. Since such a contract is infeasible to negotiate, fraudulent transfer laws offer a solution to this incompleteness by establishing a set of transfers that can be recovered from transferees in certain states of the world, Heaton (2000).

Section 548 of the Bankruptcy Code and Uniform Fraudulent Transfers Act (UFTA) or its 2014 amended version Uniform Voidable Transactions Act (UVTA) adopted by all but two states provide remedies to creditors against such transfers. Erashin et al. (2021) provide a history and overview of fraudulent transfer laws in the U.S.[7] Specifically, under the Bankruptcy Code, a transfer can be avoided if it can be shown that,

(a) it was done either with an "actual intent" to hinder, delay or defraud creditors or,

(b) if the transferor received less than "reasonably equivalent value" in exchange

Some additional requirements for the second case include if the transferor was insolvent at the date of transfer, became insolvent as a result of the transfer or whether the transfer was for the benefit of an insider. Proving actual intent can be difficult so courts consider a number of factors such as if the transferee is an insider, the transferor retains control or possession of assets after transfer, the transfer was disclosed or concealed, substantially all assets were transferred etc.[8] Differences exist between the Bankruptcy Code and UVTA such as the latter differentiating between creditors whose claims arose before or after the transfer in question, "look-back" periods etc. For instance, the Bankruptcy code considers transfers up to two years before the date of bankruptcy filing while UVTA allows for up to four years. States may adopt look-back periods different from that prescribed in the UVTA. Additionally, the Bankruptcy Code allows for state laws to be invoked if the trustee believes creditors would benefit. Finally, a transferee can refute avoidance claims if she can prove that she acted in "good-faith". As in the case with the actual intent of fraud, "good-faith" is also not defined in the laws. However, a lack of "good-faith" can be established if, for example, the transferee knew or had a reason to believe the transfers are fraudulent.

Highland Capital vs UBS

In this section, we briefly discuss a recent lawsuit between the now bankrupt asset manager Highland Capital Management (Highland Capital) and investment bank UBS Securities that involved fraudulent transfer claims among others - fraud, breach of contract, tortious interference, general partner liability, and alter ego liability, by UBS against Highland Capital and its affiliated entities. UBS secured an award of over a billion dollars in 2020 for breach of contract claims. A default judgement was granted against Highland entities on fraud, fraudulent transfers and alter ego liability for failure to appear in a pre-trial conference in

[7] Table 1 therein documents the staggered adoption of UFTA by states from 1980 to 2006. We provide updated information on the adoption of UFTA or UVTA from the website of Uniform Law Commission.

[8] See 11 U.S. Code § 548 - Fraudulent transfers and obligations and Uniform Voidable Transactions Act.

2021.[9] In what follows, we describe the origin of dispute and fraudulent transfer claims by UBS while referring the interested reader to the case texts referred for this section for a detailed description of events and other claims.[10, 11]

Figure 1.1 shows the timeline of the lawsuit. UBS Securities and UBS AG, London Branch (collectively UBS) restructured a series of agreements with Highland Capital in March 2008 involving securitization of certain corporate loan obligations (CLOs) and reference obligations of credit default swaps (CDSs) with UBS acting as the arranger responsible for financing and and warehousing assets and Highland acting as the servicer. The restructured agreements stipulated that Highland Special Opportunities Holding Company (SOHC) and Highland CDO Opportunity Master Fund (CDO Fund), collectively "Fund Counterparties" (FCs), bear 100% of CDS losses at an agreed upon closing date. FCs were also required to transfer additional $10 million in cash or eligible securities in the event UBS' exposure exceeded $1 billion. The FCs satisfied two margin calls in September and October 2008 respectively but failed to satisfy a third margin call in November 2008 following which UBS terminated the agreements, auctioned the warehoused assets and asserted a claim of approximately $687 million.

Figure 1.2 describes UBS' allegations regarding fraudulent transfers by Highland Capital. We note that case documents in the public domain do not reveal all the details of UBS' claims. Nonetheless, the limited information available serves as an illustration of possible fraudulent transfers by a debtor.

The entity at the center of UBS' claims was Highland Financial (HiFin) that allegedly owned and/or controlled the FCs and other funds - Credit Strategies, Crusader and Credit Opportunities, collectively, "Affiliated Transferee Defendants" (ATDs). UBS alleged that after the first margin call, Highland entities started commingling assets to generate short-term liquidity for the FCs. Specifically, in September and October 2008, HiFin issued approximately $371 million in senior secured notes to ATDs in exchange for CLOs and Life settlement insurance contracts ($321 million in September 2008; amount undisclosed for October 2008). HiFin also transferred its security interest in shares of two wholly owned subsidiaries who were the ultimate receivers of above assets. Cash flows from these assets were used to pay SOHC's debt held by Barclays bank. UBS alleged that actions of HiFin as alter ego of SOHC eroded the ability of FCs to meet their obligations to UBS who was owed "hundreds of millions of dollars" at the time and was insolvent or within the zone of insolvency at the time of these events thus making above transfers fraudulent. [12]

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[9]See Judgement on breach of contract and Default judgement on other claims.

[10]Second Amended Complaint 2011, Motion for Summary Judgement 2017 and Judgement 2019.

[11]We also note that at the time of the dispute, New York - the relevant jurisdiction, was governed by the Uniform Fraudulent Conveyance Act (UFCA) adopted nearly 100 years ago and UVTA was adopted recently in 2019. Fundamental principles are the same as discussed in the previous section but the UVTA closely aligns New York fraudulent transfer laws with the Bankruptcy Code and other states. See "New York Adopts Uniform Voidable Transactions Act" for a discussion on notable changes.

[12]Alter Ego: Legal doctrine whereby the court finds a corporation lacks a separate identity from an individual or corporate shareholder, resulting in injustice to the corporation's debtors. Finding alter ego

Further, according to UBS, by March 2009 HiFin transferred all of its and SOHC's assets worth $239 million to Highland Capital (investment manager of HiFin) and ATDs and terminated the Fall 2008 Note offerings to hide fraudulent transfers. As a result, HiFin and SOHC were insolvent and incapable of satisfying their obligations to UBS. Highland sought dismissal of above claims by arguing that the termination was in relation to repayment of antecedent secured debt to "non-insiders" which was necessitated by a deterioration in the quality of CLOs received earlier that made it unlikely for HiFin to fulfill its obligations under the notes and life settlement contracts it had acquired. The court at that time dismissed this argument, ordered a jury trial in May 2018 and as mentioned earlier, eventually granted default judgement against Highland entities for failure to appear in a pre-trial conference in 2021. This example illustrates how financially distressed funds may engage in complex transactions with affiliates to avoid repayment of their debt. We now turn to a model that aims to capture these strategic actions in the simplest manner.

1.4 Model

The economy has three dates, $t = 0, 1, 2$ and consists of three types of risk-neutral agents - cash-constrained hedge fund (HF), cash-constrained prime broker (PB) and cash-rich investor. One-period risk-free rate is normalized to zero. We think of HF as a client of the PB seeking financing for investment in risky assets which we describe below. The PB has access to a cash-rich investor - money market fund (MMF) who is seeking to invest excess cash available with her. The role of MMF, as we shall describe below, is to generate costs for the PB if the manager defaults. All agents aim to maximize their wealth at the end of date 2.

Hedge Fund. The HF seeks funding for a risky assets valued at $t = 1$ either at $R > 1$ with probability $q \in (0, 1)$ or zero otherwise. We assume the investing in these assets is a positive NPV decision, i.e., $qR > 1$. The value is privately observed which we interpret that an "active" market for these assets doesn't exist which provides significant discretion to the manager over their valuation. Although cash-constrained, the HF owns one unit of a pledgeable asset that pays $\tilde{v} \sim \varphi(\cdot)$ at $t = 1$, $\tilde{v} \in [0, \overline{v}]$, and $\mu_0 \equiv E[\tilde{v}] \equiv 1$ is the market price of the asset at $t = 0$. We assume $\tilde{v}$ is publicly observable and that $\tilde{v}$, $\tilde{R}$ are uncorrelated.

Prime Broker. The role of PB is to provide financing to her client as needed. She is also cash-constrained, does not own any pledgeable asset but has access to a cash-rich MMF. However, contrary to the HF, we assume the PB is committed to repayment if she borrows from MMF. [13] If the client defaults, she can use the liquidity generated by the haircut charged to the client, if any, and borrow the rest at a rate $r_e > 1$. For instance, she

gives the court cause to pierce the corporate veil and hold individual shareholders personally liable for debts of the corporation.

[13] We do not explicitly model social benefits of intermediation over direct trade between HFs and MMFs. A possible explanation could be that MMFs are averse to take HFs as direct counterparty given the latter's opaque nature, Stein (2013).

can use any additional (unmodeled) internal liquidity if available or borrow externally. The cost r_e can then be interpreted as a combination of the opportunity cost of other productive opportunities and cost of external borrowing. For simplicity, we do not explicitly model the level of internal liquidity or an external borrowing market at date 1 and assume if there is any external borrowing, the PB has sufficient liquidity at $t = 2$ to repay. Upon repayment to MMF, collateral payoff is seized by the PB. This is akin to the exemption from automatic stay enjoyed in practice by qualified financial contracts such as repurchase agreements. Further, she has the option to audit the client's pre-default operations under the supervision of a court. The audit costs and technology are described in detail shortly below.

Money Market Fund. MMF seeks to store her excess cash C. If not lending to the PB, she can earn a gross return of $f \geqslant 1$ per-period. We assume MMF charges a fixed haircut $h \,\epsilon\, [0, 1)$ on the market value of asset at $t = 0$, and is cash-unconstrained, i.e., $C > L \equiv \mu_0(1 - h)$ where L is the amount lent to the PB.

Figure 1.3 describes the flow of funds and collateral in a typical matched-book repo at the purchase and repurchase date. At $t = 0$, the PB enters into a reverse repurchase agreement with her client promising funds B secured by $x_h \equiv 1$ units of collateral. The transaction grants her the right to rehypothecate (reuse) the asset at any time during the term of the repo . She then raises the required amount by entering into a repurchase agreement with the MMF, receiving funds $L \geqslant B$ and pledging x_h, i.e., all of the asset received from the client. The degree of pass-through of funds or the haircut is under the discretion of the PB so any difference $L - B$ is a source of liquidity. At the repurchase date, conditional on no defaults, the client repurchases the asset by paying a price D, the PB uses these funds to repurchase the asset from the MMF by paying Lf who transfers the asset back to the PB who transfers it back to the client. In the process, the PB earns an intermediation profit $D - Lf \geqslant 0$.[14]

Figures 1.4 - 1.6 show the sequence of events at the dates $t = 0, 1, 2$ respectively.

Financing and investment. At $t = 0$, the HF request funding from the PB by pledging collateral. The PB makes a take-it-or-leave-it offer (B, D) of lending and repayment amounts respectively. If the HF rejects the offer, she holds the collateral till the next date. However, if she accepts the offer, the PB enters into a repurchase agreement (L, Lf) with the MMF. Funds promised are transferred to the HF while the haircut $L - B$ is stored by the PB earning a gross return of one per-period. Finally, upon receipt of funds, the HF invests in unpledgeable risky assets.

Repayment. At $t = 1$, collateral payoff $\tilde{v}$ is revealed publicly and the HF observes the value of unpledged risky assets $\tilde{R}$ privately. On the one hand, HF can sell these assets and use PB for trade settlement which reveals the true value to the PB. We show later that in this case, HF always repays conditional on success since the PB will be able to costlessly prove fraud on part of the manager if she has unsecured claims outstanding. The threat in

[14] We assume full rehypothecation to keep the model simple. In general, amount of asset not rehypothecated may also be useful to the PB for her business operations or regulatory requirements. For example, she can lend to another client seeking to cover a short position, a process known as internalization, or to settle her own cash-asset market transaction, or if eligible, to be counted as HQLA in the liquidity coverage ratio requirement. We do not model a richer picture of prime broker operations.

turn incentivizes HF to repay. On the other hand, HF can transfer these assets to an affiliate who in turn can sell these assets to realize the gain. We assume affiliate transactions are not observable to the PB in real-time. Since the transfer implies HF has no assets other than collateral to repay PB, this situation is akin to strategic default if the true value of transferred assets is R and PB has unsecured claims outstanding. As explained earlier, in the event of HF default, PB seizes asset payoff and borrows an amount $E(B) = Lf - (L - B)$ at the rate r_e. Note that the collateral payoff does not enter the borrowing amount. We interpret this as an exogenously specified preference of the PB to not use collateral for liquidity but hold it as compensation for losses. This allows us to focus on the effects of liquidity insurance and considerably simplifies the analysis.[15]

Audit. If HF has defaulted at $t = 1$ and payoff from collateral is insufficient to cover the promised repayment amount, i.e., $\tilde{v} < D$, the PB has the option to conduct a court-supervised costly audit at $t = 2$ to detect any malfeasance by HF and in that event attempt recovery of her claims. The decision to audit will be based on her beliefs $\pi \epsilon [0, 1]$ about the true value of unpledgeable assets which are determined by HF equilibrium strategy to default. The costs of audit (pecuniary and non-pecuniary) are proportional to the total leverage of HF, $\hat{\alpha}D$. We assume the PB has sufficient resources to cover such costs. Since compared to mutual funds, hedge funds are unregulated in the amount leverage they can employ, effectively allowing them to pursue complex and opaque investment strategies, we posit that higher leverage raises the cost of audit. We now describe the audit technology. Audit can be imperfect in the sense that if true $\tilde{R} = R$, it is recovered from the affiliate with probability $p \epsilon (0, 1]$ while not recovered with probability $1 - p$. In other words, with probability p, the PB is able to detect, prove and avoid fraudulent transfer. On the other hand, if true $\tilde{R} = 0$, there is nothing to recover which the audit reveals perfectly. That is, there are no false positives. It will be convenient to work with effective audit costs $\alpha \equiv \frac{\hat{\alpha}}{p} \epsilon (0, 1)$.

As explained earlier, establishing a successful fraudulent transfer claim under the Bankruptcy Code or state laws requires either proving an "actual intent" to defraud or that the transferor did not receive a "reasonably equivalent value" in exchange for the transfer in question along with establishing either insolvency of transferor at the time of transfer, due to the transfer or the transfer was for the benefit of an insider. Thus, mechanisms that improve verifiability of managerial actions and valuation of portfolio can be expected to reduce the effective cost of audit. Some examples include independent service providers such as auditors, counsellors, board of directors certifying transfers, and supporting internal valuations with valuations from one or more independent third party sources. Valuation is also likely to be a challenge for level 2 and level 3 assets under the fair value hierarchy so a

[15]Including a decision on optimal choice of liquidity sources post-default would require explicitly modeling the market for collateral. Market liquidity may determine unsecured claims outstanding and thus PB incentives to audit. We leave this more realistic extension for future work.

higher fraction of these assets can be expected to increase effective costs of audit.[16,17]

Finally, to complete the description of the model, post-audit payoff for HF are as described below.

$$\text{Post-audit HF payoff} = \begin{cases} 0, & \text{if audit concludes fraud} \\ \tilde{R}B + \max\{\tilde{v} - D,\, 0\}, & \text{otherwise} \end{cases}$$

HF receives nothing if the creditor is successful in establishing a fraudulent transfer claim when $\tilde{R} = R$ while gets away with the unpledgable payoff and if positive, the difference between the value of asset and the debt owed at date 1 if the audit concludes $\tilde{R} = 0$. This is because creditors are entitled to collateral payoff up to the extent of their total claim D.

(I1.1) and (I1.2) below list parameter assumptions made in the model.

$$R > 1,\ q \,\epsilon \left(\frac{1}{R},\, 1\right],\ p \,\epsilon\, (0,\, 1],\ h \,\epsilon\, [0,\, 1),\ f \,\epsilon\, [1,\, \overline{r}),\ \frac{\hat{\alpha}}{p} \equiv \alpha \,\epsilon\, (0,\, 1), \tag{I1.1}$$

$$\overline{r} \int_{\overline{r}L}^{\overline{v}} \varphi(v)dv - 1 \geqslant 0 \quad \text{where, } \overline{r} = pR \tag{I1.2}$$

Assumptions (I1.1) are feasibility restrictions on the parameters. Assumption (I1.2) ensures net marginal benefit of the PB at maximum HF leverage is strictly positive. This allows us to focus our discussion solely on the impact of cost of HF default on PB incentives to supply leverage.

First-Best

This section considers the first-best case when the HF is committed to use the settlement services of PB to sell risky assets. In this case, the HF does not engage in any fraudulent actions. We do not solve this problem explicitly but note it since it will be useful for comparison with the second-best case of lack of commitment.

[16]FASB Topic 820 and IFRS 13 classify assets or liabilities into three categories based on inputs utilized for valuation - Level 1: Quoted prices (unadjusted) in active markets for identical assets or liabilities; Level 2: Other than quoted prices included within Level 1 that are observable for the asset or liability, either directly or indirectly; Level 3: Unobservable inputs, such as any assumptions used to determine the fair value of the asset or liability. Fair value is defined as the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date.

[17]SEC Form D contains data on funds' board members. Investor due-diligence reports contain data on funds' valuation practices. Form-PF Question 14 asks funds to disclose the dollar amount of Level 1, 2 and 3 assets and liabilities, separately. Question 48 in the same form asks for information on the percentage of funds' net asset value subject to a side pocket arrangement.

$$\max_{B,\,D} V_F(B,\,D) \qquad \text{s.t.} \qquad (B,\,D)\,\epsilon\,\mathcal{F}, \qquad H_F(B,\,D) \geqslant \mu_0 \quad \text{where,}$$

$$V_F(B,\,D) = \int_D^{\overline{v}} (D - E(B))\varphi(v)dv + \int_0^D (q(D - E(B)) + (1-q)(v - r_e E(B))\varphi(v)dv,$$

$$= \int_D^{\overline{v}} (D - E(B))\varphi(v)dv + \int_0^D (v - r_e(E(B))\varphi(v)dv + q\int_0^D (D - v + (r_e - 1)E(B))\varphi(v)dv$$

$$H_F(B,\,D) = \mu_0 + qRB - \left[D + (1-q)\int_0^D (v - D)\varphi(v)dv)\right],$$

$$\mathcal{F} = \{(B,\,D)\,|\,0 \leqslant B \leqslant L,\, B \leqslant D \leqslant \overline{r}B,\, Lf \leqslant D\}, \text{ and } \overline{r} = pR \leqslant R$$

The PB earns the haircut $L - B$ and the intermediation profit $D - Lf$ when $\tilde{v} \geqslant D$ since either type of HF has sufficient resources to repay the debt. However, if $\tilde{v} < D$, repayment occurs only when the strategy has succeeded while the PB incurs the cost of liquidity insurance to repay MMF and seizes the asset payoff otherwise. Since it is common knowledge that the HF is committed to repay, there is no need to consider a decision to audit upon default. $\mathcal{F}$ represents the set of feasible contracts. The lending amount B cannot be more than what PB has raised from the MMF. She charges a non-negative net interest rate. The constraint $D \leqslant \overline{r}B$ sets the maximum interest rate that can be charged to the client. Strictly speaking, we can relax this constraint to $D \leqslant RB$. However, we show in the second-best case that the analysis is simplified with the former constraint so we maintain it throughout the chapter. Finally, the PB must earn a non-negative intermediation profit.

The optimal contract must also incentivize the HF to participate in the contract. Over and above the expected payoff of the asset, the HF earns an expected payoff qRB from the strategy less expected payment. Expected payment is the promised amount D net of savings $D - \tilde{v}$ upon default due to strategy failure and insufficient resources to repay, i.e., $\tilde{v} < D$.

Second-Best

We solve the second-best case when HF may transfer risky assets to affiliate using the standard backward induction method. The following section characterizes the equilibrium default and audit strategy at dates 1 and 2.

Equilibrium Default and Audit Strategy

Let $u \equiv u(\tilde{R},\, \tilde{v})$ denote HF strategy to default, i.e.,

$$u(\tilde{R},\, \tilde{v}) = \begin{cases} 1, & \text{if default} \\ 0, & \text{if repay} \end{cases}$$

Denote $\pi = \text{Prob}(\tilde{R} = R \,|\, \text{Default}, \tilde{v},\, u)$. Lemma 1 characterizes the optimal decision to audit $t = 2$ given HF default and $\tilde{v} < D$.

Lemma 1.1. Suppose HF defaults and $\tilde{v} < D$. There is no incentive to audit if $\pi \leqslant \alpha$. On the other hand, if $\pi > \alpha$, the PB audits the client iff $\tilde{v} < d_c(\pi) \equiv D\left(1 - \frac{\alpha}{\pi}\right)$ while she is indifferent between audit and no audit at $\tilde{v} = d_c(\pi)$.

Proof. See Appendix A1.1.

The intuition is simple. PB strictly prefers audit when given her beliefs, the incremental net expected payoff is strictly positive. If PB's belief about high valuation is low, i.e., $\pi \leqslant \alpha$, audit is a negative NPV decision. On the other hand, if her belief is sufficiently high, i.e., $\pi > \alpha$, she audits only when the payoff from collateral is sufficiently low (or unsecured claims are sufficiently high). This is because audit is costly. Indeed, if audit was costless, i.e., $\alpha = 0$, she would always audit when there are positive unsecured claims. Proposition 1.1 characterizes the Perfect Bayesian Equilibrium (PBE) of default and audit strategies of HF and PB respectively.

Proposition 1.1. Equilibrium default and audit strategies for the HF and PB respectively are as follows.

(i) Suppose the option to audit is (a) not available or, (b) available but $\alpha \geqslant q$.

$$u(\tilde{R},\, \tilde{v}) = \begin{cases} 1, & \text{if } \tilde{v} < D \\ 0, & \text{if } \tilde{v} \geqslant D \end{cases} \quad \forall\, \tilde{R} = \{0,\, R\}$$

(ii) Suppose $\alpha < q$, and $D \leqslant \overline{r}B$ where, $\overline{r} = pR$.

$$u(\tilde{R},\, \tilde{v}) = \begin{cases} 1, \quad \text{if } (\tilde{v} < D \,\&\, \tilde{R} = 0) \text{ or } (\tilde{v} \,\epsilon\, (d_c(q),\, D) \,\&\, \tilde{R} = R) \\ \begin{cases} 1 \text{ with prob. } \gamma, \\ 0 \text{ with prob. } 1 - \gamma, \end{cases} , \quad \text{if } \tilde{v} \,\epsilon\, [0,\, d_c(q)] \,\&\, \tilde{R} = R \\ 0, \quad \text{if } \tilde{v} \geqslant D \,\&\, \tilde{R} = \{0,\, R\} \end{cases}$$

Conditional on default, audit is not conducted by PB when $\tilde{v} \epsilon (d_c(q), D)$ while conducted with probability $\Lambda(\tilde{v}, B, D)$ when $\tilde{v} \epsilon [0, d_c(q)]$ where,

$$\gamma \equiv \Gamma(\tilde{v}, D) = \left(\frac{1-q}{q}\right)\left(\frac{\pi(\tilde{v}, D)}{1-\pi(\tilde{v}, D)}\right), \qquad \pi(\tilde{v}, D) = \frac{\alpha D}{D-\tilde{v}}$$
$$\Lambda(\tilde{v}, B, D) = \frac{D-\tilde{v}}{\overline{r}B}$$

Proof. See Appendix A1.2.

Proposition 1.1 shows that strategic default occurs only when the PB will have some positive unsecured claims outstanding post-default, irrespective of the possibility of an audit mechanism. This is because (i) when the option to audit is not available, HF is indifferent between repaying or default. In this case, we assume he repays, and (ii) if the option to audit is credible, repayment is a weakly dominant strategy when payoff from collateral is sufficient to cover the repayment amount, i.e., $\tilde{v} \geqslant D$ since the decision entails a wealth gain of $\tilde{v} - D$ for the HF. A pooling PBE exists for default strategy when effective costs of audit are sufficiently high to render the threat not credible or the option to audit is not available. When $\tilde{v} < D$, "low-type" HF has no other option than to default while for the "high-type", repayment entails a loss in wealth which can be avoided by defaulting since default is costless.

Now suppose the threat of audit is credible, i.e., $\alpha < q$, and $D \leqslant \overline{r}B$. Absent the latter restriction, default will be a strictly dominant strategy for the high-type client in the range $\tilde{v} \epsilon [0, D - \overline{r}B)$ and in general, incentives to audit will also depend on the initial loan amount B. This considerably complicates the analysis. Economically, the constraint implies as long as the repayment amount is not too high, HF strictly prefers to repay if he anticipates an audit upon default.

As before, the "low-type" has no other option than to default when $\tilde{v} < D$. A pooling equilibrium of defaulting exists when $\tilde{v} \epsilon [d_c(q), D)$ since the strategy implies $\pi = q$ and by Lemma 1.1 unsecured claims are not high enough to incentivize audit. However, in contrast to the case of audit threat not credible, a pure-strategy pooling or separating equilibrium cannot exist when $\tilde{v} \epsilon [0, d_c(q))$. Indeed, a pooling equilibrium would imply $\pi = q$ and incentivize the PB to audit by Lemma 1.1. Anticipating this, the "high-type" HF prefers deviating to repayment. However, a separating equilibrium will imply $\pi = 0$ so the PB does not audit. Anticipating this, the "high-type" HF prefers deviation to defaulting. Hence, the only possible PBE is one with "high-type" HF following a mixed-strategy. Moreover, the mixed-strategy must also make PB indifferent between requesting audit or not. If in contrast, the mixed-strategy were such that the implied belief entails a pure-strategy for PB, the "high-type" HF will prefer following a pure-strategy as well. Again, this follows from the restriction $D \leqslant \overline{r}B$.

Note that, if payoff from investment opportunity were observable to the PB, for instance either because there is an active market or the HF utilized her trading and settlement services, then fraudulent transfers could be costlessly proven and the proposition shows that the high-type HF always repays PB in equilibrium, i.e., $\gamma = 0$ and first-best is achieved.

The next corollary describes comparative statics for the probability of default, conditional on success, and the total ex-ante probability of default which is the sum of probability of strategic default and the probability of balance sheet default. For brevity, we shall use d_c as a shorthand for $d_c(q)$.

Corollary 1.1. Suppose the threat of audit is credible, i.e., $\alpha < q$.

(i) When $\tilde{v} \,\epsilon\, (0,\, d_c)$, we have, $\partial\gamma/\partial\alpha > 0,\ \partial\gamma/\partial q < 0$ and $\partial\gamma/\partial D < 0$

(ii) Denote $\mathcal{P}_d$ as the ex-ante probability of default. We have, $\partial\mathcal{P}_d/\partial q < 0$, $\partial\mathcal{P}_d/\partial\alpha > 0$ while $\partial\mathcal{P}_d/\partial D$ is ambiguous.

Proof. See Appendix A1.2.1.

Corollary 1.1 highlights the impact of effective audit costs, ex-ante probability of success (or failure) and debt burden on the probability of repayment, conditional on success, when collateral is in the least valuable range, i.e., $\tilde{v} \,\epsilon\, (0,\, d_c)$. In this region, PB must be indifferent to audit, i.e., expected net payoff from audit is zero, $\pi - \frac{\alpha D}{D-\tilde{v}} = 0$ where, $\pi = \frac{q\gamma}{1-q+q\gamma}$. First, as effective audit costs α increases (audit costs $\hat{\alpha}$ increases or the probability of a successful audit p decreases), strategic default is more likely. Since PB is disincentivized to audit, expected benefit from audit needs to increase to satisfy the indifference condition. This occurs when the high-type client defaults with a higher probability, increasing the belief that the client is of high-type. Second, "high-quality" funds in the sense of higher ex-ante probability of success represent a lower risk of strategic default. This is because, equilibrium belief π is higher when the fund is more likely to succeed ex-ante so she has higher incentives to audit. Thus, for her to be indifferent to audit, the probability of repayment must increase. Third, if debt burden increases, the HF is less likely to default strategically. This is because for a given belief π that the client is of high-type, an increase in debt burden increases incentives to audit. Thus, to induce the PB to be indifferent between audit and no audit, the client is forced to follow a strategy where she repays with higher probability leading to a downward adjustment in equilibrium belief π.

Combining these results, the second part of the corollary implies that the probability of default is decreasing in ex-ante likelihood of success which is intuitive. Probability of default is increasing in effective audit costs. This follows directly from Part (i) because α impacts only the strategic default component of the overall probability of default which is increasing in α. Thus, difficulties in establishing a successful fraudulent transfer claim are synonymous with the risk of fraud. However, the impact of debt burden D is ambiguous. On the one hand, increasing debt burden increases the likelihood that the PB will have unsecured claims outstanding thus exposing her to HF default. On the other hand, by Part (i), HF is induced to repay more often in the region $\tilde{v} \,\epsilon\, (0,\, d_c)$ so the net impact is ambiguous. These results are consistent with some findings in the literature on hedge fund survival as we explain below.

Brown et al. (2012) utilize internal governance disclosures in investor due-diligence reports for hedge funds to develop a measure of operational risk, the ω-score. They find that funds with high ω-score and therefore high operational risk are more likely to fail.

Operational risk is high when fund auditor is less reputable and fund uses day-to-day internal accounting. These characteristics by arguably decreasing the verifiability of managerial actions and portfolio value can increase incentives to strategically default by fraudulently transferring assets leading to a higher observed probability of fund failure, consistent with the above discussion. The model also predicts funds with a higher fraction of hard-to-value unencumbered assets are more likely to fail. To the best of our knowledge, this relationship remains unexplored presumably due to lack of data on portfolio composition of hedge funds.

Literature on hedge fund survival has documented mixed evidence on the impact of leverage on the likelihood of fund failure. For instance, Baba and Goko (2009), Liang and Park (2010) report an insignificant relationship between leverage and fund survival while Lee and Kim (2014) report a significant negative relationship. Our model suggests a possible reconciliation of these disparate results. Generally speaking, probability of default is the sum of probability of strategic default and probability of balance sheet default. While higher debt increases the likelihood of PB being unsecured thus exposing her to HF default risk, her incentives to scrutinize pre-bankruptcy affairs of the client also increase that in turn reduce incentives for strategic default. Indeed, if the option to audit were not available or the threat were not credible as in Lemma 2(a), the model would imply higher likelihood of default at higher debt. We now turn to characterizing the optimal debt contract at date 0.

Optimal Contract at $t = 0$

Proposition 1.1 allows us to partition the parameter space $\theta \equiv (\alpha,\, q) \,\epsilon\, \Theta \equiv (0,\, 1) \times (\frac{1}{R},\, 1)$ into two disjoint sets - $\mathcal{C} = \{\theta \,\epsilon\, \mathcal{C} \,|\, \alpha < q\}$ where the threat of audit is credible, and $\Theta \backslash \mathcal{C} = \{\theta \,\epsilon\, \Theta \,|\, \alpha \geqslant q\}$ where the threat is not credible, as shown in Figure 1.7(a). It is easy to show that for a given contract $(B,\, D)$ and probability of success q, $V_F > V_S(\theta \,\epsilon\, \mathcal{C}) > V_S(\theta \,\epsilon\, \Theta\backslash\mathcal{C})$ and $H_F < H_S(\theta \,\epsilon\, \mathcal{C}) < H_S(\theta \,\epsilon\, \Theta\backslash\mathcal{C})$ where, V_S, H_S are PB and HF payoffs in the second-best case respectively. This provides a rationale for creditor rights in bankruptcy, specifically, that allows them to investigate and recover fraudulent transfers. Since we are mainly concerned with the implications of effective audit costs, in what follows, we solve only for the general second-best case when the threat of audit is credible, i.e., $\theta \,\epsilon\, \mathcal{C}$. Solution for $\theta \,\epsilon\, \Theta\backslash\mathcal{C}$ can be deduced by substituting $\alpha = q$.

For a given $\theta \,\epsilon\, \mathcal{C}$, we can write the optimization problem for the PB,

$$\max_{(B,\, D)} V_S(B,\, D) \quad \text{s.t.} \quad (B,\, D) \,\epsilon\, \mathcal{F}, \quad H_S(B,\, D) \geqslant \mu_0$$

Payoff functions $V_S(B,\, D)$ and $H_S(B,\, D)$ for the PB and HF are as follows,

$$\begin{aligned} V_S(B,\, D) &= \int_D^{\bar{v}} (D - E(B))\varphi(v)dv + \int_0^D (v - r_e E(B))\varphi(v)dv + \int_0^{d_c} q(1-\gamma)(D - v + (r_e - 1)E(B))\varphi(v)dv \\ &= V_F(B,\, D) - \underbrace{\left[\int_{d_c}^{D} q(D - v + (r_e - 1)E(B))\varphi(v)dv + \int_0^{d_c} q\gamma(D - v + (r_e - 1)E(B))\varphi(v)dv \right]}_{\text{Expected Loss due to Strategic Default} \equiv \mathcal{L}} \end{aligned} \tag{1.1}$$

$$\begin{aligned} H_S(B,\, D) &= \mu_0 + qRB - \left[D + (1-q)\int_0^D (v - D)\varphi(v)dv + q\int_{d_c}^D (v - D)\varphi(v)dv \right] \\ &= H_F(B,\, D) + \underbrace{q\int_{d_c}^D (D - v)\varphi(v)dv}_{\substack{\text{Expected Gain due to} \\ \text{Strategic Default}}} \end{aligned}$$

Compared to first-best, payoff for PB differs due to expected loss incurred from strategic default, $\mathcal{L}$. This occurs with certainty when $\tilde{v} \,\epsilon\, [d_c,\, D)$ or with probability $\gamma < 1$ when $\tilde{v} \,\epsilon\, [0,\, d_c)$. The loss is the difference between the repayment amount owed and the value of collateral seized plus the interest costs of liquidity insurance. It is easy to see that expected loss is increasing in effective audit costs α. The manager saves an additional $D - \tilde{v}$ in the range $\tilde{v} \,\epsilon\, [d_c,\, D)$ by avoiding repayment when the strategy succeeds at $t = 1$. Moreover, this gain is higher in expectation if effective audit costs are higher.

We focus on equilibrium where $B^* > 0$ and show in the proof of Proposition 2 below that whenever $D^* < \bar{r}B^*$ holds in equilibrium, the HF is indifferent between accepting the contract or rejecting it, i.e., the participation binds. Further, we will also restrict our attention where PB earns strictly positive intermediation profit if HF repays, i.e., $D^* > Lf$.

It is useful to partition the set $\mathcal{C}$ into five disjoint sets as shown in Figure 1.7(b) as defined below.

$$\begin{aligned} &C_1 = \{\theta \,\epsilon\, \mathcal{C} \mid q \,\epsilon\, [\frac{\bar{r}}{R},\, 1)\}, && C_2 = \{\theta \,\epsilon\, \mathcal{C} \mid q \,\epsilon\, [\bar{q},\, \frac{\bar{r}}{R})\} \\ &C_3 = \{\theta \,\epsilon\, \mathcal{C} \mid q \,\epsilon\, (\underline{q},\, \bar{q}),\, \alpha \,\epsilon\, [t(q),\, q)\}, && C_4 = \{\theta \,\epsilon\, \mathcal{C} \mid q \,\epsilon\, (\underline{q},\, \bar{q}),\, \alpha \,\epsilon\, (0,\, t(q))\} \\ &C_5 = \{\theta \,\epsilon\, \mathcal{C} \mid q \,\epsilon\, (\frac{1}{R},\, \underline{q}]\} \end{aligned} \tag{1.2}$$

where, $\underline{q}$, $\bar{q}$ are given by equations (A1.5.2”) and (A1.5.2’) respectively, and $t(q)$ solves the equation $H_S(L,\, \bar{r}L;\, q,\, \alpha = t(q)) = \mu_0$ for $q \,\epsilon\, (\underline{q},\, \bar{q})$. We will also assume that client default is costly in equilibrium, i.e., (I1.3) holds.

$$\frac{\partial^2 V_S^*}{\partial r_e \partial B} + \overline{r}\frac{\partial^2 V_S^*}{\partial r_e \partial D} < 0 \tag{I1.3}$$

Equation (I1.3) represents the change in net marginal benefit of PB due to ceteris paribus increase in costs of liquidity insurance which we assume to be negative. In other words, client default is costly. To get some intuition of the main results, it useful to rearrange the participation constraint of HF as follows,

$$qRB \geqslant D + \int_0^D (v - D)\varphi(v)dv - q\int_0^{d_c} (v - D)\varphi(v)dv \tag{1.3}$$

The LHS is the expected benefit of investing in the strategy consisting of the return on success. The RHS of equation (1.3) is the expected repayment. A loss is incurred due to repayment when collateral is in the least valuable range, i.e., $\tilde{v} \epsilon [0, d_c]$. The RHS is increasing in D and decreasing in α/q, effective audit costs normalized by the probability of success. Thus, for a given contract (B, D) and probability of success q, HF achieves maximum payoff with $\alpha \geqslant q$ (no threat of audit upon default) while minimum payoff is attained in the first-best case with $\alpha = 0$ (always audit upon default).

Let $a^* = 1$ if $H_S(B^*, D^*) > \mu_0$, zero otherwise.

Proposition 1.2. Suppose client default is costly in equilibrium, i.e., (I1.3) holds. In an equilibrium with $B^* > 0$ and $D^* < \overline{r}B^*$ it must be that $a^* = 0$. Further,

(a) Suppose $\theta \epsilon C_5$. For any $r_e \geqslant 1$, $B^* \leqslant L$, $D^* < \overline{r}B^*$

(b) Suppose $\theta \epsilon C_4$. For any $r_e \geqslant 1$, either (i) $B^* = L$, $D^* < \overline{r}B^*$ or, (ii) $B^* < L$ and $D^* \leqslant \overline{r}B^*$. Moreover, there exists $\theta \epsilon C_4$ such that $B^* < L$, $D^* < \overline{r}B^*$

Proof. See Appendix A1.3.

Part (a) establishes that when $\theta \epsilon C_5$, the probability of success is so low, the participation constraint will be violated for any contract $(B^*, \overline{r}B^*)$, even if the threat of audit were not credible (the maximum possible HF payoff). In this case, the final outcome is that the fund is indifferent to the investment opportunity.

Part (b) highlights the impact of effective costs of audit on the optimal contract. When $\theta \epsilon C_4$, in an equilibrium with PB lending the maximum amount possible L, some interest must be forgone, i.e., $D^* < \overline{r}L$. The intuition is that equation (1.3) shows two factors govern the expected payoff from strategic default - the probability of success q and the level of effective audit costs relative to the probability of success, i.e., α/q. While the former has increased compared to the case of $\theta \epsilon C_5$, effective audit costs are still "too low" for a given likelihood of success. The net impact is that levering up to the maximum and paying maximum interest is not attractive enough for the client. In this sense, option to defraud is out-of-money under the contract $(B^*, D^*) = (L, \overline{r}L)$. The result implies that the only way HF strictly prefers to invest in this region is to reduce leverage, i.e., $B^* < L$. Moreover, some funds are indifferent even with a lower leverage.

This result raises an interesting question for the setting with agency issues between managers and investors which our model abstracts from. Papers have documented documented evidence on better governance mitigating agency costs between fund managers and investors. Clifford et al. (2018) study the market for independent directors for hedge funds who help set internal controls, appoint auditors and other service providers, approve valuation of illiquid assets etc. They find that funds with reputable directors are less likely to commit fraud, abuse discretionary liquidity restrictions or engage in performance-based risk-shifting. Honigsberg (2019) argues that hedge funds reduced misreporting following registration with the SEC and this was due to funds hiring or switching auditors. If part of attractiveness to invest in profitable opportunities comes from the possibility of misappropriating their payoff and strong governance reduces such ill-gotten gains, then it plausibly reduces incentives to invest in the first place. If this were true, investors may be willing to pay higher fee to restore incentives. This is consistent with Cassar and Gerakos (2010) finding a significant positive relationship between internal governance and incentive fee. However, they posit better internal governance reduces agency costs which allows managers to charge higher performance fee because investors become more willing to rely on reported performance. Our model suggests an alternative channel may also be at work though a rigorous analysis of this possibility requires a different model which we leave for future work.

The next set of results link cost of liquidity insurance with supply of leverage.

Proposition 1.3. Suppose client default is costly in equilibrium, i.e., (I1.3) holds. If $\theta \,\epsilon\, C_1$, $D^* = \overline{r}B^*$ and $a^* = 1$. Further, for $\theta \,\epsilon \bigcup_{j=1}^{3} C_j$, define $int(\bigcup_{j=1}^{3} C_j) \equiv \bigcup_{j=1}^{3} C_j \backslash \{(t(q), q)\}$. There exists $\overline{r}_e(\theta) > 1$ such that,

(i) If $r_e \leqslant \overline{r}_e(\theta)$, $(B^*, D^*) = (L, \overline{r}L)$. Moreover, $a^* = 1$ for $\theta \,\epsilon\, int(\bigcup_{j=1}^{3} C_j)$ while, $a^* = 0$ for $\theta \,\epsilon \{(t(q), q)\}$

(ii) If $r_e > \overline{r}_e(\theta)$, then $B^* < L$

Proof. See Appendix A1.3.

When $\theta \,\epsilon \bigcup_{j=1}^{3} C_j$, internal governance or portfolio valuation are no longer a binding concern at maximum leverage. That is, the participation constraint for the client at the contract $(B, D) = (L, \overline{r}L)$ is non-binding even if threat of audit is always credible ($\alpha = 0$). A stronger statement can be made for $\theta \,\epsilon\, C_1$. Here, the probability of success is so high that participation constraint is non-binding for any initial lending amount B. The primary concern now is the cost of liquidity insurance for PB. As long as $r_e \leqslant \overline{r}_e(\theta)$, the PB optimally supplies maximum possible leverage. Conversely, if $r_e > \overline{r}_e(\theta)$, then conditional on participation, the PB reduces the supply of leverage by charging a positive haircut. However, we are not able to characterize the participation decision in closed-form for this case. Thus, $\overline{r}_e(\theta)$ can be interpreted as a client specific "haircut hurdle rate" (HHR). The PB receives liquidity through intermediation only if cost of liquidity insurance is above the hurdle rate. Note that the HHR equals one for all $\theta \,\epsilon\, C_4$. How does the HHR vary with fund characteristics effective costs of audit and probability of success for $\theta \,\epsilon \bigcup\limits_{j=1}^{3} C_j$? Lemma 1.2 provides an answer for this question which is useful to generalize Proposition 1.3 to all types of funds.

Lemma 1.2. Assuming (I1.3) and (I1.4) in equilibrium, we have, $\partial \overline{r}_e/\partial \alpha < 0$ and $\partial \overline{r}_e/\partial q > 0$.

$$\begin{aligned} \frac{\partial^2 V_S^*}{\partial \alpha \partial B} + \overline{r}\frac{\partial^2 V_S^*}{\partial \alpha \partial D} < 0 \\ \frac{\partial^2 V_S^*}{\partial q \partial B} + \overline{r}\frac{\partial^2 V_S^*}{\partial q \partial D} > 0 \end{aligned} \tag{I1.4}$$

Proof. See Appendix A1.4.

Recall from Corollary 1.1 that higher likelihood of failure and higher effective costs of audit are synonymous with higher overall default risk and fraud risk respectively. Assumption (I1.4) implies all else equal, the net marginal benefit for the PB in an equilibrium with client participation is decreasing in effective audit costs and likelihood of failure. Thus, in this sense, lending to funds with higher risk of default and fraud is costly. Consequently, the HHR is lower for these clients. This result allows us to generalize Proposition 1.3 to all funds in $\bigcup\limits_{j=1}^{3} C_j$ for a given r_e.

Proposition 1.4. Suppose $\theta \,\epsilon \bigcup\limits_{j=1}^{3} C_j$ and (I1.3), (I1.4) holds. Denote $\overline{r}_e^{\,s}(q) = \lim\limits_{\alpha \to 0^+} \overline{r}_e(q,\, \alpha)$ and $\overline{r}_e^{\,i} = \lim\limits_{\alpha \to q} \overline{r}_e(q,\, \alpha)$. Define $q' \,\epsilon\, (\underline{q},\, 1)$ as $r_e = \overline{r}_e^{\,s}(q')$.

(a) q' exists as long as $r_e \,\epsilon\, (\overline{r}_e^{\,s}(\underline{q}),\, \overline{r}_e^{\,s}(1))$ and $dq'/dr_e > 0$

(b) Let q'' be defined as below. For $q \,\epsilon\, (q'',\, 1)$, there exists a unique $\overline{\alpha}(q) \,\epsilon\, (0,\, q)$ such that $r_e = \overline{r}_e(q,\, \overline{\alpha}(q))$. Moreover, $d\overline{\alpha}/dq > 0$

$$q'' = \begin{cases} \underline{q}, & \text{if } r_e \,\epsilon\, (\overline{r}_e^{\,i},\, \overline{r}_e^{\,s}(\underline{q})] \\ q', & \text{if } r_e \,\epsilon\, (\overline{r}_e^{\,s}(\underline{q}),\, \overline{r}_e^{\,s}(1)) \end{cases}$$

(c) For $r_e \,\epsilon\, (\overline{r}_e^{\,i},\, \overline{r}_e^{\,s}(1))$, define $\widehat{C}(r_e) = (\bigcup\limits_{j=1}^{3} C_j) \bigcap \{q \,\epsilon\, (q'',\, 1),\, \alpha \,\epsilon\, (0,\, \overline{\alpha}(q)]\}$ and $\check{C}(r_e) = \bigcup\limits_{j=1}^{3} C_j \backslash \widehat{C}(r_e)$

(i) $r_e \,\epsilon\, (1,\, \overline{r}_e^i]$ implies $(B^*,\, D^*) = (L,\, \overline{r}L)$ and $a^* = 1$ for all $\theta \,\epsilon\, \bigcup_{j=1}^{3} C_j$

(ii) $r_e \,\epsilon\, (\overline{r}_e^i,\, \overline{r}_e^s(1))$ implies $(B^*,\, D^*) = (L,\, \overline{r}L)$ and $a^* = 1$ for $\theta \,\epsilon\, \widehat{C}(r_e)$ while $B^* < L$ for $\theta \,\epsilon\, \check{C}(r_e)$. Further, for any $r_{e,l},\, r_{e,h} \,\epsilon\, (\overline{r}_e^i,\, \overline{r}_e^s(1))$ such that $r_{e,h} > r_{e,l}$, $\widehat{C}(r_{e,h}) \subset \widehat{C}(r_{e,l})$.

(iii) $r_e \geqslant \overline{r}_e^s(1)$ implies $B^* < L$ for all $\theta \,\epsilon\, \bigcup_{j=1}^{3} C_j$

Proof. See Appendix A1.5.

Proposition 1.4 shows that when cost of liquidity insurance is lowest as in Part (c)(i), the PB supplies maximum leverage to any fund in the region $\bigcup_{j=1}^{3} C_j$. At the other extreme in Part (c)(iii), when the cost is quite high, any fund that borrows is charged a positive haircut. In the intermediate range in Part (c)(ii), the model suggests cross-sectional variation in haircuts. Funds that represent relatively lower default and fraud risks ($\theta \,\epsilon\, \widehat{C}(r_e)$) may enjoy zero haircut while the rest experience a positive haircut. Put differently, a PB with a high cost of liquidity insurance ($> \overline{r}_e^i$) is likely to tap "low-quality" funds in the sense of higher risk of default or risk of fraud ($\theta \,\epsilon\, \check{C}(r_e)$) for liquidity resulting in a decline in their credit supply. Moreover, as the cost of insurance increases, an increasing proportion of funds gets tapped. Figure 1.8 illustrates this result graphically. It is possible that funds who are likely to get tapped do not participate in the first place. Corollary 1.2 shows that conditional on participation, haircut is larger for funds with higher default and fraud risks, and increases as cost of liquidity increases further.

Corollary 1.2. Suppose (I1.3) and (I1.4) hold in equilibrium. Conditional on participation, $dB^*/d\alpha < 0$, $dB^*/dq > 0$ and $dB^*/dr_e < 0$ for *(a)* $\theta \,\epsilon\, C_4$ and *(b)* $\theta \,\epsilon\, \check{C}(r_e)$

Proof. See Appendix A1.5.1.

Proposition 1.4 and Corollary 1.2 together predict that funds with relatively better governance and easy-to-value portfolios should experience a lower decline in credit supply when cost of liquidity insurance rises above the HHR. A consistent finding in the literature is that funds with higher portfolio illiquidity fare worse during market stress, see for instance, Schaub and Schmid (2013), Getmansky et al. (2015). This can be explained using Brunnermeier and Pedersen (2009) in that since illiquid assets are more vulnerable to fire-sales than liquid assets, margin constraints are more binding for these assets. Funds cut such relatively "funding-intensive" positions more since they want to maximize their profit per dollar of margin. However, this explanation focuses only on the characteristics of encumbered part of portfolios.

In our model, the prime broker provides a secured loan which can be used to fund other investments. Absent an explicit lien on these investments, the lender is exposed to the risk of borrower misappropriating such assets during financial distress. In this case, ease of recovery which depends crucially on the verifiability of "intent" and "value" of transferred assets matters for funding liquidity. Figure 1.9 compares the various channels through which portfolio composition of a hedge fund can affect funding liquidity. In Panel (a), margin requirements are the driving force as in Brunnermeier and Pedersen (2009) which in turn depend on the illiquidity of underlying collateral. Fundamental volatility determines illiquidity. Panel (b) is motivated by the model in Dang et al. (2013). Investments like in our model are financed via repo. However, strategic defaults are not allowed. In the event of default, collateral can be pledged to a sophisticated investor who can produce information about collateral. Thus, illiquidity of collateral depends on its "information sensitivity". This in turn affects the terms of repo borrowing for the hedge fund.

Panel (c) illustrates our model in that we argue the part of overall portfolio not pledged may also matter for funding liquidity, in particular, its ease of valuation since that determines the risk of fraud embedded in the portfolio. Thus, our model provides a channel for funding liquidity distinct from channels previously studied in the literature which can provide an additional explanation for why funds with illiquid portfolios fare worse than other funds in times of stress.

Can assets held in margin account be fraudulently transferred?[18] SEC Rule 15c3-3 provides contractual rights to broker-dealers in margin accounts of customers in that securities with a market value of up to 140% of the total debit balance of a customer are subject to a lien and may be pledged or loaned by the broker to others to assist in financing the loans made to the customer. Further, withdrawal is permitted only if margin requirements are satisfied and the withdrawal does not create or increase a margin deficiency.[19] However, suppose that a customer is better informed than the broker about future movements of collateral held in margin accounts. He may then have an incentive to transfer securities in cash account and excess margin securities to the extent a margin deficiency is not created in anticipation of adverse movements in collateral value. We leave this interesting possibility for future work.

Our model may also partly explain the finding in Clifford et al. (2018) that among the funds that put discretionary liquidity restrictions (DLRs) such as gates and side pockets during the financial crisis, better governing funds fared better after DLRs were enforced. Specifically, funds with independent directors experienced a rebound in performance by the end of fourth quarter of establishing DLRs as opposed to funds with inside-only boards. Moreover, they outperformed by a significant 2.02% per quarter over the two years following DLRs. They suggest an explanation that independent directors are better monitors which reduces any potential abuse of DLRs by managers. Our model suggests that the better performance could partly be due to better access to funding liquidity leading to reduced fire-sales.

[18] Assets held in margin account can include cash, securities purchased on margin, securities fully paid for - not pledged or pledged to support the purchase of other securities on the margin, and securities that have no loan value for margin purposes. See 17 CFR § 240.15c3-3 - Customer protection - reserves and custody of securities and Fully Paid Securities.

[19] See 12 CFR § 220.4 - Margin account. and Excess Margin Securities.

The model also offers a competing hypothesis for some of the determinants of hedge fund leverage documented in the existing empirical literature. In addition, it also suggests an identification strategy to distinguish between the possible explanations. We begin by formulating our hypothesis followed by a discussion of existing empirical results.

In general, cost of liquidity insurance should be a function of both cost of external borrowing and internal liquidity. Cost of external borrowing can be thought of as the sum of risk-free rate and a spread capturing credit risk of the borrower. Hence, we can expect overall fundamentals of the prime broker to be an important determinant of the cost of liquidity insurance. While the prime brokerage industry is populated with prime brokers affiliated with bank holding companies (BHCs) and those functioning as independent entities, industry reports suggest that top 10 global banks have an estimated prime brokerage market share of 90% by number of clients.[20] Such entities have access to internal capital markets of the parent organization which can facilitate distribution of funds from affiliated entities utilizing either internal liquidity or their access to the federal funds market and the discount window. Therefore, overall fundamentals of BHCs connected to hedge funds via their prime brokerages can have explanatory power for cross-sectional variation in changes in hedge fund leverage. We call this the internal capital markets channel. Existing literature has documented internal capital markets of bank holding companies as a source of strength for subsidiaries, see for example, Ashcraft (2008), Correa et al. (2020) and Caglio et al. (2021).

Note that this channel is distinct from various other channels discussed in the literature. In Brunnermeier and Pedersen (2009) deleveraging by hedge funds in response to wealth shocks increases volatility that in turn leads to contagion via margin and loss spirals. Dang et al. (2013) model a chain of repurchase agreements where haircuts in an initial repo are linked to haircuts in a subsequent repo transaction through "information sensitivity" of collateral and liquidity needs and default risk of the initial lender. In Eren (2015) and Infante (2019) dealer banks obtain funding liquidity via repo intermediation. Their default risk and demand for liquidity jointly determines haircuts and repo rate charged to hedge fund clients. Finally, Lan et al. (2013), Drecshler (2014), Buraschi et al. (2014) link managerial compensation with their demand for leverage. In contrast, internal capital markets channel focuses on shocks to the ability of a parent organization to provide insurance to its prime brokerage in the event of a liquidity shock either due to clients' default or withdrawal of funding liquidity.

Ang et al. (2011) find that increases in funding costs of major commercial and investment banks, as measured by market-value-weighted CDS spreads, along with expected borrowing costs, as measured by the term spread predict decreases in monthly hedge fund leverage. They offer a demand side explanation in that the banks pass on their funding costs to hedge funds who optimally decide the amount of leverage employed. However, this is also consistent with the internal capital markets channel. To test for supply side effects, our model suggests exploiting cross-sectional variation in the impact across hedge funds. Specifically, Corollary 1.2 predicts funds with weak governance or higher fraction of unencumbered hard-to-value

[20]Bankers Love Hedge Funds for a Very Good Reason.

assets should experience larger declines in borrowing.

While systematic factors affecting the banking industry may affect hedge fund leverage, our model suggest that adverse idiosyncratic shocks to BHC fundamentals may also spillover to hedge funds connected via its prime brokerage operations. A recent study Kruttli et al. (2019) documents evidence that is consistent with this hypothesis. They utilize an adverse idiosyncratic shock to Deutsche Bank to study its impact on leverage obtained by hedge fund clients. The bank posted a loss of $6.5 billion in the third quarter of 2015 stemming from investment and retail banking divisions and expected settlement of a lawsuit by the U.S. Department of Justice.[21] As a result, five-year senior debt CDS spread spiked and remained elevated until 2016 as seen in Figure 1.10. They estimate a 10% reduction in credit supply by Deutsche bank to hedge fund clients. To distinguish between a supply based or demand based explanation, they show that reduction is lower for funds with a higher fraction of rehypothecable collateral since such funds can be expected to be able to switch to a different prime broker easier than others. This could be consistent with a shock to funding liquidity of the prime broker.

A test for whether the reduction may also be due to a shock to the ability of BHC to insure against client defaults is to exploit cross-sectional variation in funds' future prospects, governance and ease of valuation of clients' unencumbered assets. This is because our model suggests that these characteristics are directly related to probability of default and therefore the likelihood of prime broker requiring assistance.

1.5 Post-Crisis Banking Reforms

Having presented the model and evidence in support for it, in this section we discuss post-crisis regulatory developments that may have direct implications for hedge fund leverage. The Bank of International Standards (BIS) introduced a set of reforms in the bank regulatory framework in 2010, collectively known as Basel III reforms, with the aim to make banking system more resilient following the financial crisis.[22] Some example are improved bank capital requirements, minimum leverage ratio and liquidity coverage ratio. Additional reforms adopted by the Federal Reserve (Fed) focused on systemically important banks (SIBs) include stress tests and resolution planning. Extensive literature exists on costs of these regulations on real economy and financial markets, and whether the reforms have worked as intended. A review of this literature is outside the scope of this chapter. However, we highlight the work most relevant for us and discuss the implications of our model.

[21]Deutsche Bank Sees Big Loss on Write-Down in Corporate Banking.

[22]See Basel III: A global regulatory framework for more resilient banks and banking systems - revised version June 2011.

Leverage Constraints

Supplementary leverage ratio (SLR) implemented by the U.S. as part of minimum leverage ratio requirement under Basel III requires banks to hold a required minimum of tier-1 capital against a measure of total leverage exposure intended to account for on-balance sheet assets and off-balance sheet exposures such as derivatives and repo transactions.[23] Boyarchenko et al. (2020) argue that the SLR by increasing capital requirement has introduced limits to arbitrage in basis trades in fixed-income and FX markets where banks either historically participated or supplied leverage to hedge funds acting as arbitrageurs. This effect can be easily incorporated into our model by requiring that $B \leqslant \overline{L}(\lambda) \leqslant L$ where, $\overline{L}(\lambda)$ is the maximum amount that can be lent to hedge funds which is strictly decreasing in minimum capital ratio required, $\lambda \,\epsilon\, (0,\, 1)$. The primary impact of this in our model is on the HHR. It is easy to show that HHR increases in λ. The intuition is reduced lending implies improved internal liquidity from haircuts resulting in reduced liquidity assistance in the event of client default. Thus, assuming $r_e \leqslant \overline{r}_e^i(\lambda)$, i.e., cost of liquidity insurance is not a binding constraint, increasing capital requirement on prime brokers, on the one hand, reduces funding to hedge funds while on the other hand, also reduces the susceptibility of hedge funds to increases in costs of liquidity insurance. In other words, safer banks imply safer hedge funds.

Liquidity Insurance

To reduce liquidity risk in banks, Basel III reforms require them to maintain liquid assets consisting mainly of reserves, U.S. Treasuries and government-backed securities to cover estimated net cash outflows in a hypothetical 30-day stress scenario.[24] Figure 1.11 Panel (a) shows that globally systemically important banks (G-SIBs) have maintained liquidity coverage ratios well above the regulatory minimum of 100%. However, supervisors and banks may have higher internal limits. Panel (b) shows an alternative indicator of liquidity position of banks in the U.S. published by the IMF as one of the core indicators of financial soundness - ratio of liquid assets to short-term liabilities. It shows that banks maintained liquid assets to cover almost all of their short-term liabilities in 2017. The coverage declined for the next two years but stood at more than 180% in 2020 likely driven by central bank support in response to the Covid-19 pandemic.

Furthermore, in July 2021, the Fed established a Standing Repo Facility (SRF) to serve as a backstop in money markets to support the effective implementation and transmission of monetary policy and smooth market functioning.[25] With this facility, primary dealers (and certain depository institutions in the future) can monetize their high quality liquid assets such as U.S. Treasuries, agency debt and agency mortgage-backed securities by entering into a repo agreement with the Fed in times of liquidity needs thus avoid potentially steep discounts from open market liquidation. Potential benefits include increased control over the

[23] See Supplementary Leverage Ratio (SLR), Davis Polk for details.

[24] See U.S. Basel III Liquidity Coverage Ratio Final Rule, Davis Polk for details.

[25] FAQs: Standing Repo Facility.

federal funds rate, a liquidity backstop in times of stress and reducing demand for reserves held as part of liquidity regulations. Potential costs include moral hazard by incentivizing eligible participants to take excessive liquidity risk.[26]

Arguably, both reforms have reduced the cost of liquidity insurance for prime brokers. Assuming again, that cost of liquidity insurance was not a binding constraint prior to these reforms, our model suggests reduced susceptibility of hedge funds to adverse shocks to BHC fundamentals. Figure 1.12 summarizes the joint impact of SLR, LCR and SRF.

1.6 Conclusion

This chapter introduces two novel elements in a simple model of hedge fund secured borrowing via repurchase agreements - the possibility of fraudulent transfers by hedge fund and liquidity insurance for the prime broker. Our model highlights how governance and unpledged part of the portfolio of hedge funds may matter for demand of leverage and funding liquidity respectively. We offer two directions for future work - (i) the impact of governance on investment incentives in a setting with agency issues between managers and investors and (ii) the possibility of fraudulent transfers driven by superior information of the manager on future movements in value of collateral. Further, motivated by the literature on internal capital markets of bank holding companies, we provide a testable hypothesis for a link between fundamentals of bank holding companies and credit supply of connected hedge funds which has hitherto been unexplored in the literature. Finally, the literature on the impact of post-crisis banking reforms have generally focused on possible costs for real economy and financial markets in the form of reduced intermediation. Our model highlights that post-crisis banking reforms intended to make banks safer may also result in hedge funds less vulnerable to adverse shocks in the banking sector - a benefit yet to be recognized in the literature.

[26] See Minutes of the Federal Open Market Committee, October 29-30, 2019.

Figures

Figure 1.1: Timeline of Highland Capital vs. UBS

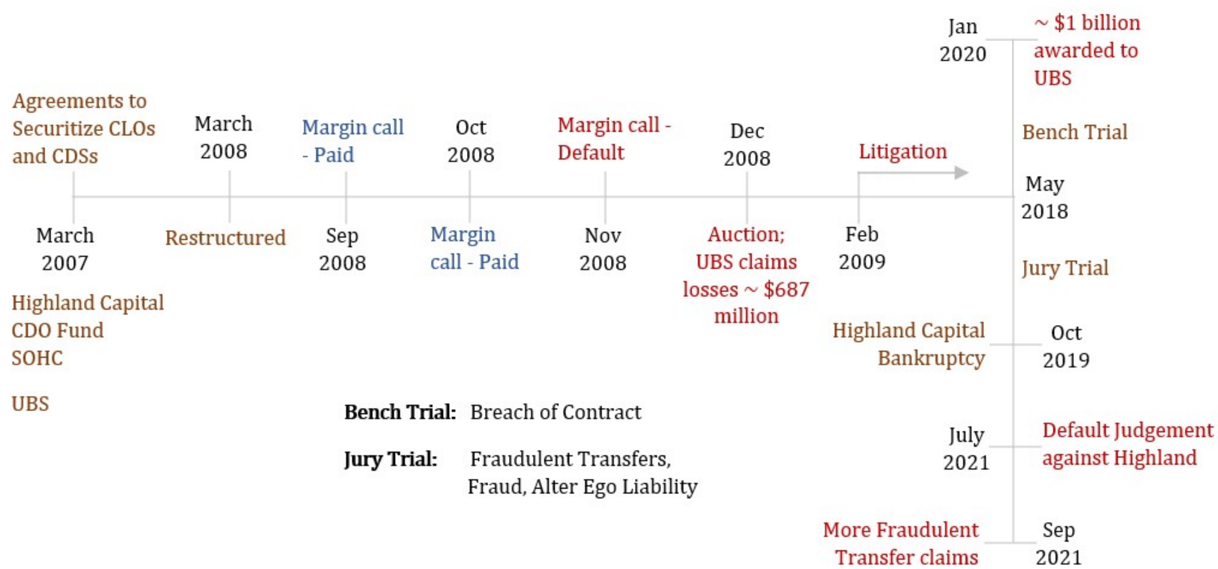


Figure 1.2: UBS' allegations of fraudulent transfers against Highland Capital and affiliated entities.

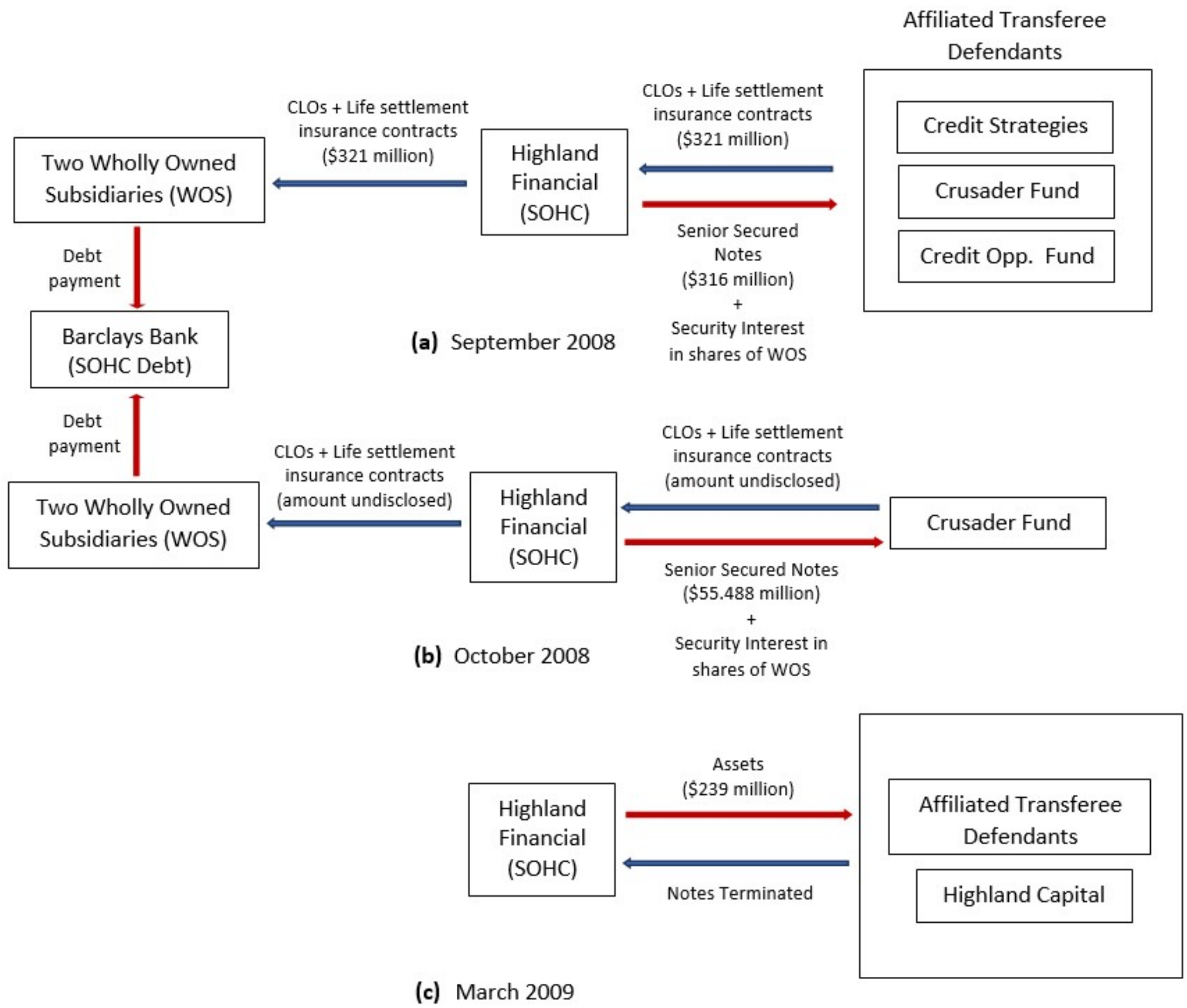


Figure 1.3: Flow of funds and collateral in a matched-book repo (a) $t = 0$ (b) $t = 1$, conditional on no defaults

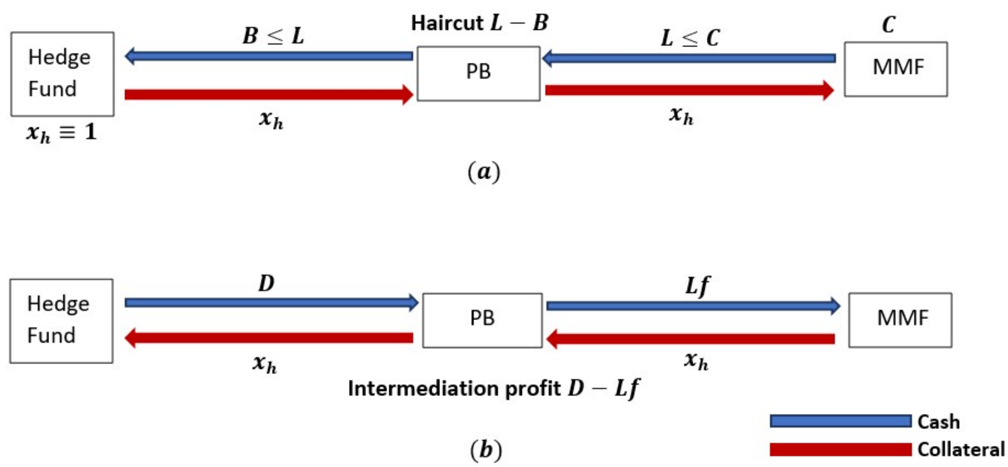


Figure 1.4: Sequence of events at $t = 0$

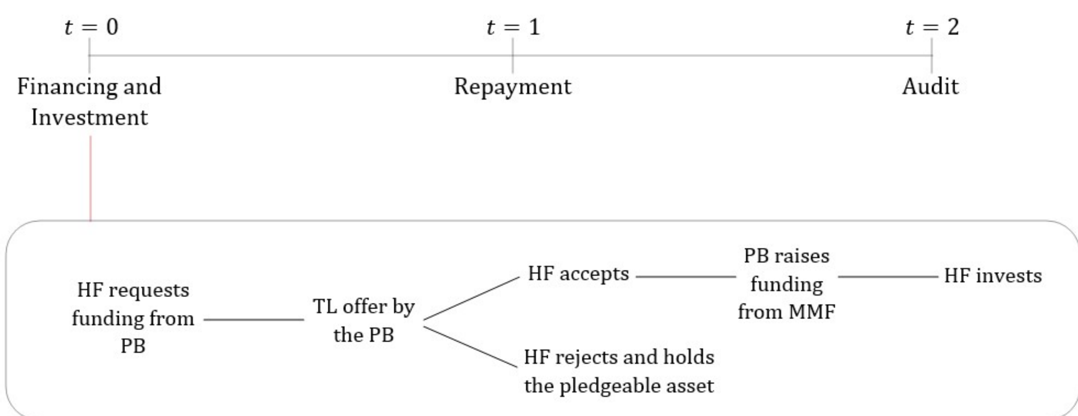


Figure 1.5: Sequence of events at $t = 1$

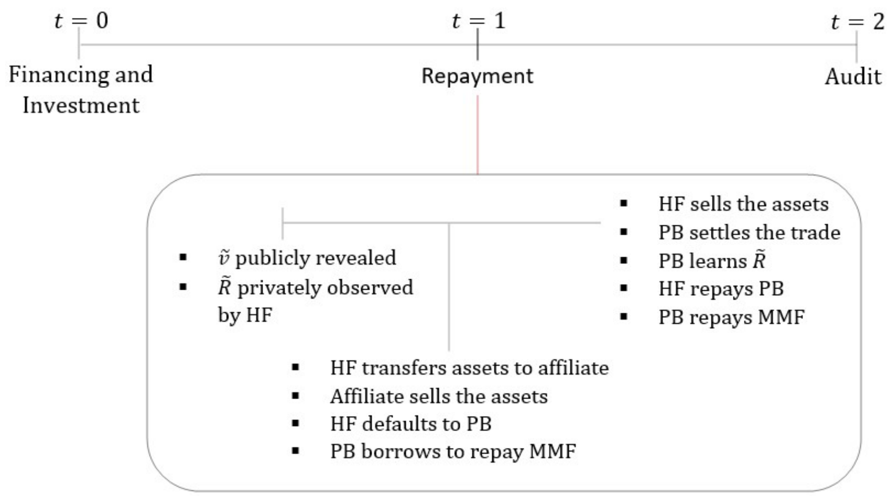


Figure 1.6: Sequence of events at $t = 2$. $\pi = \text{Prob.}(\tilde{R} = R \,|\, \text{Default}, \tilde{v}, u)$ where, u is HF equilibrium strategy for defaulting

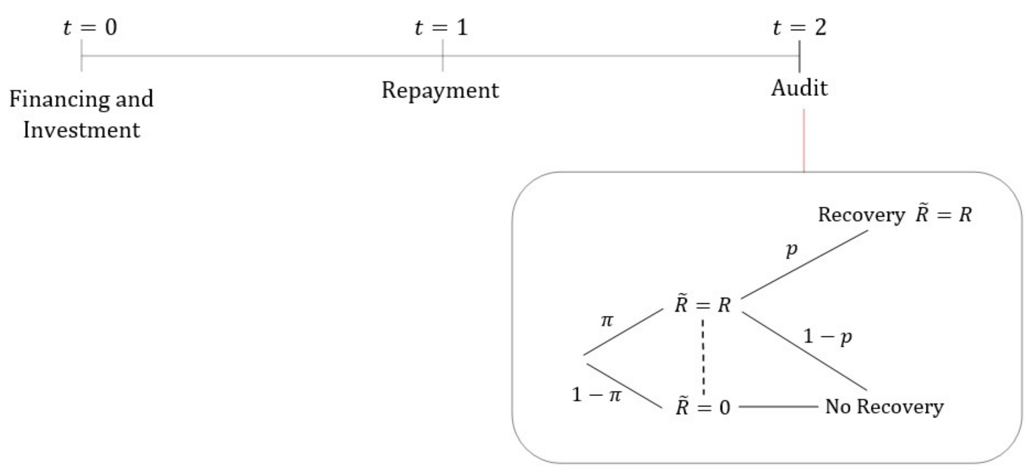
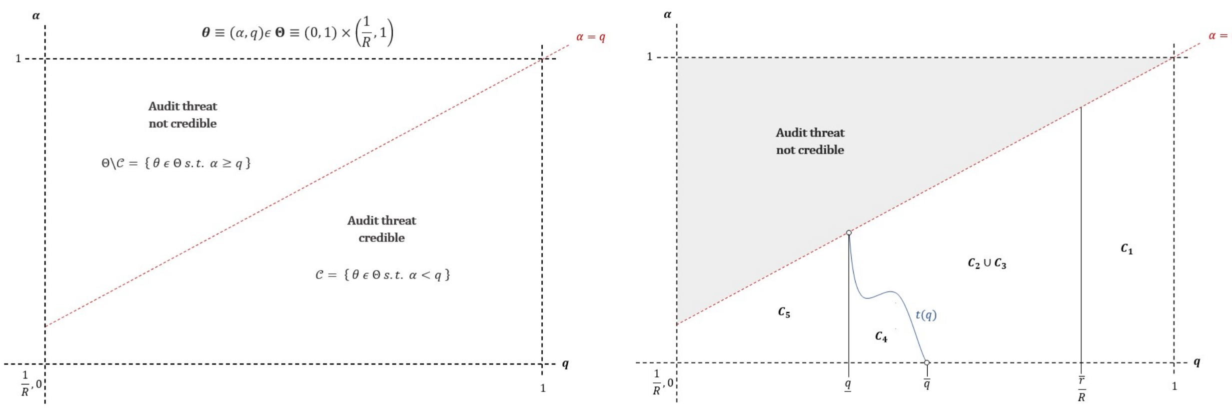
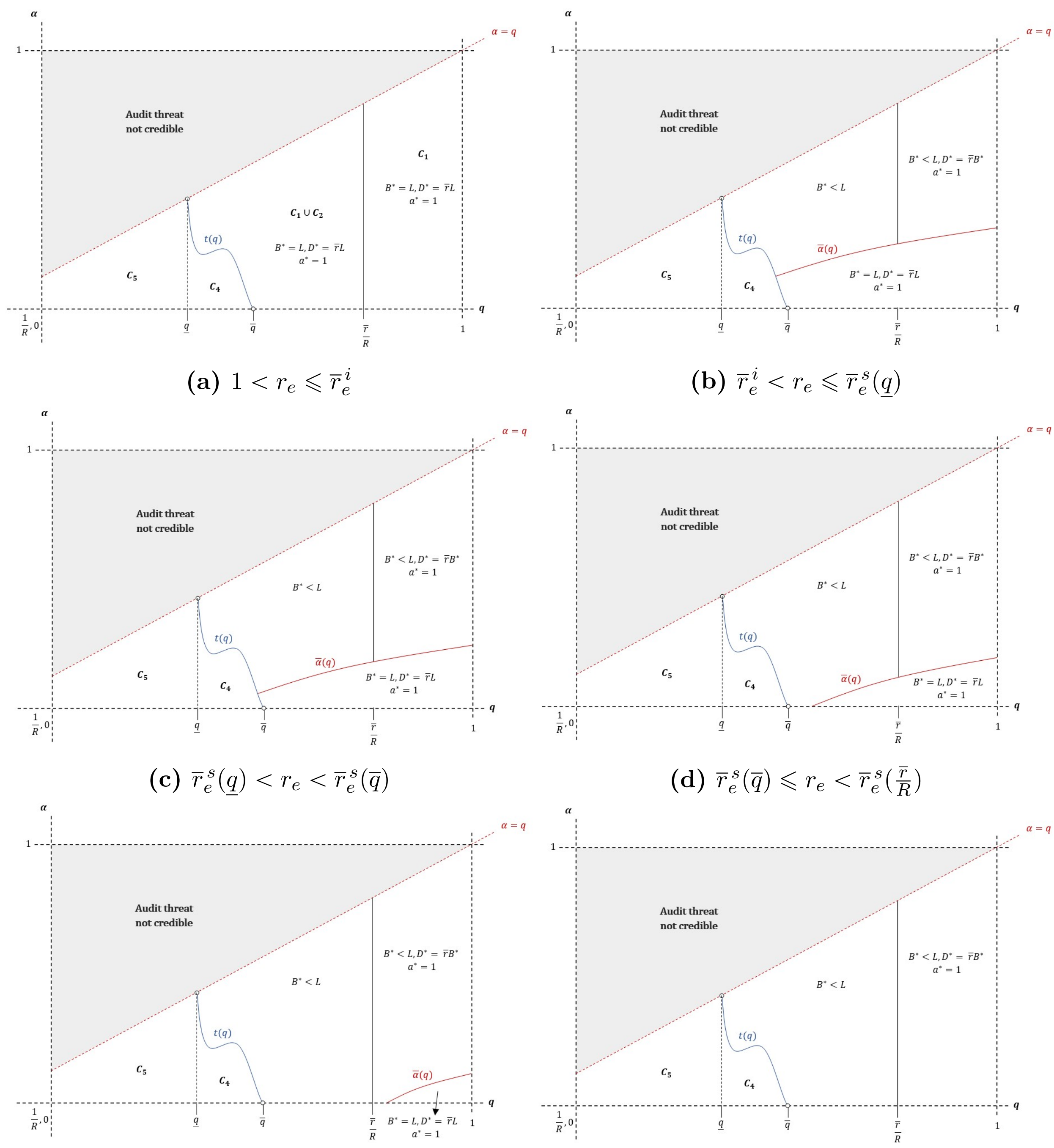


Figure 1.7: Parameter Space Partitions



(a) **(b)**

Figure 1.8: Equilibrium when the threat of audit is credible, for a given range of cost of emergency funding. Shape of $\overline{\alpha}(q)$, $t(q)$ for illustration. Intersection of $\overline{\alpha}(q)$ and $t(q)$ in (b) need not be unique



(a) $1 < r_e \leqslant \overline{r}_e^i$

(b) $\overline{r}_e^i < r_e \leqslant \overline{r}_e^s(\underline{q})$

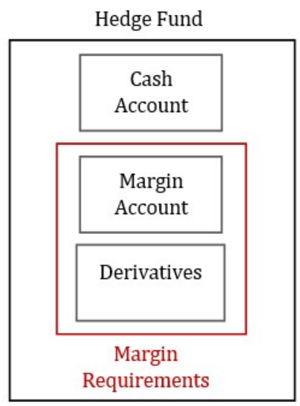
(c) $\overline{r}_e^s(\underline{q}) < r_e < \overline{r}_e^s(\overline{q})$

(d) $\overline{r}_e^s(\overline{q}) \leqslant r_e < \overline{r}_e^s(\frac{\overline{r}}{R})$

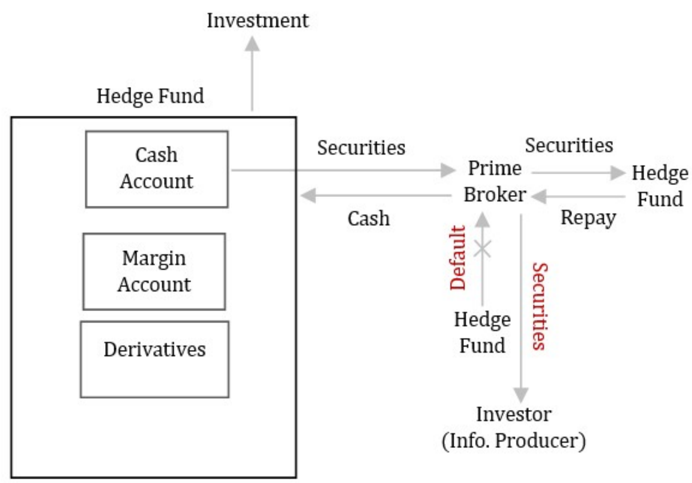
(e) $\overline{r}_e^s(\frac{\overline{r}}{R}) \leqslant r_e < \overline{r}_e^s(1)$

(f) $r_e \geqslant \overline{r}_e^s(1)$

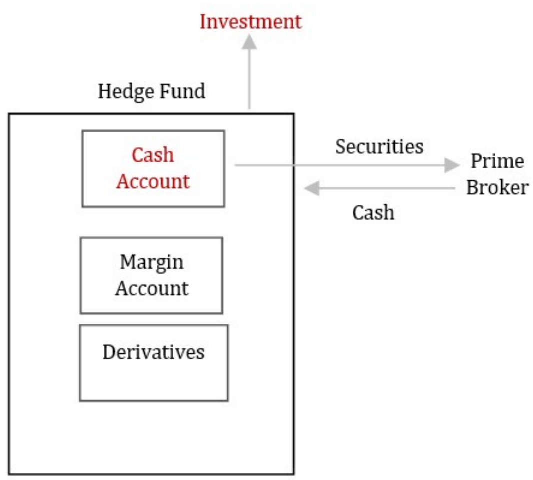
Figure 1.9: A comparison of channels through which portfolio composition of hedge fund can affect funding liquidity. In each case, the part highlighted in red is the driving force.



(a) Margin Constraints



(b) Repo Chains



(c) Fraudulent Transfers

Figure 1.10: Five-year senior debt CDS spread for Deutsche Bank, the average five-year senior debt CDS spread for all prime brokers and the largest ten prime brokers by average hedge fund lending. The averages exclude Deutsche Bank. Source: Kruttli, Monin and Watugala (2019).

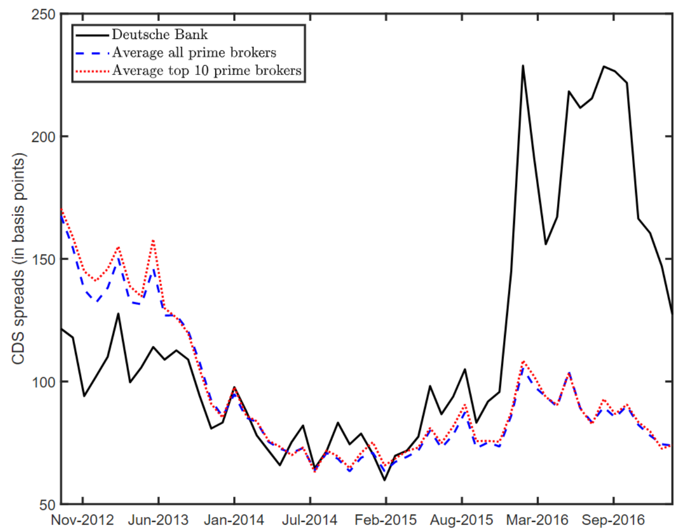
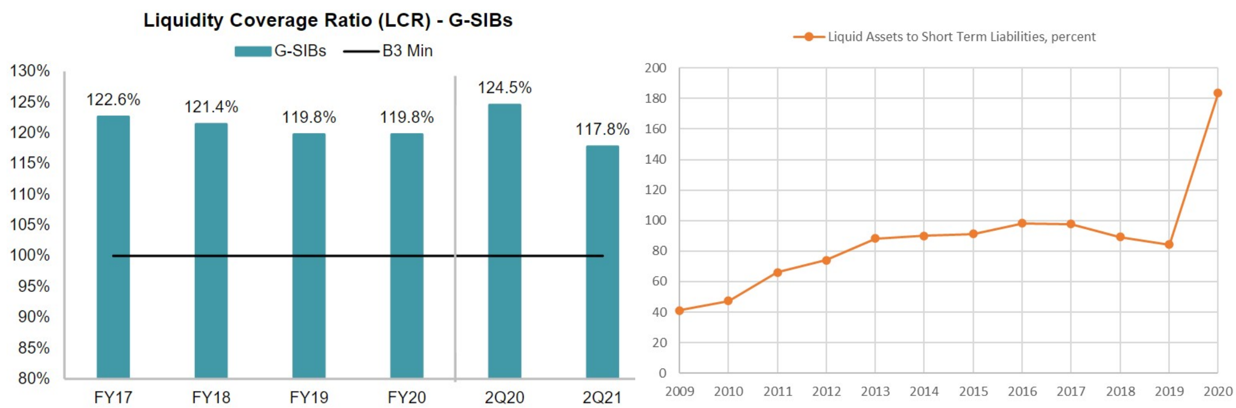
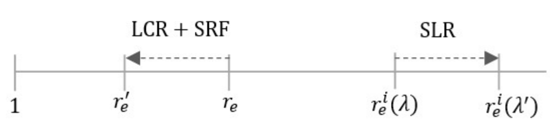


Figure 1.11: (a) Liquidity Coverage Ratio of G-SIBs. Source: SIFMA Research Quarterly - 2Q21. (b) IMF Financial Soundness Indicator (FSI) for deposit-takers in the U.S. - Liquid Assets to Short-term Liabilities. Covers domestically incorporated, domestically controlled entities in the sector, their branches (domestic and foreign), and all their subsidiaries (domestic and foreign) that are classified in the same sector as well as in other sectors. Liquid assets are defined as (1) currency, (2) deposits and other financial assets that are available either on demand or within three months or less. Short-term liabilities are defined as (1) short-term element (one year or less) of deposit takers' debt liabilities, (2) net market value of financial derivatives positions. Source: FSIs - IMF, Financial Soundness Indicators - Compilation Guide.



(a) (b)

Figure 1.12: Impact of SLR, LCR and SRF on cost of liquidity insurance (r_e) and minimum haircut hurdle rate ($\overline{r}_e^i(\lambda)$). λ, λ' are the minimum capital requirement before and after SLR respectively, $\lambda' > \lambda$.



Tables

Table 1.1: Examples of moral hazard at hedge funds categorized by primary stakeholders affected

Investors	
Misappropriation of funds	Investors' funds diverted for personal use
Fictitious assets	Financial statements showing assets which the fund does not hold
Marketing misrepresentation	Misrepresenting past performance, assets, infrastructure to prospective investors
Concealing trading losses	Financial statements showing gains when in truth fund has incurred losses
Misvaluation of fund assets	Inflating or deflating fund net asset value (NAV)
Style drift	Deviating from advertised strategy without appropriate disclosures to investors
Failure to disclose conflicts of interests	Omitting to disclose or inadequate disclosures on affiliations with service providers, economic relationships or agreements with some investors
Insider trading	Buying or selling a security, in breach of a fiduciary duty or other relationship of trust and confidence, on the basis of material, nonpublic information about the security
Inadequate risk management	Erroneous models (or lack of), failure to monitor risk exposures or taking appropriate corrective actions
Creditors	
Fraudulent transfers	Assets transferred to third parties to avoid repayment of existing debts
Inadequate risk management	Erroneous models (or lack of), failure to monitor risk exposures or taking appropriate corrective actions
Overall Financial System	
Inadequate risk management	Erroneous models (or lack of), failure to monitor risk exposures or taking appropriate corrective actions

Chapter 2

Multi-Prime Financing by Hedge Funds: A Common Agency Perspective

2.1 Introduction

In Chapter 1, we restricted our analysis to a hedge fund raising funding exclusively from a single prime broker. In practice, there are several potential costs associated with an exclusive relationship with a single prime broker which makes multi-prime arrangements desirable for hedge funds. Indeed, Figure 2.1 shows, average number of prime brokers utilized by a fund ranged from 3.6 - 4 in the period following the global financial crisis.

First, during times of market stress, hedge funds may be exposed to counterparty risk and funding liquidity risk. For instance, hedge funds that utilized Lehman Brothers as prime broker in 2008 were unable to access their assets for trading after the broker's bankruptcy and were twice as likely to fail compared to other similar funds (Aragon and Strahan, 2012). Furthermore, funds associated with distressed prime brokers exhibited lower returns and having multiple prime brokers mitigated this spillover (Klaus and Rzepkowski, 2009). Second, prime brokers by virtue of their daily involvement in funds' trading and risk management gain private information about funds' order flow and trading motives. This information may be disseminated to other valuable clients to generate significant trading commissions (Barbon et al, 2019; Maggio et al., 2019). Third, post-crisis banking reforms such as the Supplementary Leverage Ratio may have disincentivized bank-affiliated prime brokers to provide leverage to hedge fund clients (Boyarchenko et al., 2020). Finally, utilizing multiple prime brokers allows funds to secure competitive pricing in trading commissions, and securities borrowing and financing.

However, nonexclusive contracting can impose significant risk management costs on prime brokers. First, because client business is split across multiple brokers, neither broker may be fully informed about overall exposure, performance and total leverage of the client. To be clear, they are likely to be imperfectly informed and may also have to rely on clients reporting their fundamentals truthfully.[1] Second, to the extent clients' exposures are correlated across brokers, fire-sale externalities may arise in the event of fund failure thus exacerbating prime broker losses.

This chapter builds a model to study the impact of multi-prime contracting on financing secured by a hedge fund. Given the various frictions that may exist in nonexclusive contracting, we focus on moral hazard on part of the borrower - in line with the existing literature, Bizer and DeMarzo (1992), Parlour and Rajan (2001), and Green and Liu (2021). The model is like that studied in the previous chapter with the difference that now there are multiple prime brokers. Specifically, a cash-constrained hedge fund pledges collateral to two prime brokers (PBs) to secure funding for investment in some risky hard-to-value assets that mature in one period. The risks underlying the investment opportunity are common knowledge, implying position transparency among PBs. The PBs simultaneously offer one-period bilateral contracts so each PB is uninformed about competing offers. At maturity, the payoff from collateral is publicly observable while the payoff from investment is privately observed. The interpretation is that the hedge fund is better informed about the true value of hard-to-value assets. However, he can exploit this advantage by fraudulently transferring assets to third-party affiliates and avoid repayment of his obligations. The fund either repays both or defaults to both PBs. We interpret this as the presence of cross-default provisions in prime brokerage agreements and as we will see later, turns out to be crucial for our results. Finally, PBs have an option to undertake court-supervised audit to investigate potential fraudulent actions by the client and attempt recovery of their unsecured claims outstanding post-default.[2]

First, we contrast multi-prime financing with single-prime and socially optimal level of financing which in our model coincide. The latter is true because the social planner in our model cares about the aggregate payoff of prime brokers while ensuring the hedge fund prefers to participate. Thus, her problem coincides with that of the single prime broker. Our first result shows that heterogeneity in debt is crucial in determining aggregate debt. Specifically, when contracts are sufficiently homogeneous, aggregate debt secured by the fund is lower than in the case of single-prime/socially optimal level. Aggregate debt is the same only when contracts are sufficiently heterogeneous. This in contrast to the existing literature where heterogeneity in contracts has no consequence for aggregate debt. The intuition is as follows. Aggregate debt is determined by the PB with the larger share of aggregate debt

[1] For example, following the investigation of the collapse of $36 billion family office Archegos Capital Management in March 2021, the SEC alleged "...use of multiple Counterparties further limited transparency into the size of Archegos's portfolio and the extent to which it was concentrated. Although each Counterparty could see what positions Archegos held with it, each had limited, and in some cases no, visibility into Archegos's holdings elsewhere, relying upon Archegos to be truthful and accurate in whatever information it was willing to provide as to its aggregate holdings." See, SEC Charges Archegos and its Founder with Massive Market Manipulation Scheme.

[2] We do not model fire-sale externality since it has a second-order effect in that it increases unsecured claims outstanding, strengthening the incentives to audit and consequently reducing the probability of strategic default.

("the larger PB") because she takes a larger share of aggregate risk. Every additional dollar of debt supplied by the larger PB reduces the probability of strategic default. However, because the fund either repays both or none, the benefit of higher probability of repayment may accrue to both with each PB's share equal to her share in aggregate unsecured claims outstanding.

When heterogeneity is low, the likelihood that both PBs have unsecured claims outstanding post-default is high. and consequently the likelihood of the part of the marginal benefit of debt goes to the relatively smaller PB is also high. This is costly for the larger PB and disincentivizes her to provide as much funding as would have been in the case of single-prime financing where she would have been the sole beneficiary. As heterogeneity increases, the likelihood that the smaller PB is over-collateralized and consequently the larger PB is the sole beneficiary of reduced probability of strategic default increases which brings her incentives closer to that of a single-prime broker. Existing literature has not captured these nuances since it has focused on unsecured debt and does not consider costly state verification as a deterrent to strategic default. Indeed, the feature that the fund invests in hard-to-value assets allows us to interpret strategic default as fraudulent transfers which in turn makes the option to audit meaningful.

Put differently, our model highlights that multi-prime financing in the presence of position transparency may have a private and social cost in sense of lower financing secured by funds than the single-prime/socially optimal level. Our second result shows that this cost may be borne by a wide spectrum of funds. Given a portfolio composition, high-quality funds in the sense of low probability of default may suffer a loss in funding compared to single-prime level. Intuitively, for a high-quality fund and for a given offer by the larger PB, the smaller PB prefers to lend as much as feasible and minimize heterogeneity. This is costly for the larger PB who pulls back funding to a level lower than the single-prime level. Low-quality funds face a trade-off in that they may suffer a loss in funding if they choose to invest in a portfolio with a high fraction of hard-to-value, illiquid assets.

These results are in stark contrast to Bizer and DeMarzo (1992) and Green and Liu (2021) who show that nonexclusive contracting unambiguously leads to higher indebtedness compared to the case of borrowing from a single lender. Our analysis highlights the importance of collateralization and the option to pursue legal recourse against borrowers in understanding the consequences of nonexclusive contracting. They also provide a new rationale for why some funds may not prefer position transparency among prime brokers. Specifically, while existing literature recognizes that position transparency may make funds susceptible to information leakage to competitors (Barbon et al, 2019; Maggio et al., 2019) or, in distress situations, to strategic actions by prime brokers (King and Maier, 2009), our model highlights how position transparency allows prime brokers to assess the distribution of counterparty risk among themselves and consequently the supply of aggregate debt. Furthermore, while the literature emphasizes the benefits of position transparency for investors in disciplining managers by limiting incentives for excessive risk-taking and misreporting performance stemming from performance-based compensation, our model highlights multi-prime contracting in the presence of position transparency may reduce the welfare of hedge funds and prime brokers alike.

The chapter proceeds as follows. Section 2.2 discusses the related literature. Section 2.3 describes the model. Section 2.4 provides main results and their discussion. Section 2.5 concludes.

2.2 Related Literature

This chapter is related to the literature on contractual externalities in debt contracts.[3] Bizer and DeMarzo (1992), Green and Liu (2021) study a model where an entrepreneur lacks commitment to an exclusive contract with a single lender and raises funds sequentially from several lenders before investment. When the borrower can undertake costly, unobservable effort as in Bizer and DeMarzo (1992) or lacks incentive to repay as in Green and Liu (2021), future debt reduces the probability of repayment of existing debt. Thus, lenders impose negative, default externalities on each other. The central result in both papers is that borrower indebtedness is greater at loan terms worse than compared to the case of commitment to an exclusive contract.

Donaldson, Gromb and Piacentino (2020) also study a model where entrepreneur also lacks commitment to raise funding from a single creditor for multiple investment opportunities arriving over time. They find that reliance on collateral may, paradoxically, generate inefficient investment. In Brunnermeier and Oehmke (2013), the borrower raises funds from multiple creditors but lacks commitment to an aggregate maturity structure. In their model, new information may be revealed about asset quality before maturity. They show that when information is about the probability of default, the borrower prefers a maturity structure that is excessively short-term, prone to rollover risk and inefficient creditor runs. Finally, Parlour and Rajan (2001) show how bankruptcy laws in the U.S. may potentially inhibit competition and be a source of default externalities for lenders under nonexclusive contracting and provide a rational for non-competitive pricing documented in unsecured credit markets.

While our model shares some similarities such as moral hazard as in Bizer and DeMarzo (1992), Parlour and Rajan (2001) and Green and Liu (2021), simultaneous contracting as in Parlour and Rajan (2001) and secured debt as in Donaldson, Gromb and Piacentino (2020), the key differences that drive our main results are the distribution of collateral payoff debt and an option for creditors to undertake costly state verification post-default. The latter is meaningful due to our interpretation of strategic default as fraudulent transfers. Together, they create a role for heterogeneity in debt in determining aggregate debt. We also link characteristics of the borrower to indebtedness in equilibrium. These nuances have not been captured in the existing literature.

[3] There is a broader literature on externalities in nonexclusive contracts which we do not review. See, for example, Kahn and Mookherjee (1998), Segal (1999), Martimort and Stole (2003), Segal and Whinston (2003), Bisin and Guiatoli (2004), Gomes (2005), Bennardo, Pagano and Piccolo (2015), and Attar et al. (2019).

2.3 Model

The economy has three dates, $t = 0, 1, 2$ and consists of two types of risk-neutral agents - cash-constrained hedge fund (HF) and cash-rich prime brokers (PBs). One-period risk-free rate is normalized to zero. All agents aim to maximize their wealth at the end of date 2.

Hedge Fund. The HF seeks funding for risky assets valued at $t = 1$ either at $R > 1$ with probability $q \epsilon (0, 1)$ or zero otherwise. We assume investing in these assets is a positive NPV decision, i.e., $qR > 1$. The value is privately observed which we interpret that an "active" market for these assets doesn't exist which provides significant discretion to the manager over their valuation. Although cash-constrained, the HF owns one unit of a pledgeable asset that pays a random amount $\tilde{v}$ and $\mu_0 \equiv E[\tilde{v}]$ as the market price of the asset at $t = 0$. Finally, we assume $\tilde{v}$ is publicly observable and that $\tilde{v}$, $\tilde{R}$ are uncorrelated.

Prime Brokers. To fund investments, HF seeks funding from two prime brokers by pledging a fraction $k_i > 0$ to PB i, $i = 1, 2$, $k_1 + k_2 = 1$. Similar to the previous chapter, both have the option to audit the client's pre-default operations under supervision of a court. The audit costs and technology are described in detail shortly below.

Figures 2.2 - 2.4 show the sequence of events at the dates $t = 0, 1, 2$ respectively.

Financing and investment. At $t = 0$, the HF offers a fraction k_i of plegdeable asset as collateral in return for funding from PB i. Each PB makes a take-it-or-leave-it offer (B_i, D_i) of lending and repayment amounts respectively. The HF has the option to accept any number of contracts, i.e., she can either accept both or exactly one or reject both. In the third case, she holds the collateral till the next date.

Let $\mathcal{C} = \{i \, \epsilon \, \{1, 2\} \,|\, B_i > 0\}$ be the set of accepted offers at $t = 0$. The case of $|\mathcal{C}| = 1$, i.e., HF accepting exactly one offer is analogous to that of the previous chapter so in what follows we describe the case when HF has accepted both the offers. Later, we will show that a competitive equilibrium must have HF securing funding from both PBs.

Repayment. At $t = 1$, collateral payoff $\tilde{v}$ is revealed publicly and the HF observes the value of unpledged risky assets $\tilde{R}$ privately. On the one hand, HF can sell these assets and use either PB for trade settlement which reveals the true value to that PB. Subsequently, HF repays both PBs. On the other hand, as in the previous chapter, HF can transfer these assets to an affiliate who in turn can sell these assets to realize the gain. We assume affiliate transactions are not observable to any PB in real-time. Since the transfer implies HF has no assets other than collateral to repay, this situation is akin to strategic default if the true value of transferred assets is R and a PB has unsecured claims outstanding. Thus, the HF either repays both or defaults to both PBs at $t = 1$. While this simplifies the analysis of the model, this feature is motivated by the observation that prime brokerage agreements typically include cross-default provisions so default to any PB immediately triggers default with other PBs. Finally, in the event of HF default, PBs seize collateral and decide whether to audit the client at $t = 2$. We elaborate this stage next.

Audit. If HF has defaulted at $t = 1$ and payoff from collateral is insufficient to cover the repayment amount promised to PB i, i.e., $k_i\tilde{v} < D_i$, that PB has the option to conduct a court-supervised costly audit at $t = 2$ to detect any malfeasance by HF and in that event attempt recovery of her claims. The decision to audit will be based on her beliefs $\pi \in [0, 1]$ about the true value of unpledgeable assets which are determined by HF equilibrium strategy to default, whether the other PB also has unsecured claims outstanding and wishes to audit.

To see this, denote debt outstanding per unit of collateral as $d_i = D_i/k_i$, PB m, M as $d_M \geqslant d_m$ and define $g \equiv d_M/d_m \geqslant 1$, as a measure of the degree of heterogeneity in outstanding debt. Let $\mathcal{U}(\tilde{v}) = \{i \in \{m, M\} \mid \tilde{v} < d_i\}$ be the set of unsecured creditors at the time of default. Three cases are possible -

(i) Collateral payoff in high enough to cover aggregate debt, i.e., $\tilde{v} \geqslant D$. In this case, there is no need for an audit. This is because PB m has a surplus $k_m\tilde{v} - D_m$ sufficient to cover the claims $\max(D_M - k_M\tilde{v}, 0)$ of PB M while the HF receives a payoff $\tilde{v} - D$ remaining after this transfer.

(ii) $\tilde{v} \in [d_m, D)$ so that only PB M has unsecured claims outstanding of the amount $D_M - k_M\tilde{v} - (k_m\tilde{v} - D_m) = D - \tilde{v}$ post transfer.

(iii) $\tilde{v} < d_m$ so each PB has unsecured claims outstanding of the amount $D_i - k_i\tilde{v}$.

Case (ii) is analogous to that studied in the previous chapter so we focus on Case (iii). Strictly speaking, each PB may decide to pursue an audit independently or cooperate with the other PB to pursue a joint audit. Figure 2.5 illustrates the decision tree.

Let the non-cooperative total cost of audit for PB i be $\hat{\alpha}_i D$ while $s_i\hat{\alpha}_c D$ be cost of audit for PB i under cooperation, where $s_i \in (0, 1)$ and $s_m + s_M = 1$. Furthermore, let the probability of recovery be p_i, p_c under non-cooperation and cooperation respectively. Under mild assumptions $\hat{\alpha}_m + \hat{\alpha}_M > \hat{\alpha}_c$ and $p_m = p_M = p_{nc} \leqslant p_c$, it is easy to see that cooperation is always efficient. Hence, we assume that PBs cooperate should the both of them decide to audit the client. Furthermore, we assume,

$$s_i = (D_i - k_i\tilde{v})/(D - \tilde{v}) \tag{I2.1}$$

$$\hat{\alpha}_m = \hat{\alpha}_M = \hat{\alpha}_c \equiv \hat{\alpha}, \quad p_{nc} = p_c \equiv p \tag{I2.2}$$

(I2.1) implies a PB's cost of audit under cooperation is proportional to her share of unsecured claims outstanding. (I2.2) implies audit technology is the same for each PB. Recall from the discussion in the previous chapter that establishing a successful fraudulent transfer claim depends on the verifiability of managerial actions and valuation of HF portfolio. Therefore, as long as there are no significant differences in the ability of PBs to conduct an audit, cost of audit and probability of recovery are arguably determined by characteristics of hedge funds.

Under these assumptions, the payoff matrix of the audit game when $\tilde{v} < d_m$ at $t = 2$ is as follows,

Table 2.1: Audit Game when $\tilde{v} \,\epsilon\, [0,\, d_m)$

		PB M	
		Audit	**No Audit**
PB m	**Audit**	$(D_m - k_m\tilde{v})(\pi \cdot p_c - \frac{\hat{\alpha}_c D}{D-\tilde{v}})$, $(D_M - k_M\tilde{v})(\pi \cdot p_c - \frac{\hat{\alpha}_c D}{D-\tilde{v}})$	$\pi \cdot p_c(D_m - k_m\tilde{v}) - \hat{\alpha}_c D,\, 0$
	No Audit	$0,\, \pi \cdot p_c(D_M - k_M\tilde{v}) - \hat{\alpha}_c D$	$0,\, 0$

Finally, to complete the description of the model, post-audit payoff for HF are as described below.

$$\text{Post-audit HF payoff} = \begin{cases} 0, & \text{if audit concludes fraud} \\ \tilde{R}B + \max\{\tilde{v} - D,\, 0\}, & \text{otherwise} \end{cases}$$

HF receives nothing if creditor(s) are successful in establishing a fraudulent transfer claim when $\tilde{R} = R$ while gets away with the unpledgeable payoff and if positive, the difference between the value of asset and the debt owed at date 1 if the audit concludes $\tilde{R} = 0$. This is because creditors are entitled to collateral payoff up to the extent of their total claim D.

2.4 Results and Discussion

Equilibrium Default and Audit Strategies

In this section, we solve for the equilibrium default and audit strategies of HF and PBs respectively. Let $u \equiv u(\tilde{R},\, \tilde{v})$ denote HF strategy to default, i.e.,

$$u(\tilde{R},\, \tilde{v}) = \begin{cases} 1, & \text{if default} \\ 0, & \text{if repay} \end{cases}$$

Denote $\pi = Prob(\tilde{R} = R \,|\, \text{Default}, \tilde{v},\, u)$. The analysis is identical to that of the previous chapter if the HF accepted only one contract at date 0 so we refer the reader to the same for this case. In what follows, we derive the equilibrium for the case when the HF accepted both contracts at date 0.

Proposition 2.1. Suppose $D_i \leqslant \overline{r}B_i \,\forall\, i \,\epsilon\, \{m,\, M\}$. Denote $\mathcal{A} \subseteq \{m,\, M\}$ as the set of auditors.
(a) Equilibrium default strategy of HF is given by,

$$u(\tilde{R},\, \tilde{v}) = \begin{cases} 1, \quad \text{if } (\tilde{v} < D \,\&\, \tilde{R} = 0) \text{ or } (\tilde{v} \,\epsilon\, (d_c(q),\, D] \,\&\, \tilde{R} = R) \\ \begin{cases} 1 \text{ with prob. } \gamma, \\ 0 \text{ with prob. } 1-\gamma, \end{cases} \quad , \quad \text{if } \tilde{v} \,\epsilon\, [0,\, d_c(q)] \,\&\, \tilde{R} = R \\ 0, \quad \text{if } \tilde{v} \geqslant D \,\&\, \tilde{R} = \{0,\, R\} \end{cases}$$

(b) Heterogeneity in debt contracts determines the set of auditors $\mathcal{A}$ as follows.

(i) Suppose $g \geqslant \overline{g}$.

$$\mathcal{A} = \begin{cases} \varnothing, & \text{if } \tilde{v} \,\epsilon\, (d_c,\, D] \\ \{M\}, & \text{if } \tilde{v} \,\epsilon\, [d_m,\, d_c] \\ \{m,\, M\}, & \text{if } \tilde{v} \,\epsilon\, [0,\, d_m) \end{cases}$$

(i) Suppose $g \,\epsilon\, [1,\, \overline{g})$.

$$\mathcal{A} = \begin{cases} \varnothing, & \text{if } \tilde{v} \,\epsilon\, (d_c,\, D] \\ \{m,\, M\}, & \text{if } \tilde{v} \,\epsilon\, [0,\, d_c] \end{cases}$$

(c) Conditional on default, no audit occurs if $\tilde{v} \,\epsilon\, (d_c,\, D]$ while an audit occurs with probability λ when $\tilde{v} \,\epsilon\, [0,\, d_c]$. In the range $\tilde{v} \,\epsilon\, [0,\, \min\{d_c,\, d_m\})$, the equilibrium features perfectly correlated audit strategies.

$$\begin{aligned} \gamma \equiv \Gamma(\tilde{v},\, D) &= \left(\frac{1-q}{q}\right)\left(\frac{\pi(\tilde{v},\, D)}{1-\pi(\tilde{v},\, D)}\right), \qquad \pi(\tilde{v},\, D) = \frac{\alpha D}{D-\tilde{v}} \\ \lambda \equiv \Lambda(\tilde{v},\, B,\, D) &= \frac{D-\tilde{v}}{\overline{r}B}, \quad \overline{g} = \frac{1+(\alpha/q)(k_m/k_M)}{1-\alpha/q} \end{aligned}$$

Proof. See Appendix A2.1.

As in the previous chapter, the constraints $D_i \leqslant \overline{r}B_i$ ensures that repayment is preferable if an audit is anticipated upon default. A pooling equilibrium exists when $\tilde{v} \,\epsilon\, (d_c,\, D]$ since aggregate unsecured claims are not high enough to incentivize an audit thus making strategic default costless. The key insight of Proposition 2.1 is the impact of heterogeneity on default risk borne by prime brokers. Consider two different set of offers $\{(b_m,\, d_m),\, (b_M,\, d_M)\}$ and $\{(b_m^{'},\, d_m^{'}),\, (b_M^{'},\, d_M^{'})\}$ such that $(B,\, D) = (B^{'},\, D^{'})$, and $g^{'} < \overline{g} < g$. Figure 2.6 illustrates the proposition.

Define V_i, $V_i^{'}$ as the expected payoff of PB i under relatively heterogeneous ($g \geqslant \overline{g}$) and homogeneous ($g \,\epsilon\, [1,\, \overline{g})$) contracts respectively as shown in Figure 2.6 above.

$$\begin{aligned} V_m + V_M =&\ V_m^{'} + V_M^{'} \\ V_M - V_M^{'} =&\ E\Big[(D_M - D_M^{'})(\mathbf{1}\{\tilde{v} \,\epsilon\, [d_m^{'},\, \overline{v}]\} + q(1-\gamma)\cdot \mathbf{1}\{\tilde{v} \,\epsilon\, [0,\, d_c)\}) \\ &+ (k_m\tilde{v} - D_m)(\mathbf{1}\{\tilde{v} \,\epsilon\, [d_c,\, d_m^{'})\} + (1-q+q\gamma)\cdot \mathbf{1}\{\tilde{v} \,\epsilon\, [d_m,\, d_c)\})\Big] > 0 \end{aligned} \tag{2.1}$$

Equation (2.1) shows that, as one would expect, changing heterogeneity while leaving the aggregate debt unchanged results in a transfer of risk between prime brokers. Moreover, an increase in heterogeneity benefits PB M because of two factors. First, repayment amount increases conditional on no default. Second, PB M is more likely to be the sole unsecured creditor post-default thus receiving any surplus in collateral payoff remaining with PB m. Does PB M (or m) prefer higher heterogeneity for a given level of aggregate debt? This decision depends on the trade-off between the higher expected payoff and a potential increase in the lending amount $B_M - B_M'$. We will return to this question in the analysis of competitive equilibrium at $t = 0$.

Equilibrium at $t = 0$

In this section, we define competitive equilibrium at $t = 0$ and show that both contracts must be accepted by the HF.

Define H^b, H_i^o, H_j^o as the payoff for the client when she accepts both, only i, or only j contract respectively. Given an offer by PB i, PB j can offer a contract such that (i) both offers are accepted, i.e., $H^b \geqslant max(H_i^o,\, H_j^o,\, \mu_0)$ and j's (net) payoff is U_j^b or, (ii) only j is accepted, i.e., $H_j^o > max(H^b,\, H_i^o,\, \mu_0)$ and j's payoff is U_j^o. Furthermore, U_j^b in turn depends on j being m or M, and $g \gtrless \overline{g}$. Therefore, in general, there are five possible optimization problems for PB j defined as follows,

$$\begin{aligned}
&\max_{B_j,\, D_j} \overline{U}^b_{j,m} \quad \text{s.t.} \quad 0 \leqslant B_j \leqslant D_j \leqslant \overline{r} B_j,\ d_j \leqslant \frac{d_i}{\overline{g}_{j,m}},\ H^b \geqslant max(H^o_{i,M},\, H^o_{j,m},\, \mu_0)\\
&\max_{B_j,\, D_j} \underline{U}^b_{j,m} \quad \text{s.t.} \quad 0 \leqslant B_j \leqslant D_j \leqslant \overline{r} B_j,\ \frac{d_i}{\overline{g}_{j,m}} \leqslant d_j \leqslant d_i,\ H^b \geqslant max(H^o_{i,M},\, H^o_{j,m},\, \mu_0)\\
&\max_{B_j,\, D_j} \underline{U}^b_{j,M} \quad \text{s.t.} \quad 0 \leqslant B_j \leqslant D_j \leqslant \overline{r} B_j,\ d_i \leqslant d_j \leqslant \overline{g}_{j,M}\, d_i,\ H^b \geqslant max(H^o_{i,m},\, H^o_{j,M},\, \mu_0)\\
&\max_{B_j,\, D_j} \overline{U}^b_{j,M} \quad \text{s.t.} \quad 0 \leqslant B_j \leqslant D_j \leqslant \overline{r} B_j,\ d_j \geqslant \overline{g}_{j,M}\, d_i,\ H^b \geqslant max(H^o_{i,m},\, H^o_{j,M},\, \mu_0)\\
&\max_{B_j,\, D_j} U^o_j \quad\ \ \text{s.t.} \quad 0 \leqslant B_j \leqslant D_j \leqslant \overline{r} B_j,\ H^o_j \geqslant max(H^b,\, H^o_i,\, \mu_0)
\end{aligned}$$

where $\overline{U}^b_{j,k}$, $\underline{U}^b_{j,k}$ denotes the payoff for PB j when $j = k \,\epsilon\, \{m,\, M\}$, $g \geqslant \overline{g}_{j,k}$ and $g \,\epsilon\, [1,\, \overline{g}_{j,k})$ respectively.

Definition (Competitive Equilibrium)**.** A set of offers $\{(B_1^{**},\, D_1^{**}),\, (B_2^{**},\, D_2^{**})\}$ is a pure-strategy competitive equilibrium if and only if $(B_i^{**},\, D_i^{**}) = \text{argmax}(\overline{U}^{b*}_{i,m},\, \underline{U}^{b*}_{i,m},\, \underline{U}^{b*}_{i,M},\, \overline{U}^{b*}_{i,M},\, U^{o*}_i)$ $\forall\, i = 1,\, 2$.

Next, we show that in a competitive equilibrium, the hedge fund borrows from both prime brokers. The intuition is that each PB can at least "match" the other by offering the same contract per-unit of collateral.

Proposition 2.2. In an equilibrium with $B^{**} = B_1^{**} + B_2^{**} > 0$, hedge fund secures funding from both prime brokers, i.e., $B_1^{**} > 0$, $B_2^{**} > 0$.

Proof. See Appendix A2.2.

To lend some tractability to the model, it is useful to add more structure. First, collateral payoff at $t = 1$ follows the distribution $\tilde{v} \,\epsilon\, \{0,\, \acute{v},\, \hat{v},\, \overline{v}\}$ with probability $\{\underline{p},\, \acute{p},\, \hat{p},\, \overline{p}\}$ respectively and $0 = \underline{v} < \acute{v} < \hat{v} < \overline{v}$. Second, we make the following assumptions -

Assumption 1: Likelihood of extreme outcomes is sufficiently low while "good" outcome sufficiently likely,

$$\overline{p} < \frac{1}{\overline{r}},\ \underline{p} < \min\left(\frac{1}{\overline{r}} - \overline{p},\ \frac{1 - 1/\overline{r}}{1 - 1/R}\right),\ \hat{p} \geqslant \max\Big(\acute{p},\ 1 - \frac{1}{\overline{r}}\Big) \tag{I2.3.1}$$

Assumption 2: Audit costs are sufficiently low,

$$\alpha \leqslant \underline{\alpha} \equiv \min\left(\frac{1}{2R},\ \frac{1}{R}\Big(1 - \frac{\hat{v}}{\overline{v}}\Big),\ \Big(\frac{1 - \acute{v}/\hat{v}}{1 + \acute{v}/\hat{v}}\Big),\ \frac{1}{R}\left(1 - \sqrt{\frac{\acute{v}}{\hat{v}}}\right),\ 1 - \underline{p}\Big(\frac{1 - 1/R}{1 - 1/\overline{r}}\Big)\right) \tag{I2.3.2}$$

Assumption 3: Amount of collateral pledged to each PB is relatively "homogeneous" among PBs,

$$k_i \,\epsilon \left[\alpha R,\ \frac{1}{2 - \alpha}\right] \forall\, i = 1,\, 2 \tag{I2.3.3}$$

Finally, we restrict individual offers and the aggregate contract depending on heterogeneity g as follows,

(i) $g \,\epsilon\, [1,\, \underline{g})$: $0 < \acute{v} < d_{c,m} \leqslant d_c \leqslant d_{c,M} \leqslant \hat{v} < d_m \leqslant D \leqslant d_M < \overline{v}$

(ii) $g \,\epsilon\, [\underline{g},\, \overline{g})$: $0 < d_{c,m} \leqslant \acute{v} < d_c < d_m \leqslant d_{c,M} \leqslant \hat{v} < D < d_M < \overline{v}$

(iii) $g \,\epsilon\, [\overline{g},\, \overline{\overline{g}})$: $0 < d_{c,m} \leqslant \acute{v} < d_m \leqslant d_c \leqslant \hat{v} < d_{c,M} < D < d_M < \overline{v}$

(iv) $g \geqslant \overline{\overline{g}}$: $0 < d_{c,m} < d_m \leqslant \acute{v} < d_c \leqslant \hat{v} < D \leqslant d_{c,M} < d_M < \overline{v}$

where,

$$1 < \frac{1}{1 - \alpha/q} \equiv \underline{g} < \overline{g} \equiv \frac{1 + (\alpha/q)(k_m/k_M)}{1 - \alpha/q} < \overline{\overline{g}} \equiv \frac{1}{1 - (\alpha/q)(1/k_m)}$$

This leads to the simultaneous offer game at $t = 0$ as shown in Table 2.2.[4]

Table 2.2: Simultaneous Offer Game at $t = 0$

<table>
<tr><td></td><td></td><td colspan="4">PB 2</td></tr>
<tr><td></td><td></td><td>$d_2 \leqslant \acute{v}$</td><td>$d_{c,2} \leqslant \acute{v} < d_2 < \hat{v}$</td><td>$\acute{v} < d_{c,2} \leqslant \hat{v} < d_2$</td><td>$\hat{v} < d_{c,2} < \overline{v}$</td></tr>
<tr><td rowspan="4">PB 1</td><td>$d_1 \leqslant \acute{v}$</td><td rowspan="3">N/A</td><td rowspan="2">N/A</td><td>N/A</td><td>$(1, 2) = (m, M),\ g \geqslant \overline{\overline{g}}$</td></tr>
<tr><td>$d_{c,1} \leqslant \acute{v} < d_1 < \hat{v}$</td><td>$(1, 2) = (m, M),\ g \,\epsilon\, [\underline{g}, \overline{g})$</td><td>$(1, 2) = (m, M)\ g \,\epsilon\, [\overline{g}, \overline{\overline{g}})$</td></tr>
<tr><td>$\acute{v} < d_{c,1} \leqslant \hat{v} < d_1$</td><td>$(1, 2) = (M, m),\ g \,\epsilon\, [\underline{g}, \overline{g})$</td><td>$g \,\epsilon\, [1, \underline{g})$</td><td rowspan="2">N/A</td></tr>
<tr><td>$\hat{v} < d_{c,1} < \overline{v}$</td><td>$(1, 2) = (M, m),\ g \geqslant \overline{\overline{g}}$</td><td>$(1, 2) = (M, m)\ g \,\epsilon\, [\overline{g}, \overline{\overline{g}})$</td><td>N/A</td></tr>
</table>

[4]Strictly speaking, it is no longer necessary that Proposition 2.2 holds with the above simplification since it is not possible for a PB to simply "match" every possible offer of the other. However, we maintain this requirement going forward since it holds in the general case and is indeed also more realistic.

Since the goal of this chapter is to study externalities among prime brokers and consequently the aggregate debt secured by the hedge fund due to multi-prime financing, it is useful to begin with the case of single-prime finance for comparison which we turn to next.

Single-Prime

In this section, we consider the case when the hedge fund requests funding from a single prime broker. The equilibrium default and audit strategies are exactly the same as in Proposition 1 above so we discuss the optimization problem for the single PB to maximize her expected payoff,

$$\begin{aligned}
&\max_{B,\,D}\ U^S(B,\,D) = \Big[\overline{p} + \underline{p}\Big(\frac{q-\alpha}{1-\alpha}\Big)\Big]D + \acute{p}\Big(\frac{q-\acute{\pi}}{1-\acute{\pi}}\Big)(D-\acute{v}) + \hat{p}\hat{v} + \acute{p}\acute{v} - B \\
&\text{s.t.} \quad 0 \leqslant B \leqslant D \leqslant \overline{r}B, \quad H \geqslant \mu_0, \quad \acute{v} < d_c \leqslant \hat{v} < D < \overline{v}, \quad \text{where,} \\
&H = \mu_0 + qRB - \Big[D + \hat{p}(\hat{v}-D) + \acute{p}(1-q)(\acute{v}-D) + \underline{p}(1-q)(\underline{v}-D)\Big]
\end{aligned} \tag{2.2}$$

For tractability throughout the rest of the chapter, we will focus on solutions where participation constraints of the hedge fund are non-binding.

Proposition 2.3. In single-prime financing, the equilibrium debt contract at $t = 0$, $(B^S,\, D^S)$ is given by $B^S = D^S/\overline{r}$ and,

$$\underbrace{\overline{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right) + \acute{p}\left(\frac{q-\acute{\pi}^S}{1-\acute{\pi}^S}\right)}_{\substack{\text{Marginal benefit}\\ \text{conditional on repayment}}} + \underbrace{\frac{\alpha(1-q)\acute{p}\acute{v}}{(1-\acute{\pi}^S)^2(D^S-\acute{v})^2}}_{\substack{\text{Increase in probability of}\\ \text{repayment due to threat of audit}}}(D^S-\acute{v}) = \frac{1}{\overline{r}} \tag{2.3}$$

Proof. See Appendix A2.3.

The contract trades-off the marginal benefits and marginal costs of debt. The marginal benefit on the left hand side of equation (2.3) comprises of two parts. First, repayment amount conditional on no default given by the first three terms. Second, lower probability of strategic default due to stronger incentives to audit given by the fourth term.

Multi-Prime

We now turn to the case of multi-prime financing and study how it contrasts with single-prime. The key element that drives our results is a negative externality imposed by PB m on PB M, termed as "loss given default" externality. Specifically, in states of the world where PB m is over-collateralized post default, PB M receives the surplus $k_m\tilde{v} - D_m$ to cover her unsecured claims outstanding. This in turn determines her payoff in states of the world when the threat of audit is not credible, and also the marginal benefit of debt in states of the world where the threat of audit is indeed credible. Ceteris paribus, an increase in D_m increases loss given default for PB M because - (i) likelihood of PB m to be over-collateralized post-default decreases and (ii) surplus available for PB M decreases in states of the world where PB m is indeed over-collateralized post-default.

To be more precise, consider first the case of relatively homogeneous debt, i.e., $g \,\epsilon\, [1,\, \underline{g})$. The expected payoff for PB i are given by equation (2.4) below.

$$U_i^b(g \,\epsilon\, [1,\, \underline{g})) = \left[\overline{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right)\right] D_i + \acute{p}\left(\frac{q-\acute{\pi}}{1-\acute{\pi}}\right)(D_i - k_i\acute{v}) + k_i(\hat{p}\hat{v} + \acute{p}\acute{v}) - B_i \tag{2.4}$$

Since both PBs have identical risk exposure, an externality on loss given default is at its maximum strength - surplus from PB m is zero in every state of the world with default. As heterogeneity increases to $g \,\epsilon\, [\underline{g},\, \overline{\overline{g}})$, equation (2.5) below shows PB M receives $k_m\hat{v} - D_m$ form PB m when default occurs for certainty at $\tilde{v} = \hat{v}$ which reduces loss given default from $D_M - k_M\hat{v}$ to $D - \hat{v}$.

$$\begin{aligned} U_m^b(g \,\epsilon\, [\underline{g},\, \overline{\overline{g}})) &= \left[\overline{p} + \hat{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right)\right] D_m + \acute{p}\left(\frac{q-\acute{\pi}}{1-\acute{\pi}}\right)(D_m - k_m\acute{v}) + k_m\acute{p}\acute{v} - B_m \\ U_M^b(g \,\epsilon\, [\underline{g},\, \overline{\overline{g}})) &= \left[\overline{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right)\right] D_M + \acute{p}\left(\frac{q-\acute{\pi}}{1-\acute{\pi}}\right)(D_M - k_M\acute{v}) + \hat{p}(\hat{v} - D_m) + k_M\acute{p}\acute{v} - B_M \end{aligned} \tag{2.5}$$

Finally, as contracts become even more heterogeneous, i.e., $g \geqslant \overline{\overline{g}}$, PB m forgoes the benefit of auditing externality in return for reduced risk exposure. On the other hand, more surplus available for PB M in an event of default. This not only improves her payoff if HF defaults but also increases the marginal benefit of debt since is the sole beneficiary of the reduced probability of strategic default due to the threat of audit.

$$\begin{aligned} U_m^b(g \geqslant \overline{\overline{g}}) &= \left[\overline{p} + \hat{p} + \acute{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right)\right] D_m - B_m \\ U_M^b(g \geqslant \overline{\overline{g}}) &= \left[\overline{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right)\right] D_M + \acute{p}\left(\frac{q-\acute{\pi}}{1-\acute{\pi}}\right)(D - \acute{v}) + \acute{p}(\acute{v} - D_m) + \hat{p}(\hat{v} - D_m) - B_M \end{aligned} \tag{2.6}$$

Social Welfare

Before moving to competitive equilibrium, consider a social planner who wishes to maximize the aggregate payoff of prime brokers while ensuring the HF participates. Clearly, the social planner's payoff coincides with that of a single prime broker since individual broker payoffs are simply a result of distribution of available aggregate resources. It immediately follows then that the social planner's problem coincides with that of the single-prime financing case discussed earlier. This leads to the following result.

Proposition 2.4. Social welfare maximizing aggregate contract is given by $(B,\, D) = (D^S/\overline{r},\, D^S)$.

Proof. See Appendix A2.4.

Can the socially optimal aggregate contract be implemented in a competitive equilibrium? Proposition 2.5 characterizes the aggregate debt secured by the HF in multi-prime financing and compares it with the socially optimal/single-prime financing contract.

Competitive Equilibrium

Proposition 2.5. In a competitive equilibrium with $g \,\epsilon\, \mathcal{G}$ where, $\mathcal{G} \,\epsilon\, \{[1,\, \underline{g}),\, (\underline{g},\, \overline{g}),\, (\overline{g},\, \overline{\overline{g}})\}$,

$$D^{CE}(g \,\epsilon\, \mathcal{G}) < D^S = D^{CE}(g > \overline{\overline{g}}) \;\forall\; \mathcal{G}$$

Proof. See Appendix A2.5.

In multi-prime financing, incentives of PB M determine aggregate debt since PB M retains a higher risk of loss than PB m. In an equilibrium where heterogeneity is not high enough, i.e., $g \,\epsilon\, \mathcal{G}$, aggregate debt is determined by equation (2.7) below,

$$\begin{aligned} &\overline{p} + \underline{p}\Big(\frac{q-\alpha}{1-\alpha}\Big) + \acute{p}\Bigg[\frac{q-\acute{\pi}^{CE}}{1-\acute{\pi}^{CE}} + \frac{\alpha(1-q)\acute{v}}{(1-\acute{\pi}^{CE})^2(D^{CE}-\acute{v})^2}(D^{CE}-\acute{v})\Bigg] \\ &= \frac{1}{\overline{r}} + \frac{\alpha(1-q)\acute{p}\acute{v}}{(1-\acute{\pi})^2(D^{CE}-\acute{v})^2}(D^{CE}_m - k_m\acute{v}) \end{aligned} \tag{2.7}$$

Comparing (2.7) with (2.3), the key difference between incentives of PB M and a single prime broker is that the total benefit of repayment due to the threat of audit $D^{CE} - \acute{v}$ does not accrue solely to PB M - part of it goes to PB m. This represents a cost for PB M, reducing her willingness to supply debt and decreasing the overall debt from the single-prime/socially optimal level. This intuition also applies to the case of $g \,\epsilon\, [1,\, \underline{g})$ - the only difference being that both PBs face identical risk exposure and therefore enjoy partial benefit of reduced likelihood of strategic default.

On the other hand, in an equilibrium with sufficiently heterogeneous offers, i.e., $g > \overline{\overline{g}}$, equation (2.8) shows that the benefit of repayment due to threat of audit accrues completely to PB M. Thus, aggregate debt secured by the HF is exactly the same as in the case of single-prime finance.

$$\overline{p} + \underline{p}\Big(\frac{q-\alpha}{1-\alpha}\Big) + \acute{p}\Bigg[\frac{q-\acute{\pi}^{CE}}{1-\acute{\pi}^{CE}} + \frac{\alpha(1-q)\acute{v}}{(1-\acute{\pi}^{CE})^2(D^{CE}-\acute{v})^2}(D^{CE}-\acute{v})\Bigg] = \frac{1}{\overline{r}} \tag{2.8}$$

Proposition 2.5 shows how heterogeneity in debt in determines the distribution of aggregate risk and thus incentives of each prime broker. This in turn, determines the level of aggregate debt secured by the fund. Furthermore, it also shows that the socially optimal level of funding can be only be supported in a competitive equilibrium with sufficiently high heterogeneity.[5] Proposition 2.6 provides necessary and sufficient conditions for $g > \overline{\overline{g}}$ to be true in equilibrium.

[5]Note that, our assumption $\alpha \leqslant \frac{1}{R}\Big(1 - \sqrt{\frac{\acute{v}}{\hat{v}}}\Big)$ rules out D^S to be supported in a competitive equilibrium with $g = \underline{g}$ or $\overline{g}$.

Proposition 2.6. (i) A competitive equilibrium with $(i,\, j) = (m,\, M)$, $g > \overline{\overline{g}}$ exists iff $q \leqslant \underline{q}(q)$ and $D^S > \underline{D} \equiv k_i \acute{v}\left(\frac{1-\alpha/q}{k_i-\alpha/q}\right)$.

(ii) There exists $\underline{k}(\alpha,\, q) \leqslant (2-\alpha)^{-1}$ such that $k_i \,\epsilon\, [\max(\alpha R,\, \underline{k}(\alpha,\, q)),\, (2-\alpha)^{-1}]$ implies $D^S > \underline{D}$ iff $\alpha \leqslant \alpha'(q)$

Proof. See Appendix A2.6.

The key implication of Proposition 2.6 is that for funds with sufficiently high ex-ante probability of success, the equilibrium must exhibit "relatively homogeneous" contracts. To see this, suppose PB j offers $d_{c,\,j} > \hat{v}$ so that PB i has to choose a best response with either $d_i \leqslant \acute{v}$ implying $g \geqslant \overline{\overline{g}}$ or $d_{c,\,i} \leqslant \acute{v} < d_i < \hat{v}$ implying $g \,\epsilon\, [\overline{g},\, \overline{\overline{g}})$. Comparing expected payoffs $U_i^{b,*}(g \geqslant \overline{\overline{g}})$ and $U_i^{b,**}(g \,\epsilon\, [\overline{g},\, \overline{\overline{g}}))$ respectively for these options,

$$\begin{aligned} & U_i^{b,**}(g \,\epsilon\, [\overline{g},\, \overline{\overline{g}})) - U_i^{b,*}(g \geqslant \overline{\overline{g}}) \\ & = \left[\overline{p} + \hat{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right) + \acute{p}\left(\frac{q-\acute{\pi}^{**}}{1-\acute{\pi}^{**}}\right)\right](D_i^{**} - D_i^{*}) + \acute{p}\left(\frac{1-q}{1-\acute{\pi}^{**}}\right)(k_i\acute{v} - D_i^{*}) \\ & \quad - \frac{1}{\overline{r}}(D_i^{**} - D_i^{*}) \end{aligned} \tag{2.9}$$

The first term in equation (2.9) is the increase in expected payoff when HF repays, the second term is the change in payoff when HF defaults, and the third term is the increase in lending cost. By choosing higher debt, D_i^{**}, PB i exposes herself to default when collateral payoff is low, i.e., $\tilde{v} = \acute{v}$. However, even in the event of default, payoff from seizing collateral is (weakly) higher than the alternate, i.e., $k_i\acute{v} \geqslant D_i^{*}$. In other words, PB i is better-off by choosing higher debt in the event of default. Thus, PB i prefers to offer higher debt D_i^{**} as long as the expected benefit outweighs the increase in lending costs, i.e., $U_i^{b,**} - U_i^{b,*} > 0$. This is true for a fund with sufficiently high ex-ante probability of success, i.e., $q > q'(q)$.

$$q'(q) = \overline{q} - (1-\alpha)\frac{\acute{p}}{\underline{p}}\left[\frac{q-\acute{\pi}^{**}}{1-\acute{\pi}^{**}} + \left(\frac{1-q}{1-\acute{\pi}^{**}}\right)\left(\frac{k_i\acute{v} - D_i^{*}}{D_i^{**} - D_i^{*}}\right)\right] \tag{2.10}$$

The result is surprising in that "high-quality" funds are predicted to be unable to raise as much funding as in the socially optimal case. Indeed, precisely because funds have a high chance of success ex-ante, the relatively smaller creditor prefers the lowest possible heterogeneity among contracts. This in turn is costly for the relatively larger creditor because she has to share the benefits of a credible threat of audit, ultimately incentivizing her to pull back funding to a level lower than the socially optimal level.

Furthermore, the proposition highlights that if social optimum is to be supported in a competitive equilibrium for funds with relatively low chances of success, the socially optimal level of financing for these funds must be sufficiently high in the first place. To see this, suppose $D^{CE} = D^S$ and $g > \overline{\overline{g}}$ is an equilibrium where PB i offers $D_i' < k_i\acute{v}$. However, at such high heterogeneity, the risk for PB i is so low that she would like to offer the maximum debt feasible, $k_i\acute{v}$. This puts a downward pressure on heterogeneity. To maintain the same aggregate debt, PB j must decrease debt from D'_j to $D_j = D^S - k_i\acute{v}$, leading to the minimum possible heterogeneity $g_{\min} = d_j/\acute{v}$. Then, $D^S > \underline{D}$ guarantees $g_{\min} > \overline{\overline{g}}$. Part (ii) provides sufficient conditions such that any fund, regardless of their chances of success, can satisfy this requirement. This happens if the fund pledges sufficient collateral to the smaller prime broker and invests in a portfolio with a low cost of audit. That is, low chances of success of an illiquid, hard-to-value portfolio can be compensated by pledging sufficient collateral to smaller prime broker and by either employing strong internal governance or, increasing investment easy-to-value assets.

On the other hand, if a fund chooses to invest in a portfolio with a high fraction of hard-to-value assets such that $\alpha > \alpha'(q)$, then pledging more collateral to the smaller PB no longer works so $D^S > \underline{D}$ is not necessarily satisfied for every fund. Since $\underline{D}$ is decreasing in q and assumption (I2.3.2) implies D^S is increasing in q, we can interpret the requirement $D^S > \underline{D}$ as $q > \underline{\underline{q}}$, as long as $\underline{\underline{q}} \,\epsilon\, (0,\, 1)$ exists. Assuming a unique fixed-point $q_f > \max(1/R,\, \underline{\underline{q}})$ exists where, $q_f = \underline{\underline{q}}(q_f)$, social optimum can be supported in a competitive equilibrium only for "intermediate-quality" funds, i.e., with ex-ante probability of success $q \,\epsilon\, C^{SW} \equiv q \,\epsilon\, ((\max(1/R,\, \underline{\underline{q}}),\, q_f]$.

To sum up, the results of propositions 2.5 and 2.6 can be summarized as follows -

(i) $D^{CE} < D^S$ for $q \geqslant q_f(\alpha)$

(ii) $(\alpha > \alpha'(q))$ or $(\alpha \leqslant \alpha'(q)$ and $k_i \,\epsilon\, [\alpha R,\, \max(\alpha R,\, \underline{k}(\alpha,\, q)))$ implies

  (a) $D^{CE} = D^S$ possible with $(i,\, j) = (m,\, M)$ and $g > \overline{\overline{g}}$ for $q \,\epsilon\, (\max(1/R,\, \underline{\underline{q}}(\alpha)),\, q_f(\alpha))$

  (b) $D^{CE} < D^S$ for $q \,\epsilon\, (1/R,\, \max(1/R,\, \underline{\underline{q}}(\alpha))]$

(iii) $\alpha \leqslant \alpha'$ and $k_m \,\epsilon\, [\max(\alpha R,\, \underline{k}(\alpha,\, q)),\, (2-\alpha)^{-1}]$ implies $D^{CE} = D^S$ possible with $(i,\, j) = (m,\, M)$ and $g > \overline{\overline{g}}$ for $q \,\epsilon\, (1/R,\, q_f(\alpha))$

These results are in stark contrast to those of Bizer and DeMarzo (1992) and Green and Liu (2021) who show that borrowing sequentially from multiple lenders results in higher indebtedness in comparison to borrowing exclusively from a single lender. The intuition there is that new lenders offer marginal interest rate lower than the existing ones since they do not take into account the increase in default risk of existing lenders due to worsening moral hazard or lack of commitment to repay by the borrower. This incentivizes the borrower to smooth out borrowing across lenders ultimately increasing indebtedness. Furthermore, there is no role for heterogeneity in contracts. In contrast, in our model, indebtedness may decrease for certain borrowers in comparison to borrowing from a single lender and heterogeneity is crucial in determining aggregate debt.

Similar to these papers, our model also features moral hazard - in the form of borrower's lack of commitment to repay. However, unlike these papers, our model features collateralized debt and costly state verification. The latter is meaningful due to our interpretation of strategic default as fraudulent transfers. Together, these create a role for heterogeneity in debt by determining loss given default and incentives of each creditor to supply debt. Propositions 2.5 shows the impact of heterogeneity on aggregate funding secured by the borrower. Proposition 2.6 show how different characteristics of the borrower influence the level of heterogeneity possible in equilibrium. Thus, our model highlights the importance of collateral and costly state verification in understanding the consequences of non-exclusive contracting which have hitherto been unrecognized in the literature.

The results also highlight a cost of multi-prime financing in the presence of position transparency. Specifically, position transparency allows prime brokers to observe aggregate risk and distribute it according to incentives. In our model, for any given fund characterized by the share of hard-to-value assets in its portfolio, this leads to reduced funding for high *and* low-quality funds. The latter may restore funding by increasing investment in easy-to-value assets and providing sufficient collateral to the smaller prime broker. Thus, a trade-off emerges between flexibility in investment strategy and aggregate funding that can be secured by the fund. There are two implications of this result for the existing literature. First, our model highlights another rationale for why funds' may not be forthcoming in disclosing all of their positions to prime brokers, as anecdotal evidence suggests.[6] Existing literature recognizes that prime brokers may utilize private information on funds' order flow and trading motives to take strategic actions (King and Maier, 2009) or disseminate it to other valuable clients for commissions (Barbon et al., 2019; Maggio et al., 2019), whereas our model highlights a potential cost to securing financing.

Second, private and social costs in our model are perfectly aligned because the social planner cares about the aggregate risk borne by prime brokers which by definition is also the case with a single prime broker. This is in contrast to the existing debate on hedge fund transparency where the focus is largely on investor welfare which in turn comes at the cost of hedge fund welfare. For instance, proponents of public disclosures for hedge funds argue for their potential in disciplining managers by limiting incentives to undertake excessive risks and misreport performance stemming from performance-based compensation contracts. Opponents argue increased public disclosures create opportunities for competitors to exploit proprietary information to mimic or front-run funds, thus harming their performance, Cassar and Gerakos (2018).[7] Indeed, Agarwal et al. (2013), Aragon, Hertzel and Shi (2013) document evidence of hedge funds actively protecting their proprietary information by seeking confidential treatment of Form 13-F holdings. Our model highlights that in terms of financing, position transparency may reduce the welfare of prime brokers and hedge funds

[6] Lack of position transparency received significant attention following the collapse of \$36 billion family office Archegos Capital Management in March 2021. For instance, an article in a leading newspaper noted - "Archegos's lenders say they were unaware of the extent of trades he was making with other banks, information that would have encouraged them to curb their lending. Banks can ask clients for information on their loans from other banks but clients don't necessarily have to disclose it or their positions." See, Inside Archegos's Epic Meltdown.

[7] To be clear, private costs may translate into social costs. In particular, reduced profitability due to increased disclosures may disincentivize information acquisition in the first place, ultimately harming price discovery, Aragon, Hertzel and Shi (2013).

alike.

Is Social Optimum a Competitive Equilibrium?

So far, we have provided conditions that guarantee social optimum can be supported in a competitive equilibrium. However, since multiple equilibria are possible in our model, it is not necessary that it will be. Indeed, assuming the set of funds where social optimum can be supported in a competitive equilibrium, $\mathcal{C}^{SW}(\alpha)$ is non-empty, the set of possible equilibria are - (a) $g > \overline{\overline{g}}$, (b) $g \,\epsilon\, [\overline{g},\, \overline{\overline{g}})$, (c) $g \,\epsilon\, [\underline{g},\, \overline{g})$, and (d) $g \,\epsilon\, [1,\, \underline{g})$. Matters are further complicated since there are two possible equilibria for every possible class of heterogeneity - $(i,\, j) = (m,\, M)$ or $(i,\, j) = (M,\, m)$. That is, prime brokers also compete for their relative standing as a creditor for the common client. However, from a social planner's perspective, the relative standing does not matter as long as $g > \overline{\overline{g}}$ holds in equilibrium. We end our discussion by providing a partial answer to this question in Proposition 2.7.

Proposition 2.7. Suppose an equilibrium with $(i,\, j) = (m,\, M)$ and $g > \overline{\overline{g}}$ exists. Then, PB i always prefers the equilibrium with $g > \overline{\overline{g}}$ over an equilibrium with $g < \overline{\overline{g}}$.

Proof. See Appendix A2.7.

The result shows that the relatively smaller creditor prefers an equilibrium with maximum possible heterogeneity, i.e., $d_i \leqslant \acute{v}$ is a strictly dominant strategy. The intuition is as follows. Consider, for instance, equilibria with $g > \overline{\overline{g}}$ and $g \,\epsilon\, [\overline{g},\, \overline{\overline{g}})$, and denote equilibrium payoffs for PB i as $U_i^{b,*}$ and $U_i^{b,h}$ respectively.

$$
\begin{aligned}
\frac{U_i^{b,h} - U_i^{b,*}}{D_i^h - D_i^*} &= \overline{p} + \hat{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right) + \acute{p}\left(\frac{q-\acute{\pi}^h}{1-\acute{\pi}^h}\right) - \frac{1}{\overline{r}} \\
&= \overline{p} + \hat{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right) + \acute{p}\left(\frac{q-\acute{\pi}^{**}}{1-\acute{\pi}^{**}}\right) - \frac{1}{\overline{r}} + \acute{p}\left(\frac{q-\acute{\pi}^h}{1-\acute{\pi}^h}\right) - \acute{p}\left(\frac{q-\acute{\pi}^{**}}{1-\acute{\pi}^{**}}\right) \\
&< \frac{U^{b,**} - U^{b,*}}{D_i^{**} - D_i^*} < 0
\end{aligned}
$$

The change in payoff per dollar of additional debt is the increase in repayment amount in every state of the world net of an increase in lending cost. Note that, the aggregate debt $D^h < D^S$. But, PB i has already rejected a deviation to D_i^{**} such that $g \,\epsilon\, [\overline{g},\, \overline{\overline{g}})$ which would have led to an aggregate debt of $D^{**} > D^S$ and therefore a lower probability of strategic default. Therefore, an equilibrium with contracts resulting in an even lower level of aggregate debt no better. The argument for $g \,\epsilon\, [\underline{g},\, \overline{g})$ is exactly the same. Finally, the equilibrium with $(i,\, j) = (m,\, M)$ and $g \,\epsilon\, [1,\, \underline{g})$ is worse since PB i faces an even higher risk of strategic default because the threat of audit is no longer credible at $\tilde{v} = \hat{v}$.

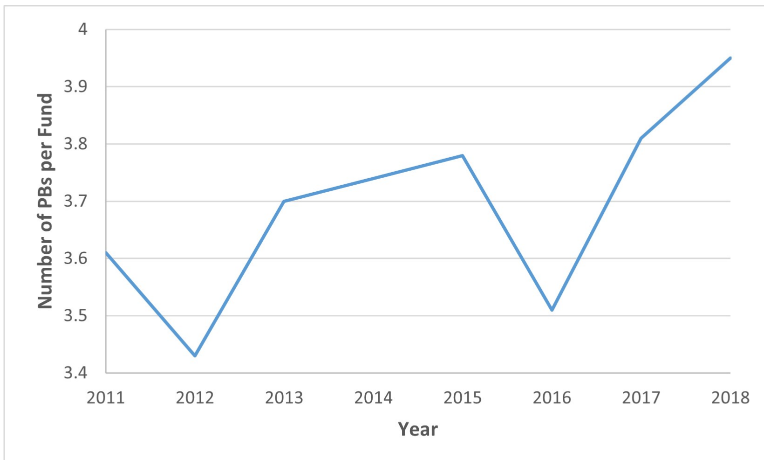
Proposition 2.7 raises the natural question whether commitment by a fund or its prime brokers to a relative standing is a binding constraint. While interesting from a theoretical perspective, an analysis of this question does not add any more insights to our previous results relevant for our goal of understanding the impact multi-prime contracting on financing secured by a hedge fund, except that in addition to characteristics of funds such as portfolio composition and internal governance, competition among prime brokers for relative standing as creditors may also preclude the existence of social optimum in a competitive equilibrium. Thus, we end our discussion on this note.

2.5 Conclusion

This chapter studies a model of nonexclusive contracting with a hedge fund raising secured debt from multiple prime brokers to invest in some hard-to-value assets. Prime brokers offer simultaneous bilateral contracts in the presence of position transparency. The key friction is the possibility of strategic default by fraudulently transferring assets to affiliates which creates a role for creditors' option to pursue a costly legal recourse. This in turn links heterogeneity in debt to aggregate debt secured in equilibrium, hitherto unrecognized in the literature. Next, we show that multi-prime financing in the presence of position transparency may reduce the welfare of hedge funds and prime brokers alike by resulting in aggregate debt below the single-prime and socially optimal level. This also leads to a new rationale for why funds may be reluctant to improve position transparency among their prime brokers. A direction for future work is to study how risk-taking and financing are jointly determined under multi-prime financing with the key friction being the lack of position transparency in that each prime broker is imperfectly informed about a client's investment financed by others.

Figures

Figure 2.1: Average Number of Prime Brokers per Hedge Fund by year



Note: This figure shows the average number of prime brokers utilized by hedge funds for the period 2011 - 2018. Source: Boyarchenko et al. (2020)

Figure 2.2: Sequence of events at $t = 0$

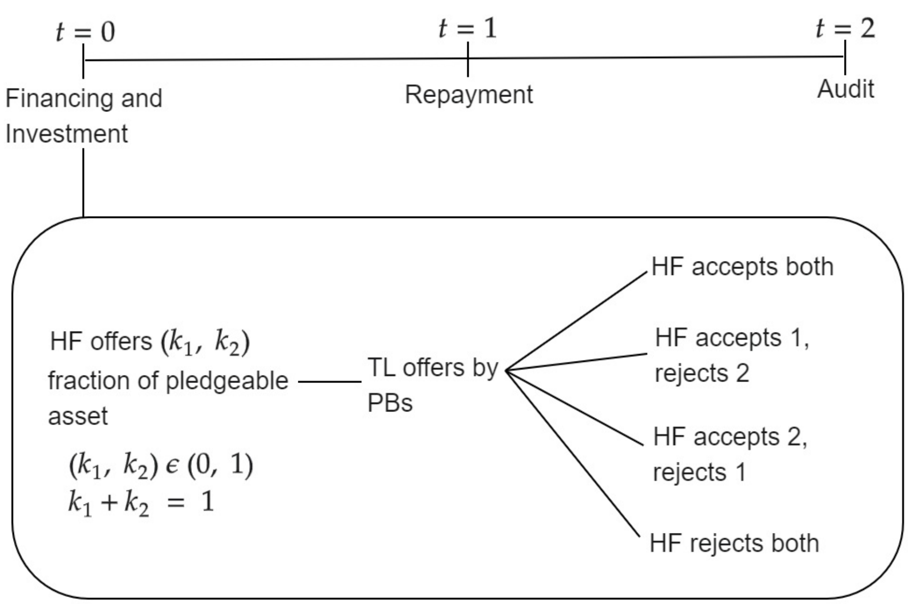


Figure 2.3: Sequence of events at $t = 1$, assuming HF accepts both offers

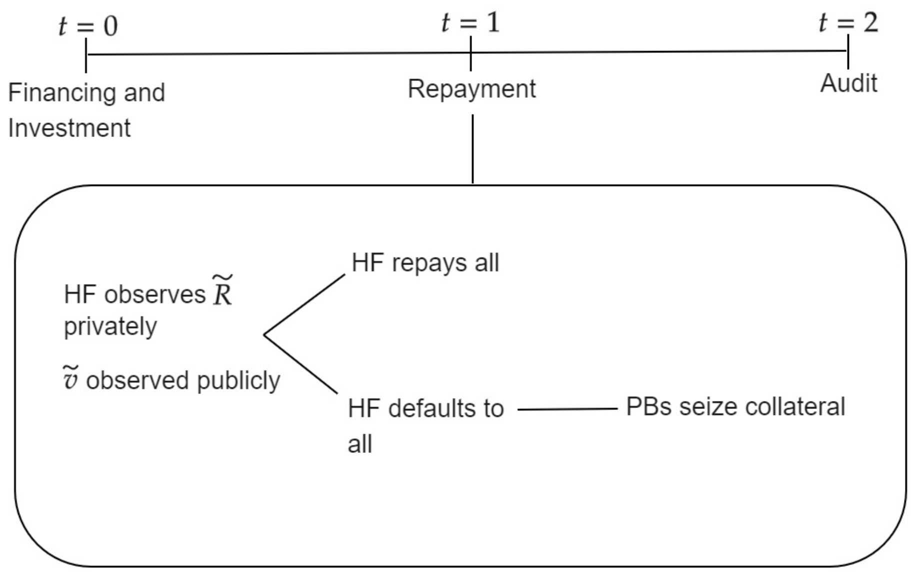


Figure 2.4: Sequence of events at $t = 2$. $\pi = \text{Prob.}(\tilde{R} = R \,|\, \text{Default}, \, \tilde{v}, \, u)$ where, u is HF equilibrium strategy for defaulting

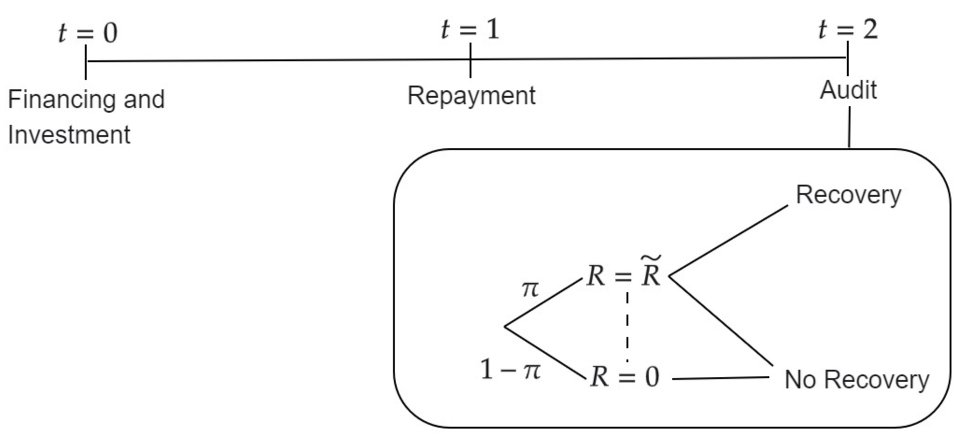


Figure 2.5: Auditing decisions at $t = 2$, assuming HF accepts both offers at $t = 0$.

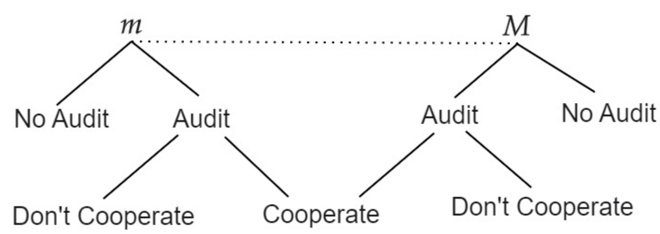
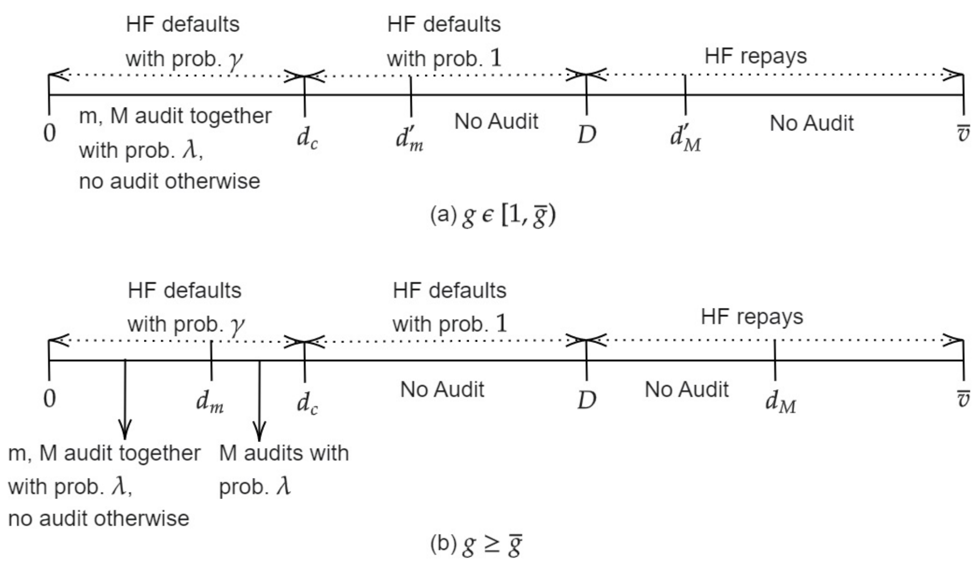


Figure 2.6: Impact of heterogeneity in debt on prime brokers' exposure to default risk



Chapter 3

Board Conduct in Banks

3.1 Introduction

The global financial crisis called into question the role played by board oversight in ensuring effective governance of banks and financial institutions. Several multilateral and national reports have highlighted the failure of bank boards in effectively assessing risks and have suggested that a key reform should be in the area of positioning risk management as a central responsibility of the board.[1] Therefore, it becomes important for academics and policymakers to observe and understand the internal operations of bank boards (Adams et al., 2010).

Prior academic research has concentrated on how board *structure* affects governance in banks (see Mehran et al. (2011); Nguyen et al. (2016)). However, board conduct in banks has not received attention, which is not an accident as board-level discussions are typically private. While minutes of board meetings are recorded, they are not shared publicly. Despite the importance of board oversight as highlighted by various policy reports analyzing the global financial crisis, no academic study examines board conduct in banks. To shed light on board conduct in banks, we obtain one instance of confidential board meeting minutes of a majority of Indian banks. Although this data naturally creates limitations with respect to generalizability, it nonetheless offers the first detailed look into board conduct in banks, which has hitherto remained private and confidential.

Using this new data, we explore the following research questions: What percentage of issues tabled in a banks board meeting is focused on strategy, risk, financial reporting, compliance, and human resources (HR)? Does this allocation correlate with the performance outcomes of the bank? Do bank boards deliberate issues at length, or do they resort to plain "box-ticking"? Due to the constraints on the external validity of our analysis, this chapter

[1]For a select few, see Senior Supervisors Group (2014); Walker (2009); UNCTAD (2010); Sheifer (2011); Group (2012). Specifically, Walker (2009) recommends that "board-level engagement in risk oversight should be materially increased, with particular attention to the monitoring of risk and discussion leading to decisions on the entity's risk appetite and tolerance."

is primarily descriptive in nature. Nevertheless, we are able to extract several patterns from this data that provide preliminary insights into these important questions.

As Schwartz-Ziv and Weisbach (2013) highlight through their analysis of the board minutes of a sample of industrial firms from Israel, an analysis of minutes of board meetings provide several advantages. First, while board structure captures *de jure* aspects of the board, board minutes capture the *de facto* working of the board. The *de facto* workings of the board can differ substantially from the *de jure* aspects due to the interpersonal interactions and relationships of board members. Board minutes come closer to capturing these interpersonal relationships than board structure. Second, board minutes enable us to understand the complexity and nuanced details of the topics brought up in the board meetings. The examination of board minutes helps identify issues such as "box-ticking" by bank boards, which would otherwise be difficult to deduce.

We follow the methodology of Schwartz-Ziv and Weis- bach (2013) to analyze the board minutes. We transform the minutes into a quantitative database, which enables us to draw inferences about the quality and quantity of discussions relating to the various functions in a bank. We classify the issues that are tabled in these meetings into five categories: risk, business strategy, financial reporting, regulation and compliance, and human resources. For each issue, we record the category to which the issue belongs and whether the board deliberated in detail on the issue or not. We record an issue as having been deliberated in detail if the board (i) asked for more information, (ii) elaborately discussed the issue, and/or (iii) the board rejected a proposal or modified it.

We report the following key findings. We find that the average number of issues brought forth before a bank board is 50 as compared to 8.5 in boards of industrial firms, as shown in Schwartz-Ziv and Weisbach (2013).[2] Regulatory and compliance-related issues account for the most (41%) of the issues tabled, followed by issues relating to business strategy (31%). Issues relating to risk account for 10% of the total issues. Overall, in our sample, we find that the regulatory and compliance issues form the largest percentage of issues tabled, followed by business strategy issues, while risk issues tabled are lesser than both of them. Statistical tests of differences in means and medians as well as first-order stochastic dominance among the respective distributions, confirm this ordinal ranking.

To test if the boards resort to "box ticking" or deliberate on the issues in detail, we examine the proportion of issues deliberated. Most of the issues that are tabled are not deliberated in detail. A natural question to ask would be whether boards do not consider risk issues much due to such issues being handled by the risk management committees (RMCs) of the boards. In this context, it is important to note that boards cannot outsource dealing with the risk issues to the RMCs. RMC is a mechanism, much like the internal audit, which provides detailed inputs to the board about risk- related issues. Further, there are board sub-committees on other topics such as compensation, audit, etc. Thus, there is

[2] We are grateful to Miriam Schwartz-Ziv for suggesting that the length of board meetings could be an explanation for this observation. Typically the bank boards in our sample meet for an entire day as opposed to the boards of industrial firms in their sample, which meet for a few hours.

no reason to expect the board to focus less on risk due to the presence of RMCs.

Next, we investigate the association of our conduct measures with bank level outcome variables. We find that the percentage of risk issues tabled is positively associated with the return on assets and return on equity, while it is negatively related to the proportion of non-performing assets to advances. However, we do not find any significant associations of most other categories of issues tabled with bank-level outcome variables, an exception being the positive relationship between the percentage of financial reporting issues tabled with the proportion of non-performing assets to advances.

Having established that board conduct is correlated with performance, we examine the association of board structure with that of board conduct. We examine this association in order to complete the loop on board structure influencing board conduct and, in turn, the banks performance. We find that prior board experience is positively associated with the percentage of risk issues tabled and negatively associated with the percentage of human resources (HR henceforth) and financial reporting issues tabled. We also find that having board members with international experience and private sector experience is positively associated with the percentage of risk issues tabled. Further, board size is positively associated with the percentage of financial reporting issues tabled and negatively with the percentage of HR issues tabled. Finally, we find that financial qualifications, prior management level experience, and independence of directors are negatively associated with the percentage of HR issues tabled. Overall, our findings suggest that our measures of board conduct are related to board characteristics and measures of bank performance.

To enable interpretation of our key findings, we construct a simple model of multi-tasking in effort by the board. The model predicts the ordinal ranking of issues tabled across three main categories strategy creation, risk mitigation, and in complying with laws and regulations and enables us to infer if the effort invested by the bank board in a particular category is efficient or not. A multi-task setting represents a natural choice given the multiple stakeholders shareholders, depositors, other creditors, and the regulator that banks have to contend with.

We obtain the following predictions. First, irrespective of the regulatory pressure faced by a bank board, the board would invest the least effort in risk mitigation. Specifically, the effort in strategy creation and that in regulation and compliance would be strictly greater than the effort by the board in risk mitigation. Second, if regulatory pressure faced by bank boards is high, the board would invest more in regulation and compliance than in strategy creation. Thus, the model generates predictions for how the ordinal ranking of the effort s in strategy creation, risk mitigation, and compliance varies with the intensity of regulatory pressure. The model also generates predictions about how over-or under-investment (compared to the optimal level) in each of the three categories varies with regulatory pressure.

We compare the model-predicted ordinal ranking of effort as a function of regulatory pressure with the ordinal ranking observed in our sample. This comparison first seems to suggest that bank boards under-invest in risk mitigation when compared to the economically optimal level; this finding is independent of the regulatory pressure faced by the banks in our sample. Second, this points in the direction of higher regulatory pressure being present in the environment in which the banks in our sample operate. The above two conclusions seem to covey that bank boards in our sample over-invest in matters pertaining to regulation and compliance. Our model also hints at depression in firm value, i.e., the value available to all claimants of banks, due to the current portfolio allocation of effort that bank boards in our sample choose low effort in risk mitigation, moderate effort in strategy creation, and high effort in regulation and compliance.

Collectively, our study provides important insights into the conduct of bank boards. First, our findings support the concern voiced in the report of the G-30 on the financial crisis that "boards that permit their time and attention to be diverted disproportionately into compliance and advisory activities at the expense of strategy, risk, and talent issues are making a critical mistake" (Group, 2012). To be precise, we only show evidence supporting the concern that boards may be permitting their attention to be diverted disproportionately into compliance at the expense of strategy and risk issues.

To our knowledge, ours is the first study to examine the con- duct of the bank boards. Our study thus complements research that focuses on how the structure of bank boards - board size, board independence, and characteristics of the board members, including their financial expertise - affects bank governance (see Mehran et. al. (2011) and the studies cited therein). For instance, Nguyen et. al. (2016) study the association between the structure of the board and CEO misconduct. Our work also relates to the literature examining the structure of risk management in banks (Ellul and Yerramilli, 2013; Aebi et al., 2012; Mongiardino and Plath, 2010a). Our study closely resembles Schwartz-Ziv and Weisbach (2013), who examine board conduct in non-financial firms and relate their evidence to various theories by carefully analyzing board minutes of Israeli government-controlled companies. In contrast to these studies, we focus on board conduct in banks and financial institutions.

Finally, although we study a snapshot of the issue by looking at one country, our findings are along the lines of several high- level committee reports that highlight similar findings in different countries. For example, the Walker (2009) report for UK banks and UNCTAD (2010) report for US banks underscore the need to materially increase the attention being paid to risk issues by bank boards. These findings suggest that the problem of under-investment in risk issues may not be peculiar to the particular country we study. We add to the literature by reporting systematic evidence beyond anecdotal evidence available in the form of these reports.

The chapter proceeds as follows. Section 3.2 discusses the differences between boards in banks and in industrial firms. Section 3.3 briefly describes the Indian banking system. Section 3.4 describes the data and methodology. Section 3.5 presents the results. Section 3.6 concludes.

3.2 Differences between boards in banks and in industrial firms

Corporate governance deals with the ways in which suppliers of finance to corporations assure themselves of getting a return on their investment (Shleifer and Vishny, 1997; Giroud and Mueller, 2010). In the corporate governance setting, board of directors provide a mechanism to mitigate conflicts of interest between managers and shareholders.

Fiduciary duty towards multiple stakeholders

In non-financial firms, it is generally accepted that the board of directors owe fiduciary duties towards shareholders while bondholders have other mechanisms such as covenants to protect their interests. However, corporate governance in banks is much more complex due to the relevance of banks in the economic system and the nature of banking business (Adams, 2010).

Three key differences distinguish the governance of banks from that of industrial firms (e.g., Ciancanelli and Reyes, 2001; Levine, 2004; Macey and O'Hara, 2003; Prowse, 1997). First, the capital structure of banks differs substantially from that of industrial firms. Banks' capital structure comprises almost 90% debt (as opposed to an average of 40% for industrial firms). A significant proportion of these debtholders are depositors who, therefore (collectively) constitute an important stakeholder. Second, partly because of the unique capital structure of banks, but also for other reasons, banks have many more stakeholders than industrial firms (Macey and O'hara, 2003; Adams and Mehran, 2003). A bank's insolvency has negative consequences for the financial system as a whole, and these spillovers need to be regulated and/or particular banks need to be bailed out. As a result, the regulator becomes a key stakeholder in the bank. The deposit insurance authority also has an interest in the bank's health, as its insurance will be called upon in the case of insolvency. The presence of multiple stakeholders can lead to diverging interests, especially with respect to risk. Shareholders may prefer volatility and may myopically focus on profits, while debtholders and regulators are likely to prefer low volatility and focus more on the long-term health of the bank.

Finally, banks' business is opaque and complex. Risks in a bank can change rapidly (Levine, 2004). For lending decisions, banks use soft information, which a third-party would find hard to verify (Bhowal et al., 2021). Banks also get involved in technically complex trading activities, which are hard for lay investors or lay depositors to understand. Since these risks are hard for investors and depositors to assess and monitor, oversight of the management is delegated to the board of directors and to the regulators. In stark contrast to industrial firms, *regulators play a critical role* in overseeing management and in bank governance.

All three features - a capital structure dominated by debt, multitude of stakeholders, and opacity and complexity of operations - play a role in the governance of banks. These affect the interaction between the board and management, on the one hand, and the relationship between the bank and its regulators, on the other hand. In fact, because of the special nature of banking and the spillover effects that banks create on other parts of the economy, *the duty of care owed by the board of a bank is substantially more expansive when compared to the duty of care owed by the board of an industrial firm.* In other words, a clear case can be made for bank boards being held to a broader, if not a higher, standard of care than boards in industrial firms. In particular, bank boards owe fiduciary duties to fixed claimants, i.e., the depositors and other debtholders, the regulator, as well as to equity claimants.

Role of regulation

Regulation presents several challenges in corporate governance. Even though regulation can be considered an additional mechanism of corporate governance, it may reduce the effectiveness of other mechanisms in coping with problems in corporate governance. The main aim of the regulator, which is to reduce systemic risk, might come into conflict with the main goal of shareholders, which is to increase equity value. The conflicting goals could also introduce a new agency problem. For example, while a regulator may focus on bank survival, 'appropriate' behavior, and acceptable performance, shareholders would focus on equity value. As well, regulators may be more risk-averse than shareholders (Kim and Prescott, 2005). Regulators may discourage competition and discipline banks by imposing restrictions on ownership structures (Prowse, 1997; Macey and O'hara, 2003). Regulators may also limit the power of markets to discipline the banks (Ciancanelli and Reyes-Gonzalez, 2001). Regulators may even pursue their own interests, thereby creating agency problems in the process of regulation (Boot and Thakor, 1993; Santomero, 1997).

3.3 The Indian banking system

To provide an overview of the institutional background, we describe the banking system in India briefly. Banks in India dominate the financial landscape. Accounts of the flow of funds into the Indian economy show that banking flows account for more than 50% of the total financial flows in the economy.[3] The Indian banking system is divided into the following categories: (i) government- owned banks, called public sector banks, (ii) private-sector banks, and (iii) foreign banks (Tantri, 2020). All public sector banks are listed and hence have a significant minority stake. Government stake in the public sector banks varies between 55% and 85%.[4] Foreign banks are fully owned subsidiaries of non-Indian banks and are registered as foreign banks in India. The banking system is regulated by the banking regulator - The Reserve Bank of India (RBI).

Corporate governance in public sector banks and privately owned banks differ significantly. The Ministry of Finance, Government of India, effectively exercises the powers of a

[3] Source: https://www.rbi.org.in/scripts/PublicationsView.aspx?id=15440.
[4] Source: http://financialservices.gov.in/banking/Shareholding.

majority shareholder in public sector banks. Laws that govern public sector banks lay down rules regarding corporate governance - the SBI Act of 1955 for the State Bank of India and the Nationalization Acts of 1967 and 1980 for the other public sector banks. The respective acts applicable to public sector banks specify the types of directors to be chosen and the way such directors are to be chosen. These different categories of directors include representatives of the Government and the RBI, qualified finance professionals, and employee representatives. After listing, the respective acts have been amended to include shareholder elected directors on the board. The positions of the Chairman of the board and that of the CEO are held by a single individual. As a majority shareholder, the Government gets to appoint the CEO, and the same is done through a bureaucratic process.

Private-sector banks, on the other hand, follow corporate law with respect to their corporate governance. Private bank boards comprise of both executive as well as independent directors in accordance with corporate law. Private-sector banks follow international best practices in matters pertaining to the appointment of the CEO and directors on the board. The process starts with the appointment of a search committee comprising of experts in banking and related areas and culminates with shareholder nod for the proposed appointment.

Responsibilities of the board

The board of a bank has the overall responsibility for the bank, including risk management, culture, governance framework, and approving as well as overseeing managements implementation of the banks strategic objectives. The central bank's guidelines on bank governance clearly state that the board is responsible for overseeing a strong risk governance framework. The board is required to take responsibility for the banks risk-taking activities, assessing risks and issues independently. Furthermore, it is in charge of defining the risk appetite of the bank and ensuring the banks adherence to the risk policy and risk limits. Other responsibilities of the board involve taking responsibility for the banks business strategy, financial soundness, key personnel decisions, and internal organization.

The board meets these responsibilities by setting agenda for its meetings and actions emanating therefrom as recorded in minutes of the meetings. The board is required to maintain appropriate records of their proceedings at each meeting, including minutes of meetings, summaries of matters reviewed, main discussions, dissenting opinions, decisions taken, recommendations made, and board resolutions. The minutes of meetings are required to be prepared in accordance with the guidelines issued by the Institute of Company Secretaries of India (ICSI).

To fulfill its responsibilities, the board has to define certain governance structures; one such structure is the formation of committees such as the risk management committee (RMC), audit committee, nomination committee, etc. For example, the nomination committee feeds in information regarding possible candidates for appointment to the board, but the final decision of who to appoint (keeping in mind the candidates skill, experience, and regulatory requirements) lies with the board. These committees only aid the board in carrying out its responsibilities but do not have the final responsibility, which lies with the board. Since the board oversees the risk profile of the bank, it is also required to consider issues not raised by the RMC that could affect the risk profile of the bank. Furthermore, boards are not limited by the reports submitted by any sub-committees such as the RMC. They are required to robustly review the findings and to challenge the assumptions behind any recommendations. The minutes that we study are of board meetings only. The issues tabled and discussed in various board committees are not considered in our analysis.

3.4 Data and methodology

Our data are based on the minutes of bank board meetings (hereafter "board minutes" for brevity) obtained from a committee instituted by the Reserve Bank of India (RBI) in January 2014 to review the governance practices of boards of Indian banks. To fulfill its mandate, the committee requested all major banks in India to provide detailed minutes of their latest board meeting. The request was sent to 24 public sector banks and 17 privately owned banks. The request was sent during the second week of February 2014. By then, not all banks had completed the board meeting for the third quarter (ending December 2013). Hence, the committee requested banks to share the minutes for the board meetings in their second quarter (ending September 2013). 17 public sector banks and 12 private banks provided the required data. The banks that provided the data are all listed and account for 70% of market capitalization and 65% of revenues of all banks in India.

Representative data from the minutes of a board meetings contain the following information: name of the bank, date and venue of the meeting, names of the directors who attended the meeting, names of the bank executives (other than directors) who were invited to the meeting, agenda for the meeting and the way the agenda items were deliberated and resolved. The document further provides information about each item on the agenda. A brief explanation is provided about the agenda item.

The document then records the views expressed by the members of the board on that agenda item, though the identity of the individuals expressing the view is not mentioned.[5] This recording of views goes beyond just noting down whether an issue was discussed or not, rather the document contains details related to concerns expressed by board members over certain issues, or expression of dissent, rejection of a policy, requests for clarification, and direction to management for further action including seeking expert opinion all of which are noted down as an issue being deliberated.

Unfortunately, the minutes do not capture the tone of a view expressed but do capture the opinions expressed. The description of a deliberated issue ends with a note about how the chair decided to close the issue. A closure usually takes one of the following forms: (i) voting; (ii) seeking clarification from the management and a discussion on what the clarification should be; (iii) postponement of the issue for further consideration in subsequent meetings;

[5] An example of one such view is as follows: "Some of the directors expressed their concern over accretion of NPA levels despite very good recovery made by Bank during the quarter".

(iv) issuing instructions to the management regarding further action; (v) seeking expert opinion on technical matters; (vi) recording of dissent; and (vii) providing advice to the management. Finally, the document records the resolution that was passed by the board.[6]

We recognize that some straightforward issues may not need deliberations. Thus, even an agenda item being tabled provides information regarding the focus and interests of the board. However, deliberations capture another dimension of board behavior. Our interest in recording whether the agenda item was deliberated or not stems from trying to identify whether board members are active in challenging the assumptions and policy decisions taken by a particular executive or a group of executives. We consider an issue being deliberated as a positive signal because it suggests that there was an open debate regarding the issues, and the decisions were not driven by one or a group of powerful board members.

In particular, the existence of active deliberations precludes the existence of executive group-think, which is known to lead to sub-optimal outcomes for the banks. The Walker report (2009) finds that one of the main characteristics of failed bank boards is the failure of the board to "challenge the executive on substantive issues as distinct from a conventional relatively box-ticking focus on process." The report further notes that this lack of challenge can show up as diffidence when discussing complex issues by not asking clarificatory questions or conforming to the opinions and decisions of stronger members to not appear disruptive, non-collegial, and even as disloyal. Thus, a board involved in box-ticking is unlikely to deliberate on issues in detail and ask uncomfortable questions to the management.

Agenda and resolutions

The board meetings do not use prepared resolutions. The resolutions are prepared during the meeting. The company secretaries use standard formats for resolutions but do not fill them up before the meeting. After the discussion on an agenda item, they fill up the relevant fields just before a resolution is taken up for voting. In a meeting conducted in its true spirit, there is no way anyone can be sure whether an agenda item will be passed in the meeting. Thus, resolutions cannot be prepared in advance.

Furthermore, from our reading of the board meetings, it does not appear that they come with prepared resolutions. The board is sometimes offered new and pertinent information during the meetings rather than before, which precludes prior preparation. For example, the meeting minutes in one of the banks stated that the Reserve Bank of India (India's central bank) had commented on the lack of policy for general provisions and reserves during its annual financial inspection (AFI). This was clearly an important point of consideration, which was only brought forward in the board meeting.

The chairperson circulates the draft agenda before the meeting. The members can suggest the inclusion of additional agenda items or exclusion of a proposed agenda item from

[6]Details of the contents of board meeting minutes are based on extensive discussions with company secretaries. Company secretaries are the members of a professional body known as the Institute of Company Secretaries of India. The body is constituted by law. Only the members of the institute can serve as secretaries to companies. They manage the process of minute writing.

the meeting. The chair does not have discretion regarding mandatory issues such as consideration of financial statements, consideration of management decisions that need the board's approval, etc. The chair eventually decides about inclusion or otherwise of other issues.

Data on financial performance

The data pertaining to bank-level variables such as the proportion of non-performing assets, return on assets, net interest in- come, etc. are from the Prowess database maintained by the Center For Monitoring Indian Economy (CMIE). CMIE is a leading Indian policy research organization, which specializes in the collection and dissemination of Indian corporate data.

Summary statistics

Our sample consists of 17 government-owned and 12 private Indian banks. Due to confidentiality agreements, we cannot identify individual banks in our sample. However, all 29 banks are among those listed in Table 3.1. Summary statistics on the performance of Indian banks coinciding with the second quarter of 2013-14, for which the board minutes are analyzed, is presented in Table 3.1.

A potential concern with our sample is the extent to which these banks are comparable to other banks across the world. Some of the large banks compare well with their global peers in terms of size. HDFC Bank, the largest Indian bank by market capitalization, is ranked 52$^{\text{nd}}$ in the world with a market capitalization in excess of $32 billion.[7] This compares well with the market capitalization of some of the well known banks in the world such as Deutsche Bank AG of Germany ($45.69 billion), Society Generale of France ($47.62 billion), Credit Suisse group of Switzerland ($51.51 billion) and Standard Chartered Bank of U.K. ($51.58 billion). ICICI Bank, the second-largest private-sector bank by market capitalization and the largest private sector bank by book value of assets, is ranked 66$^{\text{th}}$ in the world with a market capitalization in excess of $25 billion. The largest public sector bank - State Bank of India - is ranked 68$^{\text{th}}$. It is also important to note that three Indian banks are a part of the top 100 in the world in terms of market capitalization. This is comparable to industrial economies such as U.K. (5), Canada (5), Japan (4), Australia (4), France (3), Germany (2), and Brazil and South Korea (1 each).

Using metrics for operational and financial performance as of the second quarter of 2013-14, Indian banks compare well with their global peers. Indian banks maintain a capital adequacy ratio of 13.2, which is 65% higher than the Basel II norms. These numbers compare well with the average capital adequacy ratio of 15.46 maintained by American Banks.[8] In terms of operational parameters such as return on assets (ROA), the proportion of non-performing assets (NPA), net interest margin (NIM), Indian banks' performance is comparable to global standards. However, consistent with the political economy literature (Cole,

[7] https://www.relbanks.com/worlds-top-banks/market-cap.
[8] https://www.newyorkfed.org/research/banking_research/QuarterlyTrends2013Q2.pdf.

2009), private banks outperform public sector banks in almost all parameters. Panel B of Table 3.1 shows that for private-sector banks average ROA is 1.33%, Gross NPA to assets ratio is 1%, and NIM is 2.75%. The same numbers for public sector banks turn equal 0.72%, 2.2% and 2.30% respectively.

We further compare Indian banks with banks in developing economies. Table 3.11 provides comparative information about the five largest banks in Brazil, Russia, China, and India as of FY 2013-14. We find that Indian banks compare well with other developing markets in terms of critical operational parameters such as Non-performing assets (NPA) to advances ratio, Net interest margin (NIM), and Capital adequacy ratio (CAR). However, in terms of size, Indian banks are closer to Brazilian and Russian banks but are smaller than their Chinese counterparts.

Methodology

Since the data is qualitative in nature, it is important to de- scribe the methods used to convert the qualitative database into a quantitative one. We use content-analysis methodology as mentioned in Krippendorff (2012) and Lieblich et al. (1998), which specifies the procedures to reduce words of text into fewer content categories. This methodology involves constructing a quantitative database by categorizing or coding different aspects of a qualitative data set.

This categorization is done in two stages. In the first stage, we perform a preliminary examination of data from a small number of government-owned and private-sector banks to establish the list of categories a method known as emergent coding, under which categories are established following initial examination of the data (Stemler, 2001). The first step was done independently by two of the authors; after comparing notes and reaching a consensus, they established five categories - risk, business strategy, regulation and compliance, financial reporting, and human resources.

The second stage involves categorizing issues tabled in board meetings into one of the five categories. One of the two authors involved in the first stage categorized the various issues into the above-mentioned five groups, and the second author validated the categorization. In cases of disagreement, the two authors discussed and agreed on the best classification. Similar to Schwartz-Ziv and Weisbach (2013) , we used the same code for all the board meetings, which helps maintain consistent application of coding principles. Our unit of analysis is at the issue level. We outline the classification process below:

First, for each issue, we note down the name of the bank and the date of the meeting. Second, we classify each issue into one of the five categories. A brief overview of each of the categories is provided below. Table 3.2 provides more examples of issues in each category.

1. **Risk:** Risk management plays a critical role in the banking business (Ellul and Yerramilli, 2013). Therefore, we analyze matters relating to risk separately. These include reviewing large foreign exchange exposures, fixing exposure ceilings across different

sectors and products, adherence to exposure norms, and reviewing policies pertaining to credit risk management, market risk management and operational risk management.

2. **Business Strategy:** These include forward-looking issues relating to business strategy that have long-term consequences for the bank. We consider only those issues that are not mandated by the regulator as a business strategy issue. Representative examples would be a proposal to enter the insurance business by forging a joint venture with a foreign collaborator, initiating a promotional campaign, and approval of large investments.

3. **Financial Reporting:** These involve regular stock-taking of financial results. These issues are generally based on the management's presentation of financial results for the quarter. These include, for example, a discussion of quarterly performance, a review of the growth of deposits, and peer-level performance reviews.

4. **Regulation and Compliance:** Under this category, the first set of issues are generally tabled and discussed in response to either a specific instruction or a general guideline by regulators. A representative issue in this category would be a discussion on Anti-money Laundering Guidelines issued by the RBI or on meeting the KYC (Know Your Customer) norms issued by the RBI. This category also includes issues that must receive the formal approval of the board, such as granting the authority to sign a contract or financial reports, the nomination of a trustee, power of attorney, etc.

5. **Human Resources:** This includes issues such as appointments and approvals of directors, perks and perquisites for employees, incentive schemes for employees, promotion policies for employees, training, and skill development of employees.

Third, if an issue is just presented before the board and the related resolution is deemed to be passed without discussion, then we code such an issue as just presented or tabled without it being deliberated.

Finally, as mentioned earlier, we are interested in capturing whether an issue was discussed at length to pin down the presence of challenge and open debate in the board meetings. If the tabling of an issue is followed by a discussion on the same, then we code the issue as deliberated. Before coding an issue as deliberated, we make sure that a discussion on the issue is found in the minutes. Specifically, we define an issue as deliberated if the board discusses the issue in detail and takes any of the following actions:

1. directs management for further action

2. demands more information

3. expresses concern over relevant existing processes, data, performance indicators, etc.

4. rejects a new policy or proposal.

An issue where the minutes just mentions that the issue was deliberated without providing details of the discussion is not considered as deliberated.

3.5 Results

Tabling of issues across categories

Table 3.3 shows the total number of issues tabled in a board meeting for each category. Panel A shows the summary statistics for the number of issues tabled in a board. The summary statistics for the percentage of issues are shown in brackets. Note that the percentage figures in brackets need not add up to a hundred as they represent summary statistics of the percentage of a category of issues tabled. For instance, the figure in brackets in row one is the mean percentage of risk issues tabled out of all issues by bank boards.

Panel B shows the detailed distribution of issues tabled in each category. On average, bank boards table 50 issues, which is significantly greater than the 8.5 tabled in the boards of industrial firms, as shown in Schwartz-Ziv and Weisbach (2013). The bank boards in our sample table significantly more issues because they meet for an entire day, in contrast to a few hours as in the case of Israeli firms in Schwartz-Ziv and Weisbach (2013).

On average, bank boards in our sample table 18 issues in business strategy and 19 issues in regulation and compliance. In contrast, they only table six issues in risk, five in financial reporting, and three in human resources. Examining the numbers in the brackets in Panel A, we see that boards table issues relating to regulation and compliance the most, which takes up 40.88% of the total board attention. Issues relating to business strategy are next in importance as they receive 30.63% of the boards attention. In comparison, issues relating to risk only account for 10.31% of the boards attention.

In Tables 3.12 and 3.13, we formally test if the percentage of risk issues tabled is dominated by the percentage of strategy issues tabled and the percentage of regulation and compliance issues tabled. In Table 3.12, we find strong evidence that the percentage of risk issues tabled is dominated by the percentage of strategy issues tabled. The difference in means is statistically significant at the 99% level. In Table 3.13, we similarly find strong evidence that the percentage of issues tabled pertaining to regulation and compliance dominates the percentage of strategy issues tabled. The difference in means here is statistically significant at the 95% level. Overall, we find that regulation and compliance issues are tabled the most, followed by business strategy issues. The percentage of risk issues tabled is lesser than both of these categories.

Robustness of findings on issues tabled

We now examine the robustness of the above findings. To do so, we inspect the distribution of various categories of issues tabled. We also examine whether the categories of issues tabled vary with the ownership and size of the bank. Finally, we look at whether our measures of board conduct are associated with bank-level outcome variables.

Examining the entire distribution

In Panel B of Table 3.3 , for each of the categories, we examine the distribution of the number and percentage of issues tabled in a board meeting. Specifically, we show the 10th, 25th, 50th, 75th, 90th percentiles together with the mean for the number and percentage of issues tabled in a board meeting across the various categories. This table displays the distribution by the number of issues tabled while the values in brackets display the distribution for the percentage of issues tabled. In this table, we observe that the distributions for the number and percentage of business strategy issues tabled first-order stochastically dominate the distributions for the number and percentage of risk issues tabled. Similarly, we observe that the distributions for the number and percentage of regulation and compliance issues tabled first-order stochastically dominate the distributions for the number and percentage of risk issues tabled.

Finally, we observe that the number and percentage of regulation and compliance issues tabled are strictly greater than the number and percentage of strategy issues tabled at the 10th, 25th, 50th percentiles. However, the reverse is true for the 75th and the 90th percentiles. Thus, we cannot conclude that issues pertaining to regulation and compliance first-order stochastically dominate the issues pertaining to strategy.

Effect of state versus private ownership

Table 3.4 shows how the number and percentage of issues tabled across various categories vary with the nature of bank ownership.

Since the Indian banking sector comprises primarily of public sector (government owned) banks and privately owned banks, we make this important distinction. While the number of issues tabled is about 30% higher in private-sector banks than in public sector banks, the fraction of issues tabled across the various categories is similar for the private sector banks and the public sector banks.

Association with bank size

We now examine if the above inferences vary with the size of the banks in our sample. Figure 3.2 shows the correlation of the fraction of issues tabled in a particular category with bank size. From this figure, we can infer very clearly that the fraction of issues tabled in a particular category does not vary with bank size. Thus, a key bank characteristic such as bank size does not seem to drive the above inferences.

Association with bank-level variables

To examine if our measures of board conduct are indeed meaningful, we examine their relationship with various bank-level variables that capture bank-level outcomes. In Table 3.5 , we examine the relationship between various categories of issues tabled in bank board meetings with various bank-level variables. The outcome variables considered return on assets, return on equity, net non- performing assets to net advances ratio, and gross non-performing assets to gross advances ratio.

We regress a bank-level outcome variable such as return on equity on the proportion of issues of a particular category tabled in a meeting. Among the various categories of issues tabled in board meetings, we find that the percentage of issues pertaining to risk is significantly related to all the proxies for bank performance. Specifically, a higher percentage of risk issues tabled in board meetings associates positively and significantly with return on assets and return on equity and negatively and significantly with the proportion of non-performing assets to advances. However, the other categories, such as business strategy, regulation, and compliance, financial reporting, etc., do not seem to be related to bank performance. One exception to this is the positive association between the proportion of financial reporting issues tabled and the proportion of net non-performing assets to net advances. The proportion of financial reporting issues tabled is negatively related to net non-performing assets to net assets ratio. Figures 3.1 , 3.3, and 3.4, which show the scatter plot as well as the linear fit, provide the same inferences.

The regressions control for ownership type and bank size by including indicator variables representing government ownership and above median size. We further examine whether the above associations vary with the type of ownership - Government versus private-owned by including the interaction of the binary variable representing government ownership with the proportion of issues tabled in that category. Results in Table 3.14 show that the interaction between the government bank dummy and the proportion of risk issues is statistically indistinguishable from zero for all outcomes except the return on assets (ROA). Thus, the relationship is not any different for government-owned banks. When it comes to the ROA, the association is relatively lower for government banks when compared to private banks. The coefficient of the interaction term is negative and statistically significant. However, the overall positive association be- tween the proportion of risk issues tabled and the ROA is higher than the interaction term in terms of absolute magnitude (9.765 vs. 7.909). Thus, there is a positive association between the pro- portion of risk issues tabled and the ROA, even for government banks.

How does board conduct influence bank-Level outcomes?

A reader may wonder how can an active board influence a bank's operating performance. An active board member is likely to impact bank operating performance by influencing the functioning of the executives. An active board questions past performance, highlights the areas of improvement, and suggests course correction. More importantly, such boards are likely to monitor the performance of the executives concerning course corrections agreed and question them further if the progress is not satisfactory.

For instance, consider a situation where a bank presents low delinquency numbers by resorting to restructuring of loans. Under regulations prevalent during our sample period, banks could show a low level of default and higher profits by resorting to loan restructuring as the provisioning required on restructured loans was lower (Chopra et al., 2021). By carefully examining the borrower fundamentals and through penetrating questions to the executive, an alert board could recognize that most of the restructuring transactions are evergreening transactions in disguise. Boards also could monitor such transactions carefully. Such monitoring could reduce evergreening transactions and make the bank balance sheet healthy in a true sense. Such banks are less likely to see a sudden run or a crash when the evergreening is revealed through a regulatory audit or spiraling of defaults. Thus, an active board could contribute to transparency and stability.

Similarly, boards can also detect instances of enjoying a quiet life or lazy banking upon examination of lending policies, turnaround times for loan processing, investments in government securities and cash, sectoral allocation of credit, etc. Such monitoring could increase lending to profitable sectors, and hence, con- tribute to the income and profits of the banks. Given the lack of data, we cannot pinpoint the exact channel at work.

Quality of deliberation in bank boards

The Walker Report (2009), which reviewed corporate governance in UK banks, mentions that the sequence in board discussion should start with an idea being presented, followed by the idea being challenged. To examine whether bank boards follow this sequence, we investigate the level of deliberations in bank boards. Specifically, we investigate whether any board member participates beyond merely giving approval or agreeing with the items tabled in the meeting. Actions such as seeking further information or updates, expressing concerns, modifying a proposal, and dissenting with the management qualify as identifiers of deliberations on the issue. It is crucial to capture the presence of active participation and challenge in the board meetings as this was noted as one of the reasons for the failure of bank boards (Walker, 2009).

Table 3.6 shows the total number of issues that are deliberated in detail across each category. Panel A shows the summary statistics for the number of issues deliberated in detail in the board. The summary statistics for the percentage of issues deliberated in detail are presented in brackets. Panel B shows the detailed distribution for the number of issues deliberated, with the distribution of the percentage of issues deliberated in detail being presented in brackets. On average, bank boards in our sample deliberate four issues in business strategy and three issues in regulation and compliance. In contrast, they only deliberate one issue in each of risk, financial reporting and human resources.

The numbers in brackets in Panel A show that bank boards deliberate issues relating to business strategy the most, which accounts for close to 30% of the issues deliberated. Issues relating to regulation and compliance are next in importance as they account for close to

25% of the issues deliberated. Issues relating to risk account for less than 10% of the issues deliberated.

Robustness of findings on issues deliberated

We now examine the robustness of the findings relating to the issues that are deliberated. To do so, we inspect the distribution of various categories of issues deliberated. We examine whether the categories of issues deliberated vary with ownership and size of the bank. Finally, we look at whether our measures of board deliberations are associated with bank-level outcomes.

Examining the entire distribution

Panel B of Table 3.6 , which shows the distribution of the number and percentage of issues deliberated (presented in brackets) in detail across the various categories, suggests that the above findings remain robust when we examine the entire distribution rather than just the means. In this table, we observe that the distributions for the number and percentage of business strategy issues deliberated in detail first-order stochastically dominate the distributions for the number and percentage of regulation and compliance issues that are deliberated. Similarly, we observe that the distributions for the number and percentage of regulation and compliance issues that are deliberated, in turn, first order stochastically dominate the distributions for the number and the percentage of risk issues that are deliberated.

Effect of state versus private ownership

Table 3.15 shows how the number and percentage of issues deliberated across various categories vary with the nature of bank ownership. The number of issues that are deliberated in detail equal 10 for both private-sector banks and public sector banks. Further, the percentage of issues that are deliberated in detail is no different between the private sector banks and the public sector banks. As a percentage of the number of issues that are tabled in each category, the fractions are different for the private sector banks and the public sector banks. However, this is primarily because of the differences in the number of issues tabled between the public sector banks and the private sector banks, as we saw in Table 3.4.

Association with bank size

We now examine if the above inferences vary with the size of the banks in our sample. Figure 3.5 shows the correlation of the fraction of issues deliberated in detail in a particular category with bank size. From this figure, we can infer that the percentage of risk issues deliberated in detail decreases with bank size, albeit at a very low rate. However, the deliberation of issues that are related to business strategy and regulation and compliance do not vary with bank size.

Association with future bank level variables

To examine if our measures for deliberation in the board are in- deed meaningful, we examine their association with several bank level variables using a regression framework. In Table 3.7, we examine the association of the various categories of the fraction of issues deliberated in detail with return on assets, return on equity, net non-performing assets to net advances, and gross non- performing assets to gross advances. We regress a bank-level outcome variable such as return on equity on the proportion of issues of a particular category deliberated in a meeting. We include binary variables to control for differences between government-owned and private banks, and for the size of the bank.

In line with the results relating to tabling of issues presented in Table 3.5 , we find that the percentage of issues pertaining to risk is related to most of the proxies for bank performance. Specifically, the percentage of risk issues deliberated in board meetings associates positively with return on assets and return on equity, and associates negatively with the proportion of non-performing assets to advances. While these relationships are economically significant, none of them are statistically significant. We think that the primary reason for the weakening of the results is the loss of statistical power. As noted before, less than a fifth of the issues are deliberated. Hence, most of the values for the key dependent variable and the interaction term are zeros. With only 29 observations available for the test, the variation reduces significantly. Therefore, even where there is an economically meaningful relationship, it is hard to establish statistical significance.[9]

Overall, our results of low level of deliberations support the findings in the Walker Report (2009), which identifies "absence of challenge in the board room" as one of the principal deficiencies in bank boards.

Determinants of tabling of risk issues

It is possible that the reason we see fewer risk issues being discussed is due to safer banks tabling fewer issues. To address this concern, we run a determinants model to understand the drivers of propensity to discuss risk issues. We consider two types of determinants: risk-related drivers and other bank characteristics; both these drivers are calculated as average values in the three quarters prior to the second quarter of 2013 - the quarter which covers our sample period. We present the results using risk-related drivers (other bank characteristics) in Table 3.8 (Table 3.9).

We use standard measures of risk used in the literature: volatility of equity returns, volatility of earnings, capital adequacy ratio, provision coverage ratio, net NPA by net advances, and gross NPA by gross advances (Laeven and Levine (2009); Delis Kouretas (2011);

[9]We further examine whether these associations vary with the type of ownership - government versus private-owned banks. We use a binary variable Government Owned Bank, which takes the value of 1 for government-owned banks and zero otherwise. We also interact the above binary variable with the proportion of issues deliberated in each category. We present the results in Table 3.16. The relationships between various categories of issues deliberated, and bank-level variables do not appear to be different for government banks when compared to private banks.

Shehzad. de Haan, Scholtens (2010)). The measures of profitability used are return on assets (ROA), return on equity (ROE), and net interest margin. We use total assets to proxy size, loan growth to measure activity levels, and the proportion of government ownership to capture differences arising from ownership. The dependent variable in this regression is the percentage of risk issues tabled as a proportion of the total number of issues tabled in the board meeting in column (1), while the dependent variable in column (2) is the percentage of risk issues deliberated as a proportion of the total number of issues deliberated in the board meeting.

As seen Tables 3.8 and 3.9 , we do not find any significant association between prior risk-profile or bank characteristics and the propensity to discuss risk issues. This suggests that the findings related to a lower proportion of risk issues being tabled and deliberated are not driven by safer banks tabling fewer risk issues. The lack of association offers another takeaway: since boards of riskier banks are not tabling more risk issues, it is possible that even in riskier times, boards may not change their behavior to take into account the increased risk.[10]

A second concern regarding the results pertains to the uniqueness of the time period. Since we only have data for one quarter, it is important to understand whether this quarter was any different from other time periods and whether this difference could be driving the results we observe. Since we do not have data for board meetings of other periods, we do the next best thing, which is to compare the performance of the banks across different parameters over time. We graphically plot the average values of several bank characteristics for the four quarters of the year 2012 - 2013, which includes Q2 of 2013 - our sample quarter. Examining the figures 3.6 to 3.11, we do not observe any major differences in our sample period and the other quarters. Particularly, the measures of risk - NPA by advances and net provision ratio do not seem to be different for our sample quarter. The result suggests that the results we observe are not driven by idiosyncrasies of the chosen time period.

The relationship between board structure with board conduct

A large literature has carefully examined the association between board structure and performance and found equivocal results ((Hermalin and Weisbach, 1991; Yermack, 1996; Bebchuk et al., 2009; Eisenberg et al., 1998; Bhagat and Black, 2002; Ferris et al., 2003; Hillman, 2005). Various dimensions of board structure examined include the size of the board, stock ownership of the board members, whether the board members are insiders or outsiders, educational background of board members, other engagements of board members, etc. Plausible endogeneity involved in board selection and lack of data pertaining to board conduct have been major stumbling blocks in relating board structure to corporate performance via board conduct.

[10]We thank our anonymous referee for suggesting the extension of these results to offer insights about riskier periods.

Although Vafeas (1999) find that a higher frequency of board meetings is associated with better operational performance, they do not observe the actual board conduct, which should influence performance. It has also been observed that it is not apt to generalize the findings from studies on general corporate boards to banks, which are complex and opaque by nature (Aebi et al., 2012; Coles et al., 2008; Haan and Vlahu, 2016). Further, literature has also found that monitoring and advising by boards captured by proxies of board structure help to reduce misconduct (Nguyen et al., 2016).

Motivated by the above findings and by the lack of consensus in the literature, we examine the association between board structure and conduct in our sample of banks. The structural dimensions we examine are quite comprehensive. These include the size of the board, age of board members, professional experience, prior board experience, educational background, political connections, corruption charges, among other things. We first identify the attributes for each board member and then calculate the average for a bank. As mentioned earlier, our board minutes cover the meeting conducted for the July-September quarter of 2013. Therefore, we collect information about directors on bank boards as of 30$^{\text{th}}$ September 2013. As before, the issues tabled in the board are classified into five categories - financial reporting, risk, human resources, business strategy and regulation and compliance. We then regress the percentage of issues tabled as a proportion of total issues tabled in a given category on the various board characteristics. We also include binary variables to capture Government ownership and size of the bank.

The results, which are presented in Table 3.10, show some board attributes are related to the types of issues tabled in board meetings. First, prior board experience, which captures the cumulative experience of board members, is positively associated with the percentage of risk issues tabled and negatively associated with the percentage of HR and financial reporting issues tabled. This finding is not surprising because board members with significant board experience may be in a position to appreciate the importance of risk better than others and hence spend considerable time on these issues.

Second, boards with high private sector experience seem to focus more on risk-related issues. This association could be driven by the directors being aware of the perils of neglecting risk (Westphal and Milton, 2000; Cohen et al., 2008) based on their own experience/ expertise gained through their private networks.

Third, international experience is positively associated with the percentage of risk issues tabled. This is conceivable because board members with international experience may have a better understanding of risk issues to exposure to other risk management systems and awareness of other risk management procedures. Therefore, it is likely that they give priority to risk-related issues.

In addition, we find that attributes such as board size, age, financial sector experience, managerial experience, and independence are associated with a lower focus on HR related issues.

These findings, together with the correlation of board conduct with bank level variables, therefore, highlight the importance of examining the actual conduct of boards.

Comparing with a benchmark bank

To validate our inferences on the level of discussion on risk matters in the board, we employ as a benchmark a bank that has won multiple awards in the last decade for having the best risk management practices in India. The RMC of this bank meets seven times a year, as opposed to the average of four for the entire sample. In this bank, the percentage of risk issues tabled equals 22%, which is double the average of 10% for the entire sample. The risk committee of this bank ratifies 67% of the issues put forth, while the average for the entire sample is only 26%. These factoids, therefore, lend credence to our findings that the average level of focus on risk in bank boards is quite inadequate.

3.6 Conclusion

Prior academic research on bank governance has mostly concentrated on the role of board structure. However, board conduct and its relationship to governance in banks have not received attention. In this chapter, we fill this gap by analyzing the minutes of board and RMC meetings of 29 banks in India. We find that risk issues account for 10% of the board's attention, with compliance and regulation accounting for the most (41%) followed by business strategy (31%). Using a simple theoretical framework to enable the interpretation of our empirical results and to highlight the incentive mechanisms, we infer that bank boards under-invest in matters relating to risk and over-invest in matters pertaining to compliance.

It is important to keep in mind some important caveats and redeeming features relating to our study. Our sample is restricted to the minutes of one board meeting and one board-level committee meeting for each bank. Thus, despite the empirical findings being consistent with the predictions provided by a simple theoretical model, we urge caution in generalizing our findings.

Yet, some features may help in redeeming these weaknesses. Government ownership of banks is pervasive across the world (La Porta et al., 2002). Therefore, our results may extend better to several emerging economies where governments own banks when compared to studies that focus on banks in the U.S. or U.K. Given the worldwide concerns about corporate governance in banks, it helps to have an analysis of board conduct that includes both private-sector and government-owned banks.

As our study explores the conduct of bank boards for the first time, subsequent work can build on our study along several dimensions. First, given the significant limitations that we have articulated, we hope that subsequent work would overcome these limitations. Specifically, follow-up work can employ larger samples and exogenous shocks to identify how the conduct of bank boards affects bank governance, on the one hand, and how the structure of bank boards affects their conduct and, in turn, bank performance.

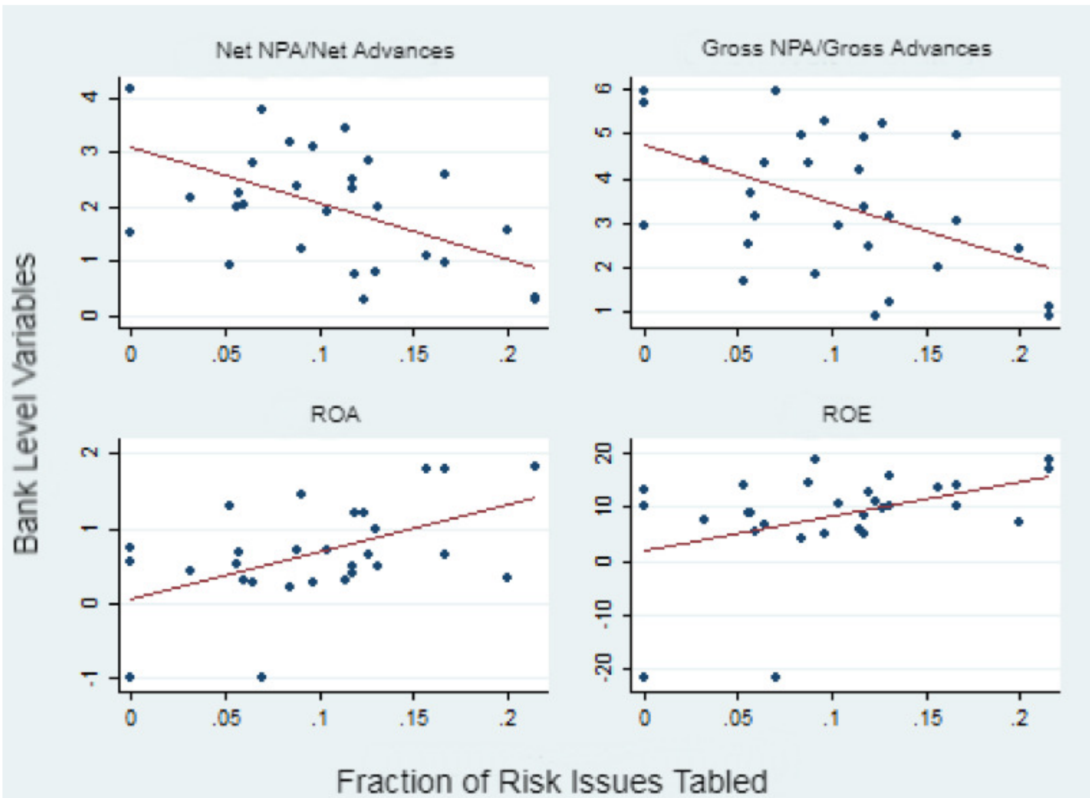
Second, could one explanation for the low level of attention paid to risk be the difficulty in understanding and evaluating risk in a bank? Risks assumed by banks may be quite complex because of lending based on soft information, which by its very nature is unverifiable and complex (Liberti and Petersen, 2019). Also, banks indulge in technically complex trading activities, which make it possibly difficult for even directors in a board to comprehend. In contrast to risk, activities falling under categories such as performance or compliance are easy to comprehend. To what extent does the complexity of the task influence the attention paid by the board to the particular task? Understanding this question can guide banks to recruit appropriate experts as directors to grapple with the complexities involved.

Third, though we have examined the distinctions in board conduct between private banks and public sector banks, we did not throw light on how the influence of bureaucrats in public sector banks affects board conduct. As government ownership of banks is pervasive across the world (La Porta et al. (2002)), such differences between private banks and public sector banks deserve attention.

Finally, the board conduct in banks may be influenced by the role that regulators play. However, little is known about the agency problems created by regulators in the financial sector, in general, and their impact on bank boards, in particular.

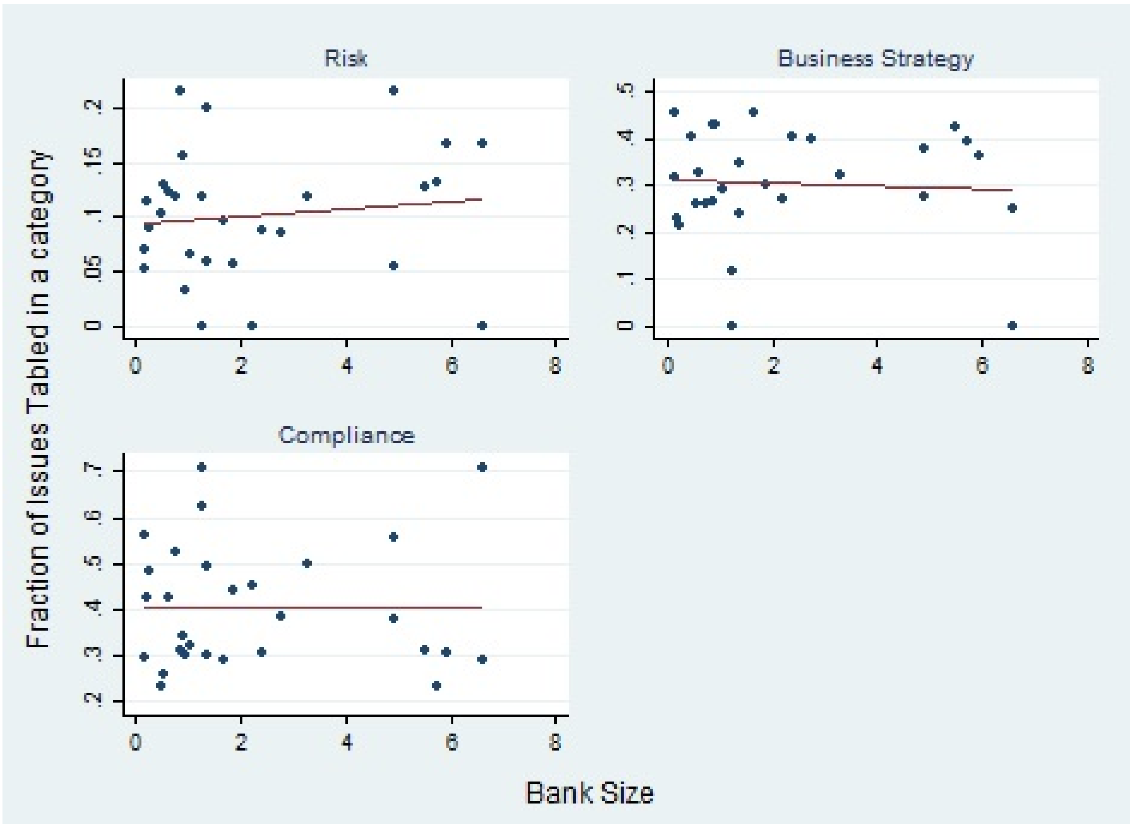
Figures

Figure 3.1: Correlation of risk issues tabled with bank-level variables



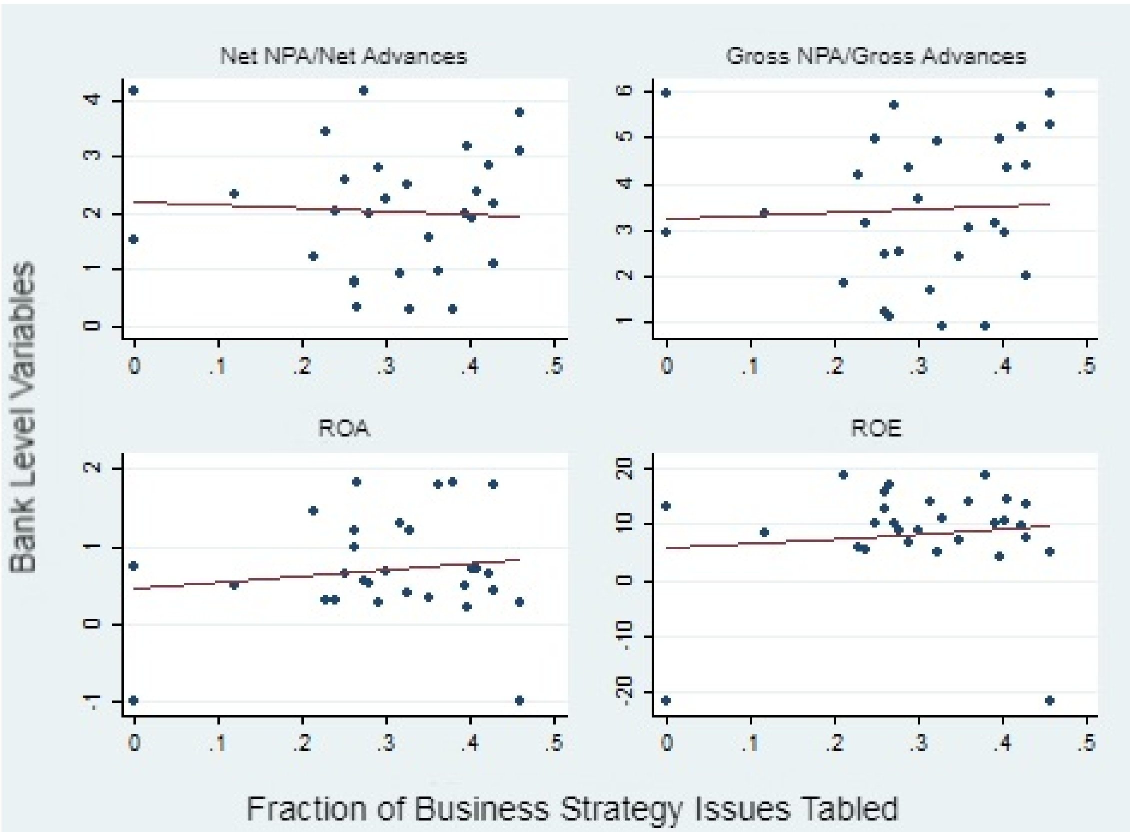
Note: Figure shows the correlation of fraction of risk issues tabled with bank level outcome variables. ROA is measured by ratio of net income to yearly averaged assets. ROE is measured as ratio of net income to equity. NPA refers to Non-performing assets. The data for bank level variables are obtained from the RBI website. Fraction of issues is obtained by deflating issues in a given category by total number of issues. All variables are winsorized at 95 percent.

Figure 3.2: Correlation of Issues Tabled with Bank Size



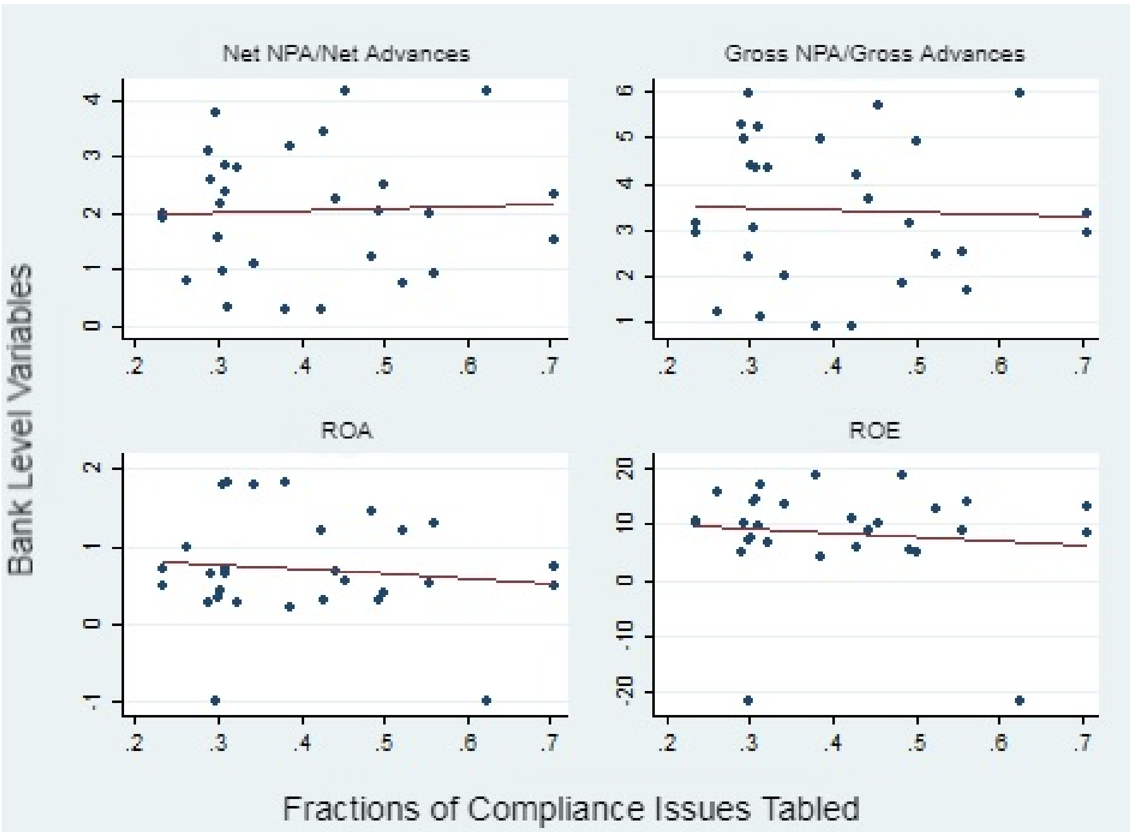
Note: The figure shows the correlation of the fraction of issues tabled across categories with bank size. Bank size is measured by total assets in Trillion Rupees. Fraction of issues is obtained by deflating the number of issues in a given category by the total number of issues. All variables are winsorized at 95 percent.

Figure 3.3: Correlation of Business Strategy Issues Tabled with Bank Level Variables



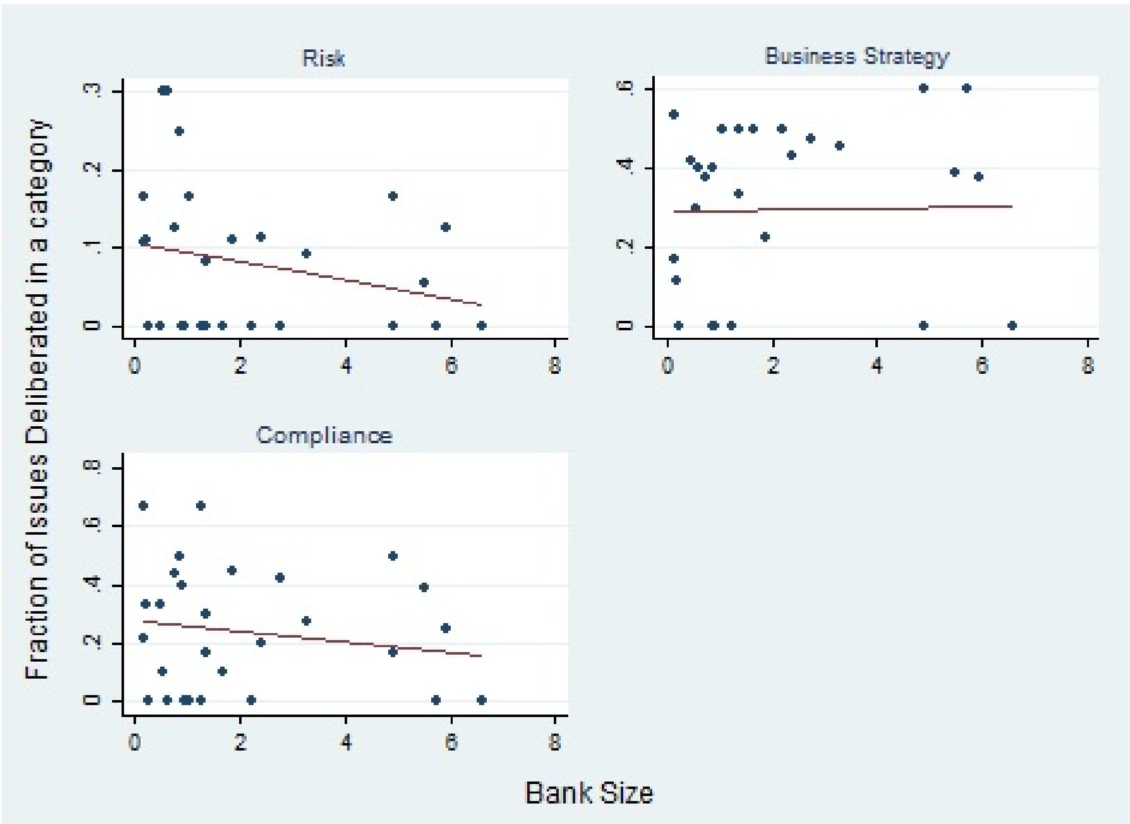
Note: The figure shows the correlation of the fraction of business strategy issues tabled with bank-level outcomes. ROA is measured by the ratio of net income to yearly averaged assets. ROE is measured as the ratio of net income to equity. NPA refers to Non-performing assets. The data for all bank-level variables are obtained from the RBI website. Fraction of issues is obtained by deflating issues in a given category by the total number of issues. All variables are winsorized at 95 percent.

Figure 3.4: Correlation of Regulatory and Compliance Issues Tabled with Bank Level Variables



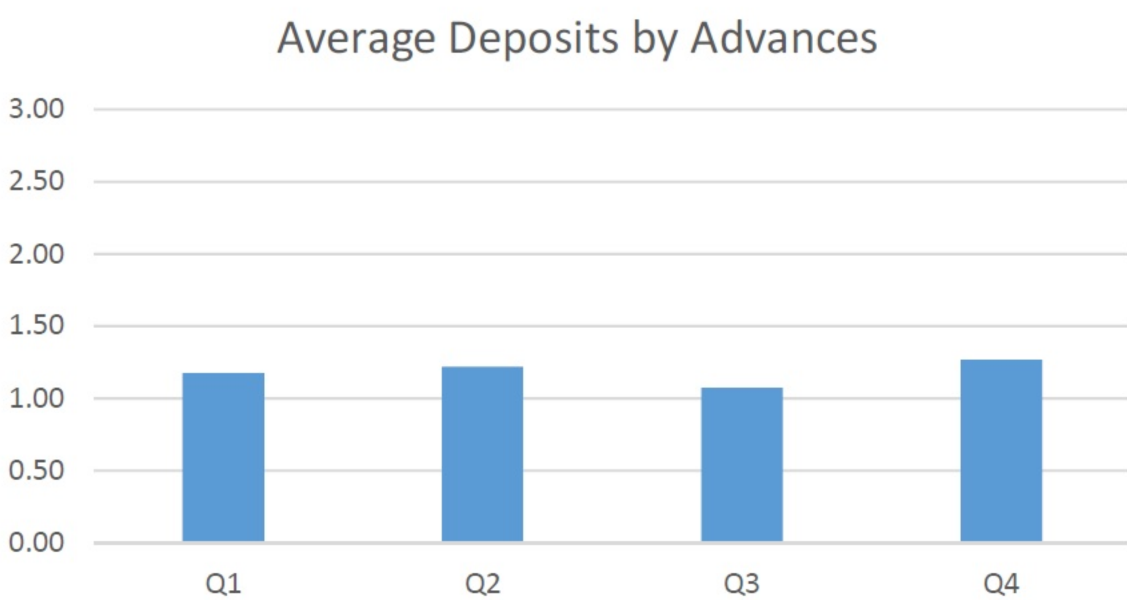
Note: The figure shows the correlation of the fraction of business strategy issues tabled with bank-level outcomes. ROA is measured by the ratio of net income to yearly averaged assets. ROE is measured as the ratio of net income to equity. NPA refers to Non-performing assets. The data for all bank-level variables are obtained from the RBI website. Fraction of issues is obtained by deflating issues in a given category by the total number of issues. All variables are winsorized at 95 percent.

Figure 3.5: Correlation of Issues Deliberated with Bank Size



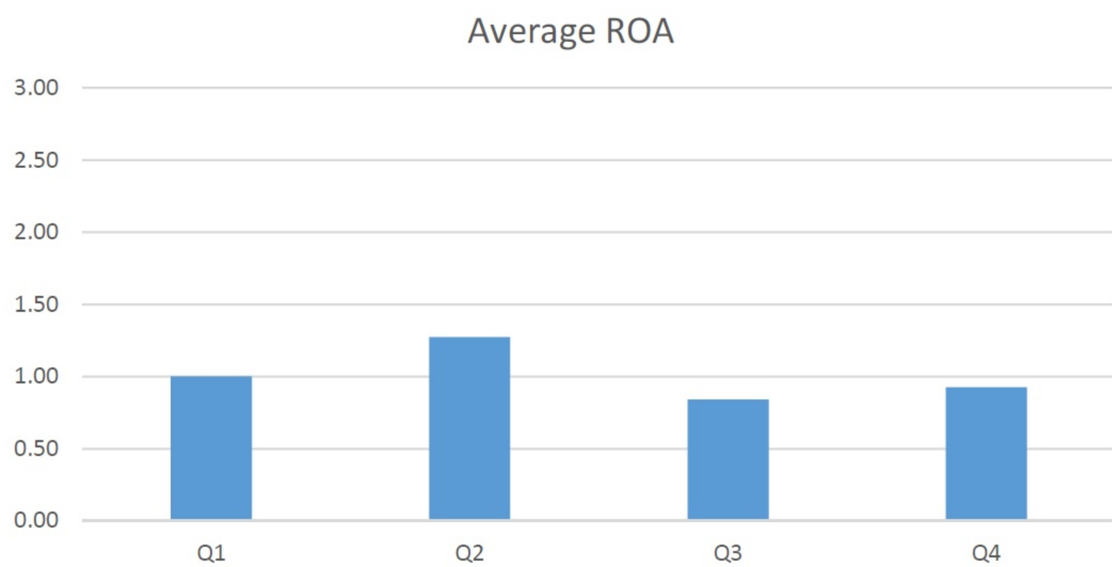
Note: The figure shows the correlation of the fraction of issues deliberated across categories with bank size. Bank size is measured total assets in INR(Trillion) and obtained from the RBI website. Fraction of issues is obtained by deflating issues deliberated in a given category by the total number of issues deliberated across all categories. All variables are winsorized at 95 percent.

Figure 3.6: Average Deposits by Advances



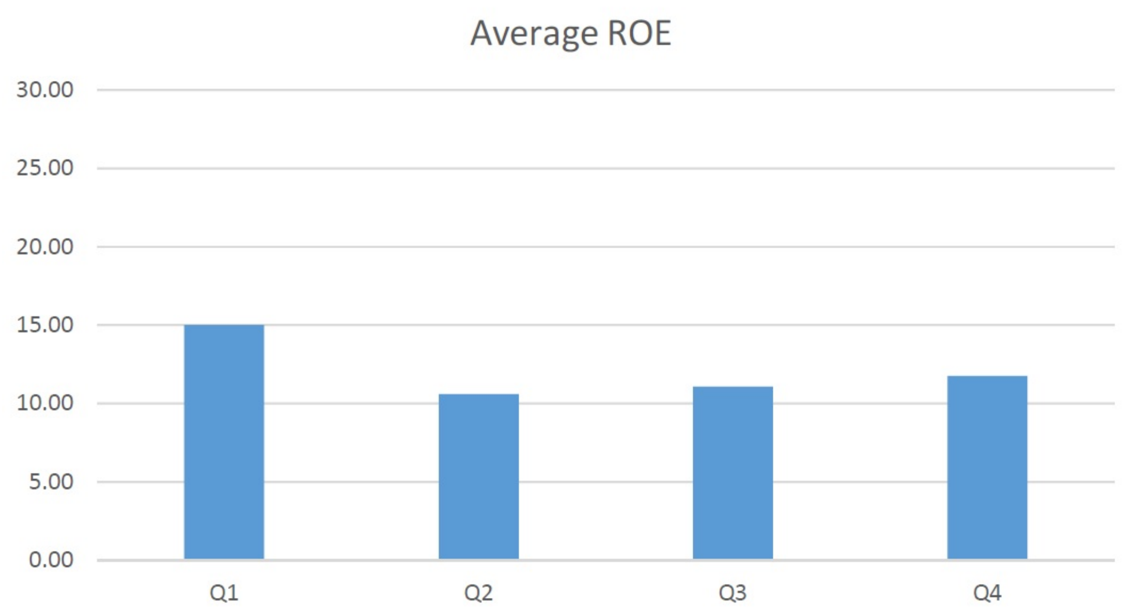
Note: The figure plots the average of deposits to advances ratio of all banks during the four quarters of the financial year 2012-2013. The y-axis in the figure represents the quarter average of the ratio for all banks, while the x-axis represents the quarters.

Figure 3.7: Average Return on Assets



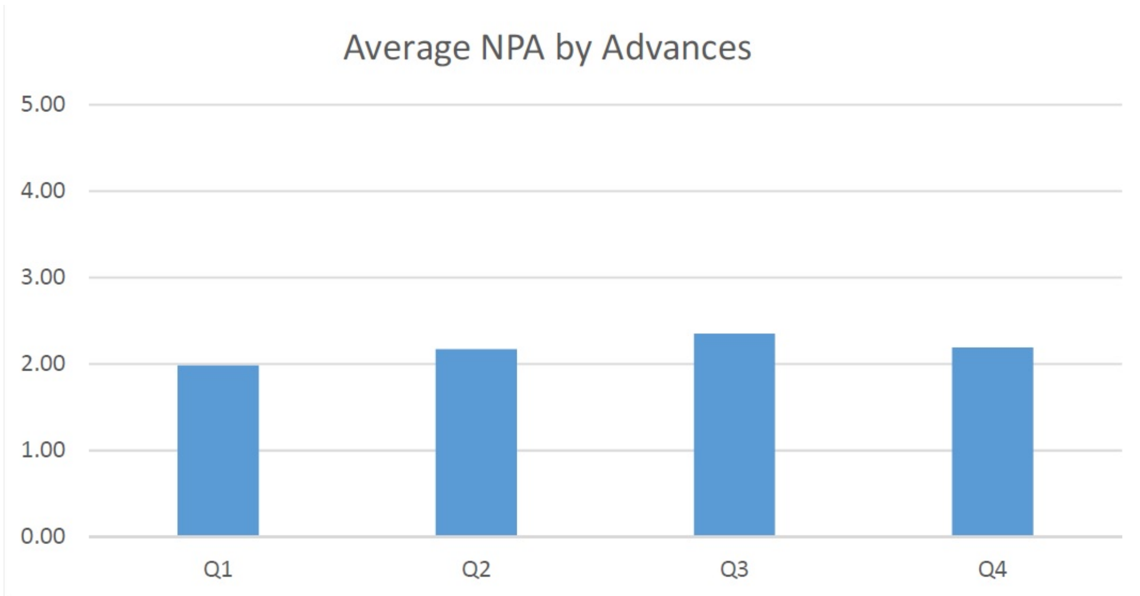
Note: The figure plots the average of return on assets (ROA) of all banks during the four quarters of the financial year 2012-2013. The y-axis in the figure represents the quarter average of ROA for all banks, while the x-axis represents the quarters.

Figure 3.8: Average Return on Equity



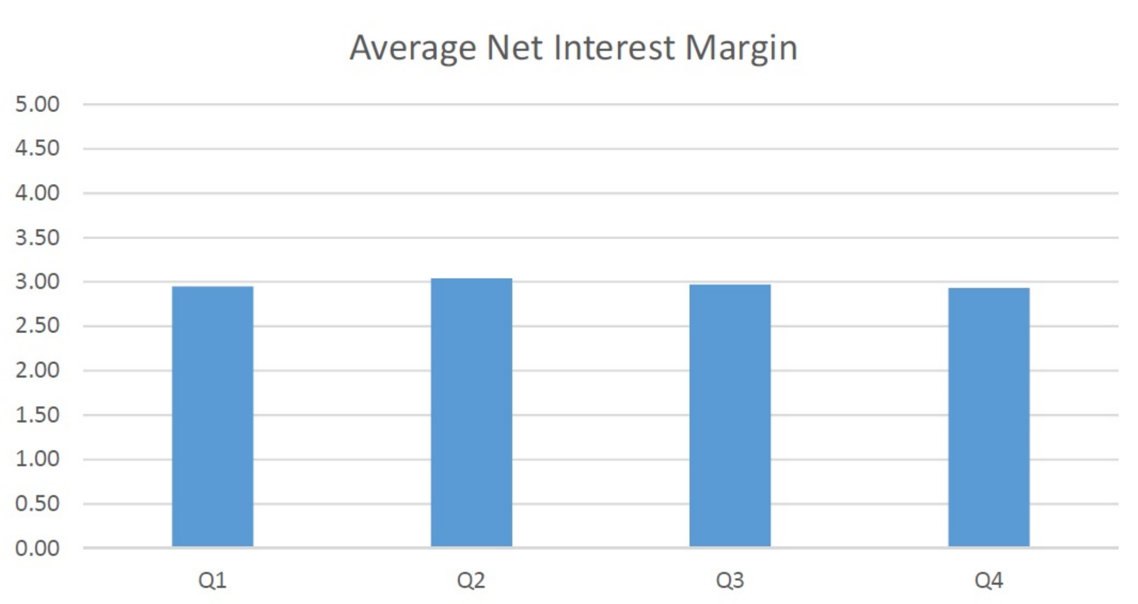
Note: The figure plots the average of return on equity (ROE) of all banks during the four quarters of the financial year 2012-2013. The y-axis in the figure represents the quarter average of ROE for all banks, while the x-axis represents the quarters.

Figure 3.9: NPA Ratio



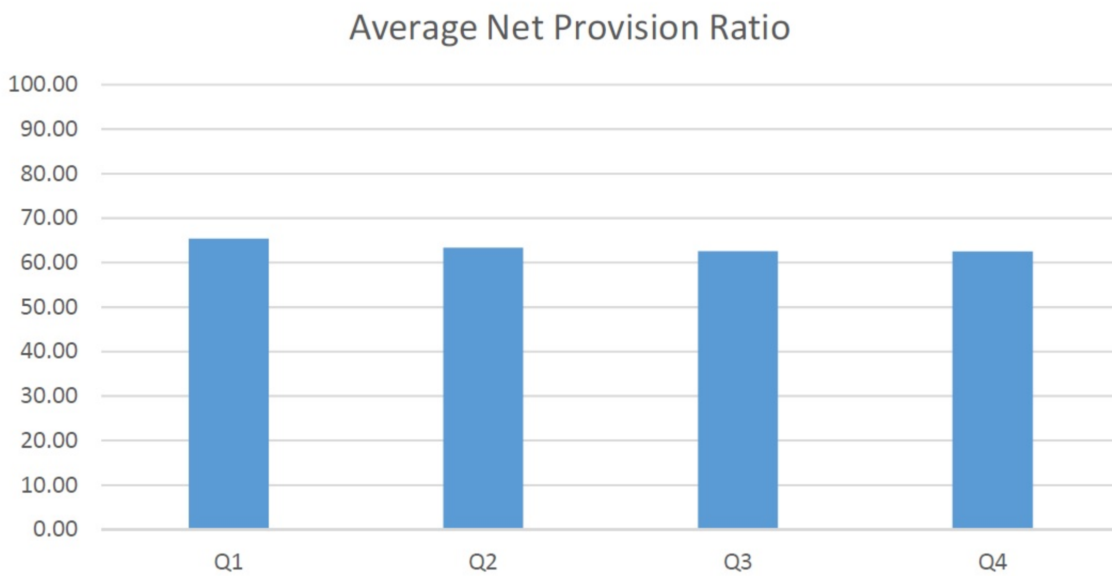
Note: The figure plots the average of NPA ratio of all banks during the four quarters of the financial year 2012-2013. The y-axis in the figure represents the quarter average of NPA ratio for all banks, while the x-axis represents the quarters.

Figure 3.10: Net Interest Margin



Note: The figure plots the average of net interest margin (NIM) of all banks during the four quarters of the financial year 2012-2013. The y-axis in the figure represents the quarter average of NIM ratio for all banks while, the x-axis represents the quarters.

Figure 3.11: Provision Coverage Ratio



Note: The figure plots the average of provision to NPA ratio of all banks during the four quarters of the financial year 2012-2013. The y-axis in the figure represents the quarter average of the ratio for all banks, while the x-axis represents the quarters.

Tables

Table 3.1: Statistics for Indian banks.This table reports summary statistics pertaining to operating performance, ownership and market capitalization of Indian banks. The Market Capitalization is calculated based on closing share price as on 31st March-2014. Government ownership is also calculated as on 31st March 2014. Other operating metrics are averaged over 2005-06 to 2013–2014. CAR refers to Capital Adequacy Ratio, NIM stands for Net Interest Margin, NII refers to Net Interest Income, NPA refers to Non Performing Assets, ROA refers to Return on Assets and finally P/B ratio refers to Price to Book Ratio.

Panel A: Government-Owned Banks									
Bank	Market Cap (In Rs. Billion)	CAR	NIM	NII Growth	Net NPA	ROA	P/B ratio	Profit Growth	Govt Stake
Allahabad Bank	49.5	12.662	2.525	0.185	1.148	1.129	1.024	0.144	0.55
Andhra Bank	37.7	12.836	2.758	0.181	0.548	1.273	1.177	0.151	0.580
Bank of Baroda	309.5	13.544	2.428	0.188	0.690	1.000	1.148	0.276	0.550
Bank of India	146.7	11.906	2.265	0.196	1.328	0.841	1.253	0.383	0.640
Bank of Maharashtra	33.2	12.229	2.535	0.176	1.263	0.599	0.872	0.623	0.810
Canara Bank	121.9	13.313	2.275	0.132	1.297	1.060	1.151	0.144	0.680
Central Bank of India	67.3	11.539	2.309	0.158	1.921	0.508	0.990	0.291	0.850
Corporation Bank	29.2	13.713	2.266	0.157	0.630	1.166	1.081	0.180	0.600
Dena Bank	32.5	11.770	2.402	0.180	1.902	0.810	0.826	0.455	0.550
IDBI Bank Ltd	104.7	13.358	0.934	0.572	1.262	0.692	0.848	0.278	0.720
Indian Bank	53.4	13.446	3.106	0.171	0.807	1.388	1.089	0.199	0.800
Indian Overseas Bank	62.8	13.349	2.691	0.144	1.329	0.937	1.102	0.044	0.740
Oriental Bank of Commerce	66.8	12.151	2.316	0.163	1.138	1.092	0.939	0.058	0.580
Punjab and Sindh Bank	12.4	12.589	2.656	0.147	1.796	0.774	0.593	-0.101	0.800
Punjab National Bank	269.3	13.160	3.016	0.182	0.812	1.200	1.452	0.187	0.580
State Bank of India	1431.7	12.957	2.703	0.163	1.881	0.906	1.776	0.188	0.620
State Bank of Travancore	21.0	11.335	2.708	0.122	1.30	0.875	0.459	0.072	0.620
Syndicate Bank	60	12.138	2.524	0.169	0.968	0.843	1.009	0.256	0.660
Uco Bank	74	12.257	2.094	0.178	2.052	0.578	0.936	0.169	0.690
Union Bank of India	86.6	12.316	2.517	0.184	1.220	1.030	1.304	0.172	0.580
United Bank of India	17.4	13.113	2.369	0.152	1.812	0.627	0.720	0.120	0.820
Vijaya Bank	34.3	12.356	2.264	0.102	1.040	0.763	0.991	0.251	0.550
Panel B: Private-Sector Banks									
Bank	Market Cap (In Rs. Billion)	CAR	NIM	NII Growth	Net NPA	ROA	P/B ratio	Profit Growth	
Axis Bank Ltd	686.2	13.538	2.453	0.390	0.581	1.433	2.754	0.411	
City Union Bank Ltd	24.3	12.780	2.861	0.245	1.182	1.549	1.282	0.287	
Development Credit Bank	18.7	12.742	2.373	0.221	2.490	–0.523	1.637	0.573	
DCB Bank	15.3	10.698	2.925	119.4	1.887	–0.394	1.392	0.095	
Federal Bank	81.8	15.625	3.72	0.187	0.583	1.255	1.179	0.334	
HDFC Bank Ltd.	1796.2	14.769	3.779	0.320	0.343	1.507	4.052	0.314	
ICICI Bank Ltd	1437.2	15.836	2.048	0.233	1.307	1.307	2.034	0.271	
Indusind Bank Ltd	263.7	13.288	2.244	0.286	1.338	0.976	2.252	0.478	
ING Vyasya Bank	118.3	11.918	2.432	0.208	0.831	0.644	1.639	1.303	
Karnataka Bank	27.3	12.709	2.139	0.218	1.467	1.037	1.020	0.130	
Karur Vyasya Bank	50.9	14.501	2.720	0.214	0.459	1.570	1.353	0.233	
Kotak Mahindra Bank LTD.	601.6	16.448	4.074	0.420	1.162	1.461	6.031	0.461	
Lakshmi Vilas Bank	12.6	12.332	2.244	0.195	2.269	0.508	0.970	1.119	
South Indian Bank	36.6	13.318	2.530	0.229	1.094	0.890	1.034	0.967	
The Dhanalakshmi Bank	9.0	11.068	2.270	0.206	1.712	0.201	1.169	–0.750	
Yes Bank Ltd.	149.3	16.923	1.996	1.009	0.063	1.436	3.186	–1.420	

Source: CMIE Prowess and Authors' Calculations; Annual Reports.

Table 3.2: Category-wise examples of issues in board minutes.

Category	Examples
Risk	At one meeting, the Board reviewed country risk management of the bank. The Board took note of country-wise exposures, their causes and steps taken to mitigate the risks.
	Following the advice of RBI from its Annual Financial Inspection, another board discussed a study concerning the implementation of a mechanism for evaluating concentration risk amongst Cash In Transit (CIT) agencies empanelled by the bank. The Board was briefed on the salient features relating to the CIT agencies on concentration risks identified, appointment, annual appraisal, recommendations etc.
	In another meeting, the Board was presented with the annual review of Market Risk & Derivative Policies covering various risk limits, monitoring and reporting arrangements of Market Risk, Treasury activities which was thereby approved.
Business Strategy	At one bank, the management sought approval for ratification for the introduction of a new retail loan product and also for delegation of powers for this specific product to branch managers from zonal managers. The Board ratified the proposals followed by specific directions regarding collection and verification of customer
	One board undertook a strategic review of the areas like, Business Plan, Capital Planning, Performance under Priority Sector advances, Performance under Lead districts, Non-fund business and prospective business/product lines and closure of existing ones.
	In another bank, the senior management presented the strategy on liability and asset to the Board. The Board also stressed to improve the turnaround time on credit to enhance customer service.
Financial Reporting	The Board reviewed the banks credit/debit/prepaid card operations. The Board was briefed on the industry snapshot, product and portfolio update, customer service indicators, KPIs, new initiatives and strategy going forward.
	All banks reviewed the financial statements for previous quarter end.
Regulation and Compliance	Following RBI directions for reporting on monthly basis on overseas regulatory violations, the Board of a bank reviewed the same for the banks overseas branches.
	In one instance, the Board of a bank considered a note on appointment of designated director under PML Act, 2002 who will be responsible to ensure overall compliance by the bank with the provisions of the Act.
Human Resources	The Board of one bank was updated on the progress made by the bank in lending to the Micro and Small (MSE) sector in the current financial year.
	One of the directors of a bank in a meeting requested for the continuation of the guidelines regarding the appointment of Part-time Sub-staff and absorption of the PTS as Sub-staff which was thereby approved.
	At another meeting, approval was accorded for Performance Appraisal System (PAF) ratings & marks of officers in SMG Scale-IV to TEG Scale-VI be made accessible to the concerned officers. The Board however desired that, (i) TEF Scale-VII officers are to included in the proposal, and (ii) the reviewing authority gives opportunity to the officer to explain, if his/her marks are below the cut-off level for promotion and such an opportunity will be given in prospective cases.

Table 3.3: This table shows the summary and the distribution of issues tabled in board meetings across different categories. Panel A provides the summary for the number of issues tabled in a board meeting and the percentage of total issues tabled across categories. The percentages are in brackets. Panel B shows the distribution of issues tabled across categories in terms of numbers and percentages. The distribution of issues tabled in a category as a percentage of the total number of issues tabled is in brackets.

Issues Tabled in Board Meetings							
				Panel A			
	N	Mean	SD	Min	Max		
Risk	29.00	5.69 (10.31)	4.40 (6.18)	0.00 (0.00)	17.00 (25.00)		
Business Strategy	29.00	17.66 (30.63)	11.85 (12.07)	0.00 (0.00)	38.00 (50.88)		
Regulation and Compliance	29.00	18.52 (40.88)	9.17 (14.38)	4.00 (21.31)	33.00 (80.00)		
Financial Reporting	29.00	5.48 (13.10)	3.30 (8.74)	1.00 (2.53)	14.00 (37.50)		
Human Resources	29.00	3.07 (5.08)	3.71 (5.56)	0.00 (0.00)	11.40 (17.46)		
				Panel B			
	N	10th Percentile	25th Percentile	50th Percentile	Mean	75th Percentile	90th Percentile
Risk	29.00	0.00 (0.00)	3.00 (5.97)	4.00 (10.39)	5.69 (10.31)	8.00 (13.04)	12.00 (20.00)
Business Strategy	29.00	2.00 (11.76)	7.00 (26.09)	17.00 (31.58)	17.66 (30.63)	29.00 (39.76)	33.00 (42.86)
Regulation and Compliance	29.00	5.00 (26.09)	12.00 (30.16)	18.00 (37.97)	18.52 (40.88)	24.00 (49.25)	32.00 (62.50)
Financial Reporting	29.00	1.00 (4.23)	3.00 (7.02)	5.00 (10.53)	5.48 (13.10)	7.00 (17.39)	10.00 (29.03)
Human Resources	29.00	0.00 (0.00)	0.00 (0.00)	1.00 (2.94)	3.07 (5.08)	6.00 (7.79)	9.00 (14.75)

Table 3.4: Summary of issues tabled by bank ownership. This table shows the distribution of issues tabled by ownership. We obtain ownership data from RBI website.

	Private			Government Owned		
	N	Mean Number of issues	As a % of total issues tabled	N	Mean Number of issues	As a % of total issues tabled
Risk	12.00	8.00	13.56	17.00	4.00	8.89
Business Strategy	12.00	20.00	33.90	17.00	16.00	35.56
Regulation and Compliance	12.00	22.00	37.29	17.00	16.00	35.56
Financial Reporting	12.00	7.00	11.86	17.00	5.00	11.11
Human Resources	12.00	2.00	3.39	17.00	4.00	8.89

Table 3.5: Relationship between issues tabled (as a fraction of total number of issues) across categories with bank-level variables. Each panel of the table reports the results of a regression of a bank-level variable on the proportion of a category of issues tabled in a meeting. We control for ownership (size) by including a dummy variable that takes the value of one for government-owned banks (banks having above the median value of assets) and zero otherwise. All bank-level variables are obtained from the RBI website, and the values are as of 31st March, 2014. All variables are winsorized at 95 percent. t-statistics is in parentheses. $***p < 0.01$, $**\ p < 0.05$, $*p < 0.1$.

	ROA	ROE	Net NPA/Net Advance	Gross NPA/Gross Advances
		Panel A		
Risk	4.464**	59.035*	–7.472**	–8.165*
	(2.291)	(1.811)	(-2.393)	(-1.862)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes
Observations	29	29	29	29
R-squared	0.421	0.174	0.440	0.440
		Panel B		
Human Resources	1.003	37.999	–3.326	–4.001
	(0.466)	(1.153)	(-0.971)	(-0.860)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes
Observations	29	29	29	29
R-squared	0.306	0.105	0.337	0.381
		Panel C		
Business Strategy	0.287	5.669	0.228	1.777
	(0.290)	(0.366)	(0.142)	(0.831)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes
Observations	29	29	29	29
R-squared	0.302	0.062	0.312	0.379
		Panel D		
Regulation and Compliance	–0.039	–4.849	–0.383	–1.578
	(-0.045)	(-0.356)	(-0.273)	(-0.841)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes
Observations	29	29	29	29
R-squared	0.300	0.062	0.314	0.380
		Panel E		
Financial Reporting	–1.981	–23.847	4.689**	5.045
	(-1.422)	(-1.077)	(2.189)	(1.684)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes
Observations	29	29	29	29
R-squared	0.352	0.099	0.422	0.427

Table 3.6: Deliberation of issues in board meetings. This table shows the summary and the distribution of issues deliberated in board meetings across different categories. Panel A provides the summary for the number of issues deliberated in a board meeting and the percentage of total issues deliberated across categories. The percentages are in brackets. Panel B shows the distribution of issues deliberated across categories in terms of numbers and percentages. The distribution of issues deliberated in a category as a percentage of the total number of issues tabled is in brackets.

Issues Deliberated in Board Meetings							
			Panel A				
	N	Mean	SD	Min	Max		
Risk	29.00	0.86 (8.18)	1.09 (10.36)	0.00 (0.00)	4.00 (40.00)		
Business Strategy	29.00	3.55 (29.82)	3.99 (21.91)	0.00 (0.00)	15.00 (66.67)		
Regulation and Compliance	29.00	2.59 (24.81)	2.71 (24.25)	0.00 (0.00)	8.00 (100.00)		
Financial Reporting	29.00	1.31 (18.68)	1.31 (22.07)	0.00 (0.00)	4.00 (100.00)		
Human Resources	29.00	0.69 (4.71)	1.26 (7.74)	0.00 (0.00)	5.00 (25.00)		
			Panel B				
	N	10th Percentile	25th Percentile	50th Percentile	Mean	75th Percentile	90th Percentile
Risk	29.00	0.00 (0.00)	0.00 (0.00)	1.00 (5.56)	0.86 (8.18)	1.00 (12.50)	3.00 (25.00)
Business Strategy	29.00	0.00 (0.00)	0.00 (0.00)	3.00 (37.50)	3.55 (29.82)	5.00 (47.37)	9.00 (53.57)
Regulation and Compliance	29.00	0.00 (0.00)	0.00 (0.00)	2.00 (21.43)	2.59 (24.81)	4.00 (40.00)	7.00 (50.00)
Financial Reporting	29.00	0.00 (0.00)	0.00 (0.00)	1.00 (11.43)	1.31 (18.68)	2.00 (25.00)	4.00 (50.00)
Human Resources	29.00	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.69 (4.71)	1.00 (10.00)	3.00 (20.00)

Table 3.7: Relationship between issues deliberated (as a fraction of total number of issues) across categories with bank-level variables. Each panel of the table reports the results of a regression of a bank-level variable on the proportion of a category of issues deliberated in a meeting. We control for ownership (size) by including a dummy variable that takes the value of one for government-owned banks (banks having above the median value of assets) and zero otherwise. All bank-level variables are obtained from the RBI website, and the values are as of 31st March, 2014. All variables are winsorized at 95 percent. t-statistics is in parentheses. $***p < 0.01$, $**\ p < 0.05$, $*p < 0.1$.

	ROA	ROE	Net NPA/Net Advance	Gross NPA/Gross Advances
		Panel A		
Risk	0.895	15.177	–3.521	–4.031
	(0.616)	(0.668)	(-1.560)	(-1.303)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes
Observations	29	29	29	29
R-squared	0.310	0.074	0.373	0.403
		Panel B		
Human Resources	0.517	21.904	–3.067	–4.720
	(0.309)	(0.848)	(-1.165)	(-1.337)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes
Observations	29	29	29	29
R-squared	0.302	0.084	0.347	0.405
		Panel C		
Business Strategy	–0.276	–2.560	0.375	0.781
	(-0.509)	(-0.301)	(0.427)	(0.661)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes
Observations	29	29	29	29
R-squared	0.307	0.061	0.317	0.373
		Panel D		
Regulation and Compliance	–0.524	–13.425	0.518	0.436
	(-0.946)	(-1.601)	(0.573)	(0.355)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes
Observations	29	29	29	29
R-squared	0.324	0.145	0.320	0.365
		Panel E		
Financial Reporting	–0.038	4.119	0.900	0.117
	(-0.055)	(-0.382)	(0.816)	(0.077)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes
Observations	29	29	29	29
R-squared	0.300	0.063	0.329	0.362

Table 3.8: Standard risk measures and risk issues. The table presents the relationship between standard measures of bank risk and the proportion of risk issues tabled and deliberated. The data are organized at a bank level. Column 1 (2) of every panel shows the results of a regression where the proportion of risk issues among all issues tabled (deliberated) is regressed on a measure of bank risk. We consider the average values of bank characteristics over three quarters before the second quarter of the year 2013. $***$, $**$, and $*$ represent significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable	Risk Issues Tabled	Risk Issues Deliberated
	Panel A	
Capital Adequacy Ratio	-0.002	0.056
	(-0.067)	(1.457)
Govt Bank and Size Controls	Yes	Yes
Observations	29	29
R-squared	0.171	0.349
	Panel B	
Provision Coverage Ratio	0.023	–0.001
	(1.030)	(-0.041)
Govt Bank and Size Controls	Yes	Yes
Observations	29	29
R-squared	0.204	0.294
	Panel C	
Net NPA by Gross Advances	–0.022	0.009
	(-0.884)	(0.234)
Govt Bank and Size Controls	Yes	Yes
Observations	29	29
R-squared	0.196	0.295
	Panel D	
Gross NPA by Gross Advances	–0.027	0.018
	(-1.057)	(0.469)
Govt Bank and Size Controls	Yes	Yes
Observations	29	29
R-squared	0.206	0.300
	Panel E	
Volatility of Earnings	0.022	0.033
	(-0.968)	(1.007)
Govt Bank and Size Controls	Yes	Yes
Observations	29	29
R-squared	0.200	0.321
	Panel F	
Volatility of Equity Returns	–0.028	–0.024
	(-1.281)	(-0.737)
Govt Bank and Size Controls	Yes	Yes
Observations	29	29
R-squared	0.222	0.309

Table 3.9: Bank characteristics and risk issues. The table presents the relationship between bank characteristics and the proportion of risk issues tabled and deliberated. The data are organized at a bank level. Column 1 (2) of every panel shows the results of a regression where the proportion of risk issues among all issues tabled (deliberated) is regressed on a measure of bank characteristic. We consider the average values of bank characteristics over three quarters before the second quarter of the year 2013. $***$, $**$, and $*$ represent significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable	Risk Issues Tabled	Risk Issues Deliberated
	Panel A	
Total Assets	0.039 (0.945)	0.041 (0.662)
Govt Bank and Size Controls	Yes	Yes
Observations	29	29
R-squared	0.199	0.306
	Panel B	
ROE	–0.012 (-0.439)	0.009 (0.230)
Govt Bank and Size Controls	Yes	Yes
Observations	29	29
R-squared	0.177	0.295
	Panel C	
ROA	0.010 (0.349)	0.035 (0.887)
Govt Bank and Size Controls	Yes	Yes
Observations	29	29
R-squared	0.175	0.315
	Panel D	
Net Interest Margin	0.021 (0.997)	–0.019 (-0.586)
Govt Bank and Size Controls	Yes	Yes
Observations	29	29
R-squared	0.202	0.303
	Panel E	
Government Holding	–0.001 (-0.646)	–0.001 (-0.876)
Govt Bank and Size Controls	Yes	Yes
Observations	29	29
R-squared	0.184	0.315
	Panel F	
Loan Growth	0.020 (0.903)	–0.000 (-0.001)
Govt Bank and Size Controls	Yes	Yes
Observations	29	29
R-squared	0.197	0.294

Table 3.10: Association between board structure and conduct. This table reports the association between board structure and conduct. Each panel reports the results of a regression of the percentage of a particular type of issues out of total issues tabled in a bank board meeting on a bank board attribute. Financial Reporting, Risk, HR, Business Strategy, and Regulation and Compliance are the categories considered. Board size is measured as the number of members in the board, Age is calculated as the average age of the board members, Financial Exp is the average experience of the board in the finance domain expressed in terms of number of years, Banking Exp is the average experience of the board in any bank expressed in terms of number of years. Similarly, Prior Board Exp, International Exp, and Private Sector Exp is the average experience of the board in sitting on any other board, working outside of India, and working in non-government companies, respectively. Political Connections is the average of political connectivity of all the board members, where political connectivity = 1 if a board member has political association mentioned in his/her cv. Financial Qualifications is the average of a binary variable that takes a value of 1 if a board member has received a degree in finance. Managerial experience is the average of a binary variable that takes a value of 1 if a board member has held a managerial position in any other firm in the past. Independent Directors is the average of a binary variable that takes a value of 1 if a board member is an independent director. We control for ownership (size) by including a dummy variable that takes the value of one for government-owned banks (banks having above the median value of assets) and zero otherwise. $***$, $**$ and $*$ represents significance at 1%, 5%, and 10% respectively.

Dependent Variable	Financial Reporting	Risk	HR	Business Strategy	Regulation and Compliance
			Panel A		
Board Size	0.013*	–0.004	–0.008*	–0.010	0.009
	(1.820)	(-0.849)	(-1.846)	(-0.992)	(0.705)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes	Yes
Observations	24	24	24	24	24
R-squared	0.148	0.194	0.151	0.099	0.083
			Panel B		
Age	0.010	0.001	–0.012**	-0.015	0.016
	(0.898)	(0.159)	(-2.122)	(-1.037)	(0.904)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes	Yes
Observations	24	24	24	24	24
R-squared	0.045	0.166	0.189	0.103	0.097
			Panel C		
Financial Exp	0.001	–0.001	–0.006**	–0.005	0.011
	(0.202)	(-0.409)	(-2.327)	(-0.768)	(1.431)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes	Yes
Observations	24	24	24	24	24
R-squared	0.008	0.172	0.218	0.082	0.147

Table 3.10 continued from previous page

Dependent Variable	Financial Reporting	Risk	HR	Business Strategy	Regulation and Compliance
			Panel D		
Banking Exp	–0.000	–0.003	–0.003	–0.002	0.008
	(-0.040)	(-0.845)	(-1.222)	(-0.371)	(1.089)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes	Yes
Observations	24	24	24	24	24
R-squared	0.007	0.194	0.075	0.061	0.113
			Panel E		
Prior Board Exp	–0.016*	0.011*	–0.014**	0.009	0.010
	(-1.783)	(1.868)	(-2.770)	(0.669)	(0.587)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes	Yes
Observations	24	24	24	24	24
R-squared	0.143	0.289	0.282	0.075	0.076
			Panel F		
Managerial Positions	–0.040	0.039	–0.039*	–0.000	0.040
	(-1.094)	(1.641)	(-1.936)	(-0.004)	(0.643)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes	Yes
Observations	24	24	24	24	24
R-squared	0.063	0.264	0.163	0.055	0.079
			Panel G		
Independent Directors	–0.049	0.010	–0.038*	0.005	0.073
	(-1.377)	(0.386)	(-1.916)	(0.109)	(1.190)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes	Yes
Observations	24	24	24	24	24
R-squared	0.093	0.171	0.160	0.055	0.122
			Panel H		
International Experience	0.012	0.025**	–0.012	–0.008	–0.017
	(0.725)	(2.428)	(-1.249)	(-0.336)	(-0.594)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes	Yes
Observations	24	24	24	24	24
R-squared	0.032	0.355	0.078	0.060	0.076
			Panel I		
Private Sector Exp	–0.003	0.021**	-0.000	–0.003	–0.014
	(-0.227)	(2.347)	(-0.001)	(-0.162)	(-0.567)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes	Yes
Observations	24	24	24	24	24
R-squared	0.009	0.345	0.006	0.056	0.075
			Panel J		
Political Connections	–0.012	0.248	–0.044	–0.183	–0.008
	(-0.029)	(0.931)	(-0.188)	(-0.335)	(-0.012)
Govt Bank and Size Controls	Yes	Yes	Yes	Yes	Yes
Observations	24	24	24	24	24
R-squared	0.007	0.200	0.008	0.060	0.060

Table 3.10 continued from previous page

Dependent Variable	Financial Reporting	Risk	HR	Business Strategy	Regulation and Compliance
			Panel K		
Financial Qualifications	–0.094	0.046	–0.138*	–0.132	0.318
	(-0.715)	(0.516)	(-1.933)	(-0.743)	(1.493)
Govt Bank and Size Dummy	Yes	Yes	Yes	Yes	Yes
Observations	24	24	24	24	24
R-squared	0.031	0.176	0.163	0.080	0.154

Table 3.11: In this table, we compare the five largest banks of Brazil, Russia, and China with the five largest banks in India. We use Net Interest Margin (NIM), Non Performing Assets (NPAs) to Total Assets Ratio, Total NPAs , Capital Adequacy Ratio (CAR), Market Capitalization, Net Profit, Deposits and Loans. Panel A reports the numbers for Brazil, panel B covers China, Panel C covers Russia, and Panel D reports the numbers for India. Market Capitalization is computed as of the end of the year 2013. All other variables are averaged over five years. All values other than ratios are reported in billion US dollars.

Panel A: Brazilian Banks								
Bank Name-Brazil	NIM	NPAs to total assets	Total non performing assets	CAR	Market Cap	Net Profit	Deposits	Loans
ITAU UNIBAN-PREF	19	3.2	5.2	17	27.87	2.47	62.61	56.07
BRADESCO SA-PREF	17	2.8	5.22	16.3	24.18	2.17	43.77	49.22
BANCO DO BRASIL	16.8	4.5	10.24	15.1	14.93	2.35	101.52	80.32
BANCO SANTA-UNIT	19.4	3.8	3.68	19.3	12.37	1.02	40.38	34.27
GRUPO BTG-UNIT	24	0.2	0.08	16.9	5.69	0.51	62.07	20.54
Country Average	19.2	2.9	4.89	16.9	16.7	1.71	62.07	44.39
Panel B: Chinese Banks								
Bank Name-China	NIM	NPAs to total assets	Total non performing assets	CAR	Market Cap	Net Profit	Deposits	Loans
IND & COMM BK-A	39.7	1.1	19.19	13.3	264.66	27.03	2058.78	1108.21
AGRICULTURAL-A	27.7	2.9	32.79	11.5	149.43	15.53	1715.73	841.11
CHINA MERCH BK-A	35.3	0.7	2.37	11.3	50.97	4.91	370.97	230.89
CHINA MINSHENG-A	29.6	0.7	2.21	10.3	29.26	3.55	369.27	170.93
CHINA EVERBRIG-A	32.7	1.2	2.02	9	23.77	2.36	294.51	124.74
Country Average	33	1.3	11.72	11	103.62	10.68	961.86	495.18
Panel C: Russian Banks								
Bank Name-Russia	NIM	NPAs to total assets	Total non performing assets	CAR	Market Cap	Net Profit	Deposits	Loans
SBERBANK	27.1	2.6	5.13	14.9	27.71	3.23	200.76	133.7
VTB BANK PJSC	16	4.8	5.06	15.7	11.07	0.62	72.33	63.94
BANK OTKRITIE FI	24.7	2	0.31	15.8	1.66	0.12	14.61	8.45
BANK ST PETERSBU	23.9	2.2	0.11	14.3	0.36	0.52	5.05	3.13
BANK VOZROZHDENI	13	4.7	0.14	15.1	0.32	0.25	2.68	1.91
Country Average	21	3.3	2.15	15.2	8.22	0.81	59.09	42.23
Panel D: Indian Banks								
Bank Name-India	NIM	NPAs to total assets	Total non performing assets	CAR	Market Cap	Net Profit	Deposits	Loans
STATE BANK IND	17.6	2.2	6.17	12.9	20.18	1.89	195.51	158.67
ICICI BANK LTD	15.6	1.8	1.67	17.8	17.26	1.02	43.83	44.86
HDFC BANK LTD	26.2	0.6	0.45	15.8	16.15	0.73	34.11	27.4
AXIS BANK LTD	29	0.7	0.29	14.4	7.2	0.55	27.81	21.92
KOTAK MAHINDRA	18.5	1	0.14	19	6.09	0.24	5.03	5.88
Country Average	21.4	1.3	1.75	16	24.33	0.89	61.26	51.75

Table 3.12: Comparison of fraction of Risk Issues Tabled with Business Issues Tabled. This table shows the test of means of risk issues tabled with business strategy issues tabled. Since we are testing whether risk issues tabled is lesser than that of business strategy issues tabled, we are interested in the first alternate hypothesis of $\Pr(T < t)$.

Variable	Obs	Mean	S.E	S.D	95% C.I.	
Risk Tabled/Total Tabled	29	0.1	0.1	0.06	0.07	0.12
Strategy Tabled/ Total Tabled	29	0.3	0.02	0.12	0.26	0.35
Difference	29	-0.2	0.02	0.12	-0.24	-0.15

mean(diff) = mean(risk - busstrategy)		$t = -9.3643$
Ha: mean(diff) < 0	Ha: mean(diff) $\neq 0$	Ha: mean(diff) > 0
$\Pr(T < t) = 0.0000$	$\Pr(\|T\| > \|t\|) > 0.0000$	$\Pr(T > t) = 1.0000$

Table 3.13: Comparison of fraction of Business Strategy Issues Tabled with Regulation and Compliance Issues Tabled. This table shows the test of means of business strategy issues tabled with compliance issues tabled. Since we are testing whether business strategy risk issues tabled is lesser than that of regulation and compliance issues tabled, we are interested in the first alternate hypothesis of $\Pr(T < t)$.

Variable	Obs	Mean	S.E	S.D	95% C.I.	
Strategy Tabled/Total Tabled	29	0.3	0.02	0.12	0.26	0.35
Compliance Tabled/ Total Tabled	29	0.4	0.02	0.14	0.35	0.46
Difference	29	-0.1	0.04	0.24	-0.19	-0.07

mean(diff) = mean(busstrategy-compliance)		$t = -2.2137$
Ha: mean(diff) < 0	Ha: mean(diff) $\neq 0$	Ha: mean(diff) > 0
$\Pr(T < t) = 0.0176$	$\Pr(\|T\| > \|t\|) > 0.0352$	$\Pr(T > t) = 0.9824$

Table 3.14: Bank Level Outcome Variables And Risk Issues Tabled- Government Banks And Others. The table presents the relationship between bank characteristics and the proportion of risk issues tabled. The data are organized at a bank level. Each column presents the results of a regression where a bank characteristic is regressed on the proportion of a category of issues among all issues tabled. In Panel A, we consider the proportion of risk issues among all issues tabled as the main explanatory variable. Similarly, we consider human resources, business strategy, and regulation and compliance in subsequent panels, as shown in the Table. The data for all bank-level variables are obtained from the RBI website. The data pertain to the year ending 31st March, 2014. All variables are winsorized at 95 percent. Government-Owned Bank is a dummy variable that takes the value of one for government-owned banks and zero otherwise. $***$, $**$, and $*$ represent significance at the 1%, 5%, and 10% levels, respectively.

	ROA	ROE	Net NPA/Net Advance	Gross NPA/Gross Advances
	Panel A			
Risk	9.765***	99.228*	-11.849**	-13.673*
	(3.170)	(1.913)	(-2.301)	(-1.851)
Government Owned Bank	0.404	5.53	0.11	0.443
	(0.835)	(0.679)	(0.136)	(0.382)
Risk x Government Owned Bank	-7.909**	-60.837	6.964	9.147
	(-2.068)	(-0.945)	(1.089)	(0.997)
Observations	29	29	29	29
R-squared	0.488	0.201	0.46	0.437
	Panel B			
Human Resource	-1.565	32.356	0.232	-3.31
	(-0.417)	(0.567)	(0.040)	(-0.411)
Government Owned Bank	-0.866**	-5.139	1.566***	2.039***
	(-2.756)	(-1.077)	(3.216)	(3.025)
Human Resource x Government Owned Bank	3.15	2.84	-5.357	-1.891
	(0.688)	(0.041)	(-0.755)	(-0.193)
Observations	29	29	29	29
R-squared	0.283	0.091	0.351	0.37
	Panel C			
Business Strategy	-2.468	-65.327*	2.987	6.337
	(-1.108)	(-2.057)	(0.826)	(1.307)
Government Owned Bank	-1.816**	-32.104**	2.330*	3.655*
	(-2.213)	(-2.743)	(1.748)	(2.045)
Business Strategy x Government Owned Bank	3.506	88.265**	-3.369	-5.464
	(1.417)	(2.501)	(-0.838)	(-1.014)
Observations	29	29	29	29
R-squared	0.326	0.246	0.329	0.389
	Panel D			
Regulation and Compliance	1.384	22.812	-1.902	-2.7
	(0.791)	(0.86)	(-0.681)	(-0.711)
Government Owned Bank	-1.953	-37.175	0.482	1.373
	(-0.966)	(-1.214)	(0.366)	(0.768)
Regulation and Compliance x Government Owned Bank	0.055	10.561	2.004	1.403
	(0.067)	(0.846)	(0.621)	(0.320)
Observations	29	29	29	29
R-squared	0.294	0.109	0.323	0.366
	Panel E			
Financial Reporting	-4.635	-9.976	8.22	6.674
	(-1.377)	(-0.188)	(1.618)	(0.916)
Government Owned Bank	-1.083**	-1.834	1.720**	2.034*
	(-2.128)	(-0.228)	(2.239)	(1.847)
Financial Reporting x Government Owned Bank	3.197	-16.902	-4.283	-2.004
	(0.863)	(-0.289)	(-0.766)	(-0.250)
Observations	29	29	29	29
R-squared	0.341	0.096	0.434	0.410

Table 3.15: Summary of Issues deliberated by bank ownership. This table shows the issues deliberated in board meetings across different categories, split by ownership. Ownership classification is obtained from RBI website.

	Private				Public			
	N	Mean Number of Issues	As a % of total issues deliberated	As a % of issues tabled in that category	N	Mean Number of Issues	As a % of total issues deliberated	As a % of issues tabled in that category
Risk	12	1.00	10.00	22.20	17	1.00	10.00	12.40
Business Strategy	12	4.00	40.00	17.10	17	4.00	40.00	20.30
Regulation and Compliance	12	3.00	30.00	13.40	17	3.00	30.00	15.00
Financial Reporting	12	2.00	20.00	21.00	17	1.00	10.00	35.50
Human Resources	12	0.00	0.00	2.08	17	1.00	10.00	23.90

Table 3.16: Bank Level Outcome variables And Risk Issues Deliberated- Government Banks And Others. The table presents the relationship between bank characteristics and the proportion of risk issues deliberated. The data are organized at a bank level. Each column presents the results of a regression where a bank characteristic is regressed on the proportion of a category of issues deliberated. In Panel A, we consider the proportion of risk issues deliberated as the main explanatory variable. Similarly, we consider human resources, business strategy, and regulation and compliance in subsequent panels. The data for all bank-level variables are obtained from the RBI website. The data pertain to the year ending 31st March, 2014. All variables are winsorized at 95 percent. Government-Owned Bank is a dummy variable that takes the value of one for government-owned banks and zero otherwise. $***$, $**$, and $*$ represent significance at the 1%, 5%, and 10% levels, respectively.

	ROA	ROE	Net NPA/Net Advance	Gross NPA/Gross Advances
	Panel A			
Risk	0.728	11.777	-4.497*	-5.915
	(0.416)	(0.44)	(-1.709)	(-1.632)
Government Owned Bank	-0.649*	-3.39	0.668	1.02
	(-1.849)	(-0.631)	(1.265)	(1.402)
Risk x Government Owned Bank	0.291	10.264	3.418	6.279
	(0.088)	(0.202)	(0.686)	(0.915)
Observations	29	29	29	29
R-squared	0.277	0.068	0.383	0.407
	Panel B			
Human Resource	-0.632	27.3	-2.905	-6.328
	(-0.195)	(0.553)	(-0.578)	(-0.928)
Government Owned Bank	-0.785***	-5.049	1.405***	2.013***
	(-2.863)	(-1.211)	(3.312)	(3.497)
Human Resource x Government Owned Bank	1.571	-7.532	-0.229	2.194
	(0.412)	(-0.130)	(-0.039)	(0.274)
Observations	29	29	29	29
R-squared	0.275	0.078	0.345	0.389
	Panel C			
Business Strategy	-0.906	-19.588	0.289	1.518
	(-0.963)	(-1.392)	(0.191)	(0.741)
Government Owned Bank	-1.047**	-12.152*	1.205*	2.125**
	(-2.522)	(-1.958)	(1.808)	(2.353)
Business Strategy x Government Owned Bank	1.102	26.316	0.167	-0.868
	(0.961)	(1.535)	(0.09)	(-0.348)
Observations	29	29	29	29
R-squared	0.297	0.135	0.316	0.363
	Panel D			
Regulation and Compliance	0.456	1.642	0.061	0.54
	(0.51)	(0.124)	(0.042)	(0.269)
Government Owned Bank	-0.393	0.52	1.097*	1.875**
	(-1.069)	(0.096)	(1.832)	(2.273)
Regulation and Compliance x Government Owned Bank	-1.389	-22.568	0.763	0.077
	(-1.230)	(-1.353)	(0.415)	(0.03)
Observations	29	29	29	29
R-squared	0.324	0.189	0.324	0.35
	Panel E			
Financial Reporting	0.786	1.321	0.065	0.003
	(0.623)	(0.178)	(0.049)	(0.002)
Government Owned Bank	-0.321	0.613	1.128*	1.786**
	(-1.12)	(0.086)	(1.832)	(2.123)
Financial Reporting x Government Owned Bank	-1.112	-12.163	0.712	0.067
	(-1.112)	(-1.353)	(0.425)	(0.031)
Observations	29	29	29	29
R-squared	0.312	0.168	0.421	0.459

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Appendix A

Proofs of Chapter 1 and 2

A1.1 Proof of Lemma 1.1

Dealer requests audit iff expected incremental payoff from audit is strictly positive, i.e.,

$$p\pi(D - \tilde{v}) + (1 - p\pi) \cdot 0 - \hat{\alpha} D > 0 \tag{A1.1}$$

Clearly, inequality (A1.1) is always violated if $\pi \leqslant \alpha$ while holds when $\tilde{v} < d_c(\pi) \equiv D(1 - \frac{\alpha}{\pi})$ if $\pi > \alpha$

$\square$

A1.2 Proof of Proposition 1.1

Clearly, if $\tilde{R} = 0$, HF cannot repay if $\tilde{v} < D$ and must default. So suppose either (i) $\tilde{R} = 0$ and $\tilde{v} \geqslant D$ or, (ii) $\tilde{R} = R$. Both cases imply $\tilde{R}B + \tilde{v} - D \geqslant 0$.

(A) If the option to audit is not available, HF repays iff $\tilde{R}B + \tilde{v} - D \geqslant \tilde{R}B + \max\{\tilde{v} - D, 0\}$, i.e., HF is indifferent between repaying and defaulting when $\tilde{v} \geqslant D$ while defaults otherwise. In the former case, we assume HF repays.

(B) If option to audit is available, payoffs from repayment or default are characterized as follows,

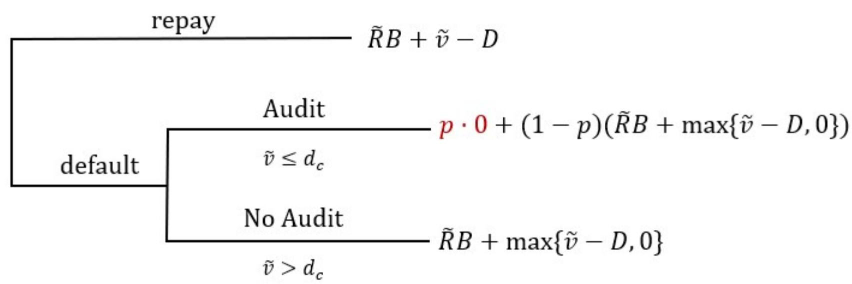


Figure A1.1: Expected payoff for HF at $t = 2$ when $(i)\, \tilde{R} = 0$ and $\tilde{v} \geqslant D$ or, $(ii)\, \tilde{R} = R$.

It is easy to see from Figure A1.1 that repayment is a (weakly) dominant strategy for all $\tilde{R} \,\epsilon\, \{0,\, R\}$ if $\tilde{v} \geqslant D$. The optimal decision for $\tilde{R} = R$ and $\tilde{v} < D$ remains to be characterized. So, suppose $\tilde{R} = R$ and $\tilde{v} < D$. Clearly, defaulting is a (strictly) dominant strategy if an audit is not anticipated upon default. However, if an audit is anticipated upon default, repayment is preferable as long as $\tilde{v} \geqslant D - \bar{r}B$. Hence, $D \leqslant \bar{r}B$ ensures that repayment is preferable whenever audit is anticipated upon default. We can now prove the main statement of the lemma.

(a) Suppose $q \leqslant \alpha$. It is easy to see that $u(R,\, \tilde{v}) = 1\, \forall\, \tilde{v} < D$ is a perfect bayesian equilibrium (PBE). This is also unique, i.e., $u(R,\, \tilde{v}) = 1$ for $\tilde{v} \,\epsilon\, X \subset [0,\, D)$ cannot be a PBE. Suppose there is such an equilibrium. Then, $\pi(\tilde{v} \,|\, u) = q\, \forall\, \tilde{v} \,\epsilon\, X$ and $\pi(\tilde{v} \,|\, u) = 0\, \forall\, \tilde{v} \,\epsilon\, X^c \equiv [0,\, D) \setminus X$. However, deviation to default is clearly profitable if $\tilde{v} \,\epsilon\, X^c$ since PB's belief imply $\tilde{R} = 0$ with probability one and therefore no audit.

(b) Finally, suppose $q > \alpha$. Let $u(R,\, \tilde{v}) = 1$ for $\tilde{v} \,\epsilon\, X \subseteq [0,\, D)$. Then, $\pi(\tilde{v} \,|\, u) = q\, \forall\, \tilde{v} \,\epsilon\, X$. Then, it must be that upon default HF does not anticipate an audit for any $\tilde{v} \,\epsilon\, X$. This implies $X \cap [0,\, d_c(q)] = \varnothing$ so that $X = \varnothing$ or $X = (d_c(q),\, D)$. Former cannot be a PBE. If it were, then $\pi(\tilde{v} \,|\, u) = 0\, \forall\, \tilde{v} < D$ and deviation to default is always profitable. Next, it is easy to verify that default when $\tilde{v} \,\epsilon\, (d_c(q),\, D)$ is indeed a PBE.

Is repayment an equilibrium for $\tilde{v} \,\epsilon\, [0,\, d_c(q)]$? If it were, then $\pi(\tilde{v} \,|\, u) = 0\, \forall\, \tilde{v} \,\epsilon\, [0,\, d_c(q)]$. However, this implies no audit upon default so that deviation to default is strictly preferable by HF. Thus, the only possible PBE for $\tilde{v} \,\epsilon\, [0,\, d_c(q)]$ must have HF following a mixed-strategy. Suppose HF follows a mixed-strategy, given by $u(R,\, \tilde{v}) = 1$ with probability γ and $u(R,\, \tilde{v}) = 0$ with probability $1 - \gamma$. This implies $\pi(\tilde{v} \,|\, u) = \frac{q\gamma}{q\gamma + 1 - q}$ for $\tilde{v} \,\epsilon\, [0,\, d_c(q)]$. If π is such that the PB follows a pure-strategy to audit, then the HF must follow a pure-strategy to repay since $D \leqslant \bar{r}B$. On the other hand, if π is such that the PB strictly prefers not to audit, then HF strictly prefers to default. Thus, the PB must also follow a mixed-strategy and be indifferent between requesting or not requesting an audit . Therefore, first, it must be that $D(1 - \frac{\alpha}{\pi}) = \tilde{v}$ which pins down $\gamma = \Gamma(\tilde{v},\, D)$. Second, if the PB requests an audit with probability λ, the HF must be indifferent between defaulting or repaying, i.e., $\lambda(p \cdot 0 + (1-p)RB) + (1-\lambda)RB = RB + \tilde{v} - D$. This pins down $\lambda = \Lambda(\tilde{v},\, B,\, D)$.

□

A1.2.1 Proof of Corollary 1.1

$$\frac{\partial \gamma}{\partial y} = \left(\frac{1-q}{q}\right) \cdot \frac{1}{(1-\pi)^2} \cdot \frac{\partial \pi}{\partial y}, \qquad y = \{\alpha,\, D\}$$
$$\frac{\partial \pi}{\partial \alpha} = \frac{D}{D-\tilde{v}} > 0, \qquad \frac{\partial \pi}{\partial D} = -\frac{\alpha \tilde{v}}{(D-\tilde{v})^2} < 0$$
$$\frac{\partial \gamma}{\partial q} = -\frac{1}{q^2}\left(\frac{\pi}{1-\pi}\right) < 0$$

$$\begin{aligned}
\mathcal{P}_d &= q \cdot Pr(\text{default}\,|\,\text{success}) + (1-q) \cdot Pr(\text{default}\,|\,\text{failure}) \\
&= q\left[\int_{d_c}^{D} \varphi(v)dv + \int_0^{d_c} \gamma\varphi(v)dv\right] + (1-q)\int_0^{D} \varphi(v)dv
\end{aligned}$$

$$\frac{\partial \mathcal{P}_d}{\partial \alpha} = q\left[\varphi(d_c)\frac{D}{q} - \underbrace{\gamma(d_c)}_{=1}\varphi(d_c)\frac{D}{q} + \int_0^{d_c} \frac{\partial \gamma}{\partial \alpha}\varphi(v)dv\right] > 0$$

$$\begin{aligned}
\frac{\partial \mathcal{P}_d}{\partial q} &= q\left[-\varphi(d_c)\frac{\alpha D}{q^2} + \underbrace{\gamma(d_c)}_{=1}\varphi(d_c)\frac{\alpha D}{q^2} + \int_0^{d_c} \frac{\partial \gamma}{\partial q}\varphi(v)dv\right] + \left[\int_{d_c}^{D} \varphi(v)dv + \int_0^{d_c} \gamma\varphi(v)dv\right] - \int_0^{D} \varphi(v)dv \\
&= q\int_0^{d_c} \underbrace{\frac{\partial \gamma}{\partial q}}_{<0} \varphi(v)dv - \int_0^{d_c} (1-\gamma)\varphi(v)dv < 0
\end{aligned}$$

$$\begin{aligned}
\frac{\partial \mathcal{P}_d}{\partial D} &= q\left[-\varphi(d_c)(1-\frac{\alpha}{q}) + \varphi(D) + \underbrace{\gamma(d_c)}_{=1}\varphi(d_c)(1-\frac{\alpha}{q}) + \int_0^{d_c} \frac{\partial \gamma}{\partial D}\varphi(v)dv\right] + (1-q)\varphi(D) \\
&= \underbrace{\varphi(D)}_{>0} + q\int_0^{d_c} \underbrace{\frac{\partial \gamma}{\partial D}}_{<0} \varphi(v)dv
\end{aligned}$$

□

A1.3 Proof of Proposition 1.2 and 1.3

$$
\begin{aligned}
\max_{B,\,D} V_S(B,\,D) &= \int_D^{\overline{v}} (D - E(B))\varphi(v)dv + \int_0^D (v - r_e E(B))\varphi(v)dv \\
&\quad + \int_0^{d_c} q(1-\gamma)(D - v + (r_e - 1)E(B))\varphi(v)dv \\
\text{s.t} &\quad 0 \leqslant B \leqslant L, \quad B \leqslant D \leqslant \overline{r}B, \quad Lf \leqslant D \\
H_S(B,\,D) &= \mu_0 + qRB - \underbrace{\left(D + \int_0^D (v - D)\varphi(v)dv - q\int_0^{d_c} (v - D)\varphi(v)dv \right)}_{\equiv G(D)} \geqslant \mu_0
\end{aligned}
\tag{A1.2}
$$

Remark 1. If HF participation constraint is satisfied by a feasible contract $(B,\,D)$, then it is strictly satisfied by any other feasible contract $(B,\,D')$ with $D' < D$, for every $\theta \,\epsilon\, \mathcal{C}$. This follows from the fact that $G(D)$ is strictly increasing in D, for every $\theta \,\epsilon\, \mathcal{C}$.

Remark 2. The function $\frac{\overline{r}}{R} + \frac{1}{Rx}\int_0^{\overline{r}x}(v - \overline{r}x)\varphi(v)dv$ is strictly decreasing in x.

Equations (A1.3.1), (A1.3.2) are the first order conditions w.r.t $(B,\,D)$ respectively ($\eta_i \geqslant 0$, $i = 1, \ldots, 6$ are Lagrange multipliers for the constraints). For ease of exposition, we omit writing complementary slackness conditions.

$$
\eta_1 + \overline{r}\eta_4 + qR\eta_6 = \eta_2 + \eta_3 - \frac{\partial V_S}{\partial B} \qquad \text{(w.r.t } B) \tag{A1.3.1}
$$

$$
\eta_4 + \eta_6\frac{\partial G}{\partial D} = \eta_5 + \eta_3 + \frac{\partial V_S}{\partial D} \qquad \text{(w.r.t } D) \tag{A1.3.2}
$$

where,

$$
\begin{aligned}
-\frac{\partial V_S}{\partial B} &= 1 + (r_e - 1)\left(\int_0^D \varphi(v)dv - \int_0^{d_c} q(1-\gamma)\varphi(v)dv \right) \\
\frac{\partial V_S}{\partial D} &= \int_D^{\overline{v}} \varphi(v)dv + \int_0^{d_c} \left(q(1-\gamma) + \frac{1-q}{(1-\pi)^2}\frac{\alpha v}{(D-v)} \right)\varphi(v)dv \\
&\quad - (r_e - 1)E(B)\left(\varphi(D) - \int_0^{d_c} \frac{1-q}{(1-\pi)^2}\frac{\alpha v}{(D-v)^2}\varphi(v)dv \right)
\end{aligned}
\tag{A1.4}
$$

$$
\frac{\partial G}{\partial D} = \int_D^{\overline{v}} \varphi(v)dv + q\int_0^{d_c} \varphi(v)dv + \alpha d_c\varphi(d_c)
$$

Note that if $D^* < \overline{r}B^*$, then by equation (A1.3.1), $\eta_1 \geqslant 0, \eta_6 \geqslant 0$ with at least one strict inequality. That is, either the PB does not lend at all, $B^* = 0$ or the participation constraint binds. In an equilibrium with $B^* > 0$ and $D^* > Lf$, we have $\eta_1 = \eta_5 = 0$. Further, $qR > 1$ implies $D^* > B^*$ or $\eta_3 = 0$. We will verify that there exists $\eta_2, \eta_4, \eta_6 \geqslant 0$ that satisfy equations (A1.3.1), (A1.3.2), and complementary slackness for the proposed equilibrium under a given range of q and r_e.

Since $G(D) < D \leqslant \overline{r}B$, $H_S(B, D) - \mu_0 > (qR - \overline{r})B$. Therefore, if $q \geqslant \frac{\overline{r}}{R}$, manager PC is slack and he will accept any contract offered. This further implies $\eta_6 = 0$ and $D^* = \overline{r}B^*$ from equation (A1.3.1). Since we also have $q > \alpha$, define $C_1 = \{\theta \,\epsilon\, \mathcal{C} \,|\, q \,\epsilon\, [\frac{\overline{r}}{R}, 1)\}$. Suppose $\theta \,\epsilon\, C_1$. As argued above, any equilibrium must have $D^* = \overline{r}B^*$. From equations (A1.3.1), (A1.3.2), this is an equilibrium only if

$$\frac{\partial V_S}{\partial B} + \overline{r}\frac{\partial V_S}{\partial D} = \eta_2 \ (\geqslant 0) \tag{A1.5.1}$$

Using equation (A1.4), $B^* = L$ is an equilibrium only if

$$\begin{aligned} &\overline{r}\int_{\overline{r}L}^{\overline{v}} \varphi(v)dv + \overline{r}\int_0^{d_c^*(\theta)} \left(q(1-\gamma) + \frac{1-q}{(1-\pi)^2}\frac{\alpha v}{(\overline{r}L - v)}\right)\varphi(v)dv - 1 \\ &\geqslant (r_e - 1)\left[\overline{r}Lf\left(\varphi(\overline{r}L) - \int_0^{d_c^*(\theta)} \frac{(1-q)}{(1-\pi)^2}\frac{\alpha v}{(\overline{r}L - v)^2}\varphi(v)dv\right) + \left(\int_0^{\overline{r}L}\varphi(v)dv - \int_0^{d_c^*(\theta)} q(1-\gamma)\varphi(v)dv\right)\right] \end{aligned}$$

where, $d_c^*(\theta) = \overline{r}L(1 - \dfrac{\alpha}{q})$

(A1.5.1')

The LHS is the net marginal benefit of lending a dollar and charging interest rate $\overline{r}$ while the RHS is the net marginal cost of emergency borrowing in client defaults. Assumption (I1.3) ensures default is costly, i.e.,

$$\overline{r}Lf\left(\varphi(\overline{r}L) - \int_0^{d_c^*(\theta)} \frac{(1-q)}{(1-\pi)^2}\frac{\alpha v}{(\overline{r}L - v)^2}\varphi(v)dv\right) + \left(\int_0^{\overline{r}L}\varphi(v)dv - \int_0^{d_c^*(\theta)} q(1-\gamma)\varphi(v)dv\right) > 0$$

This implies PB charges zero haircut as long as $r_e \leqslant \overline{r}_e(\theta)$ where, $\overline{r}_e(\theta)$ solves equation (A1.5.1') with equality. Conversely, if $r_e > \overline{r}_e(\theta)$, then it must be that $B^* < L$, $D^* = \overline{r}B^*$ with B^* pinned down by equation (A1.5.1) with $\eta_2 = 0$.

Suppose $\theta \,\epsilon\, \mathcal{C}\backslash C_1$. An equilibrium with HF PC slack and $(B^*, D^*) = (L, \overline{r}L)$ must satisfy equation (A1.5.1') and,

$$qRL > \overline{r}L + \int_0^{\overline{r}L}(v - \overline{r}L)\varphi(v)dv - q\int_0^{d_c^*}(v - \overline{r}L)\varphi(v)dv = G(\overline{r}L;\,\theta) \tag{A1.5.2}$$

Does there exist a $q \in \mathcal{C} \backslash C_1$ such that the inequality (A1.5.2) is satisfied for every $\alpha \in (0, q)$? Note that, for a given q, $\frac{\partial G(\overline{r}L;\theta)}{\partial \alpha} < 0$. Thus, if q is such that $qRL \geqslant G(\overline{r}L;\, q,\, \alpha = 0)$ then inequality (A1.5.2) is satisfied for all $\alpha \in (0, q)$. The aforementioned condition is satisfied for all $q \geqslant \overline{q}$.

$$\overline{q} = \frac{\frac{\overline{r}}{R} + \frac{1}{RL}\int\limits_0^{\overline{r}L}(v - \overline{r}L)\varphi(v)dv}{1 + \frac{1}{RL}\int\limits_0^{\overline{r}L}(v - \overline{r}L)\varphi(v)dv} \qquad \text{(A1.5.2')}$$

It is easy to see that $\overline{q} \leqslant \frac{\overline{r}}{R}$ with equality iff $\overline{r} = R$. Define $C_2 = \{\theta \in \mathcal{C} \,|\, q \in [\overline{q},\, \frac{\overline{r}}{R})\}$. Therefore, $(B^*,\, D^*) = (L,\, \overline{r}L)$ for $\theta \in C_2$ as long as $r_e \leqslant \overline{r}_e(\theta)$.

Similarly, if q is such that $qRL \leqslant G(\overline{r}L;\, q,\, \alpha = q)$, then inequality (A1.5.2) is never satisfied for any $\alpha \in (0, q)$. The aforementioned condition is satisfied for $q \leqslant \underline{q} < \overline{q}$ where,

$$\underline{q} = \frac{\overline{r}}{R} + \frac{1}{RL}\int\limits_0^{\overline{r}L}(v - \overline{r}L)\varphi(v)dv > \frac{1}{R} \qquad \text{(by (I1.2))} \qquad \text{(A1.5.2")}$$

Therefore, if $\theta \in C_5 \equiv \{\theta \in \mathcal{C} \,|\, q \in (\frac{1}{R},\, \underline{q}]\}$, then $B^* = L$ implies $D^* < \overline{r}B^*$ for manager PC to be satisfied. This further means PC must bind, i.e., $\eta_6 > 0$. We can also prove that PC must bind even if $B^* < L$. Suppose not, so that $B^* < L$ and PC is slack, implying $D^* = \overline{r}B^*$. A slack PC necessitates

$$q > \frac{\frac{\overline{r}}{R} + \frac{1}{RB^*}\int\limits_0^{\overline{r}B^*}(v - \overline{r}B^*)\varphi(v)dv}{1 + \frac{1}{RB^*}\int\limits_0^{d_c^*}(v - \overline{r}B^*)\varphi(v)dv} > \frac{\overline{r}}{R} + \frac{1}{RB^*}\int\limits_0^{\overline{r}B^*}(v - \overline{r}B^*)\varphi(v)dv > \underline{q}, \quad d_c^* = \overline{r}B^*(1 - \frac{\alpha}{q})$$

by Remark 2. This is a contradiction since $q \leqslant \underline{q}$.

Suppose $\theta \in C' \equiv \{\theta \in \mathcal{C} \,|\, q \in (\underline{q},\, \overline{q})\}$. For every such q, $qRL \in (G(\overline{r}L;\, q,\, \alpha = q),\, G(\overline{r}L;\, q,\, \alpha = 0))$ by definition of $\underline{q},\, \overline{q}$. By the Intermediate Value Theorem (IVT) and the fact that $\frac{\partial G(\overline{r}L;\theta)}{\partial \alpha} < 0$, there exists a unique $t(q) \in (0, q)$ such that $qRL \geqslant G(\overline{r}L;\, q,\, \alpha)$, $\forall\, \alpha \in [t(q),\, q)$ while $qRL < G(\overline{r}L;\, q,\, \alpha), \forall\, \alpha \in (0,\, t(q))$.

Define $C_3 = \{\theta \in \mathcal{C} \,|\, \alpha \in [t(q),\, q),\, q \in (\underline{q},\, \overline{q})\}$ and $C_4 = \{\theta \in \mathcal{C} \,|\, \alpha \in (0,\, t(q)),\, q \in (\underline{q},\, \overline{q})\}$. Clearly, if $\theta \in C_4$ and $B^* = L$ holds in equilibrium, then we must also have $D^* < \overline{r}B^*$ or, a binding PC. In this case, * is pinned down by equation (A1.5.3) below,

$$qRL = D^* + \int\limits_0^{D^*}(v - D^*)\varphi(v)dv - q\int\limits_0^{d_c^*}(v - D^*)\varphi(v)dv \qquad \text{(A1.5.3)}$$

We now show that there exists $\theta \,\epsilon\, C_4$ such that $B^* < L$ and $D^* < \overline{r}B^*$. This statement is trivial if the condition holds for all $\theta \,\epsilon\, C_4$. Therefore, suppose there exists at least one $\theta^{'} \,\epsilon\, C_4$ such that $B^*(\theta^{'}) < L$, $D^*(\theta^{'}) = \overline{r}B^*(\theta^{'})$ and the PC is slack where, $(B^*(\theta^{'}), \overline{r}B^*(\theta^{'}))$ solves equation (A1.5.1) with $\eta_2 = 0$. By definition, this implies $H_S(B^*, \overline{r}B^*; \theta^{'}) > \mu_0$. Pick $\theta^{''} = (\alpha, \underline{q})$ for any $\alpha < \underline{q}$. We know from above discussion that $H_S(B^*, \overline{r}B^*; \theta^{''}) < \mu_0$ for all $\theta^{''}$ where, $(B^*(\theta^{''}), \overline{r}B^*(\theta^{''}))$ solves equation (A1.5.1) with $\eta_2 = 0$. Then, by IVT, there exists a non-empty subset of $(\underline{q}, q(\theta^{'}))$ where $H_S(B^*, \overline{r}B^*; q, \alpha(\theta^{'})) < \mu_0$ for $q \,\epsilon\, (\underline{q}, q(\theta^{'}))$. This completes the proof.

Finally, for $\theta \,\epsilon\, C_3$ such that $\alpha > t(q)$, PC is slack at $(B^*, D^*) = (L, \overline{r}L)$ which is an equilibrium as long as $r_e \leqslant \overline{r}_e(\theta)$ while set $\eta_6 = 0$ for $\alpha = t(q)$ to arrive at the same conclusion.

□

A1.4 Proof of Lemma 1.2

$\overline{r}_e(\theta)$ is given by the equation,

$$\frac{\partial V_S(\overline{r}_e,\, \alpha,\, q;\, L,\, \overline{r}L)}{\partial B} + \overline{r}\frac{\partial V_S(\overline{r}_e,\, \alpha,\, q;\, L,\, \overline{r}L)}{\partial D} = 0$$

Differentiating above w.r.t. α yields,

$$\underbrace{\left(\frac{\partial^2 V_S}{\partial r_e \partial B} + \overline{r}\frac{\partial^2 V_S}{\partial r_e \partial D}\right)}_{<0 \text{ by (I1.3)}}\frac{\partial \overline{r}_e}{\partial \alpha} + \underbrace{\left(\frac{\partial^2 V_S}{\partial \alpha \partial B} + \overline{r}\frac{\partial^2 V_S}{\partial \alpha \partial D}\right)}_{<0 \text{ by (I1.4)}} = 0$$

Proof of $\partial \overline{r}_e / \partial q > 0$ is similar.

□

A1.5 Proof of Proposition 1.4

Let $\theta \,\epsilon \bigcup\limits_{j=1}^{3} C_j$. We want to characterize whether $r_e \gtrless \overline{r}_e(\theta)$ for $\theta \,\epsilon \bigcup\limits_{j=1}^{3} C_j$. Fix $q \,\epsilon\, (\underline{q}, 1)$. By Lemma 1.2, ceteris paribus, $\overline{r}_e(\theta)$ is strictly decreasing in α. Define $\overline{r}_e^{\,s}(q) \equiv \lim\limits_{\alpha \to 0^+} \overline{r}_e(q, \alpha)$ and $\overline{r}_e^{\,i} \equiv \lim\limits_{\alpha \to q} \overline{r}_e(q, \alpha)$ as the supremum and infimum respectively of $\overline{r}_e(q, \alpha)$ in the set $\alpha \,\epsilon\, (0, q)$. Note that the infimum is not a function of q.

If $r_e \geqslant \overline{r}_e^{\,s}(q)$, then $r_e > \overline{r}_e(\theta)$ for all $\alpha \,\epsilon\, (0, q)$. Similarly, if $r_e \leqslant \overline{r}_e^{\,i}$, then $r_e < \overline{r}_e(\theta)$ for all $\alpha \,\epsilon\, (0, q)$. So suppose, $r_e \,\epsilon\, (\overline{r}_e^{\,i}, \overline{r}_e^{\,s}(q))$. By IVT, there exists a unique level of audit costs $\overline{\alpha}(q)$, such that $r_e > \overline{r}_e(\theta)$ for $\alpha \,\epsilon\, (\overline{\alpha}(q), q)$ while $r_e \leqslant \overline{r}_e(\theta)$ for $\alpha \,\epsilon\, (0, \overline{\alpha}(q)]$.

Repeating the above discussion for $q \,\epsilon\, (\underline{q},\, \overline{q})$ and $r_e \,\epsilon\, (\overline{r}_e^i,\, \overline{r}_e^s(q))$, $r_e > \overline{r}_e(\theta)$ for $\alpha \,\epsilon\, [t(q),\, q] \cap (\overline{\alpha}(q),\, q]$ while, $r_e < \overline{r}_e(\theta)$ for $\alpha \,\epsilon\, [t(q),\, \overline{\alpha}(q)]$.

Furthermore, note that $\overline{r}_e^s(q)$ is increasing in q. Define $q' \,\epsilon\, (\underline{q},\, 1)$ as $r_e = \overline{r}_e^s(q')$. $\overline{r}_e^s(q)$ increasing in q implies $r_e > \overline{r}_e^s(q)\ \forall\ q \,\epsilon\, (\underline{q},\, q')$ while $r_e \leqslant \overline{r}_e^s(q)\ \forall\ q \,\epsilon\, [q',\, 1)$. This allows us to write the following cases -

(a) $r_e \geqslant \overline{r}_e^s(1) \,:\, r_e > \overline{r}_e^s(q)\ \forall\ q \,\epsilon\, (\underline{q},\, 1)$

(b) $r_e \,\epsilon\, [\overline{r}_e^s(\frac{\overline{r}}{R}),\, \overline{r}_e^s(1)) \,:\, q' \,\epsilon\, [\frac{\overline{r}}{R},\, 1)$

(c) $r_e \,\epsilon\, [\overline{r}_e^s(\overline{q}),\, \overline{r}_e^s(\frac{\overline{r}}{R})) \,:\, q' \,\epsilon\, [\overline{q},\, \frac{\overline{r}}{R})$

(d) $r_e \,\epsilon\, (\overline{r}_e^s(\underline{q}),\, \overline{r}_e^s(\overline{q})) \,:\, q' \,\epsilon\, (\underline{q},\, \overline{q})$

(e) $r_e \,\epsilon\, (\overline{r}_e^i,\, \overline{r}_e^s(\underline{q})] \,:\, \overline{r}_e^i < r_e < \overline{r}_e^s(q)\ \forall\ q \,\epsilon\, (\underline{q},\, 1)$

(f) $r_e \,\epsilon\, (1,\, \overline{r}_e^i] \,:\, r_e < r_e(\theta)\ \forall\ \theta \,\epsilon\, \bigcup_{j=1}^{3} C_j$

Consider the region $q \,\epsilon\, [q',\, 1)$ with $q' \,\epsilon\, (\underline{q},\, 1)$. By definition of $\overline{\alpha}(q)$, $r_e = \overline{r}_e(q,\, \overline{\alpha}(q))$. For cases (b)-(c) above, by Lemma 1.2, $d\overline{\alpha}/dq = -(\partial\overline{r}_e/\partial q)/(\partial\overline{r}_e/\partial\alpha) > 0$. For case (d), $t(q') - \overline{\alpha}(q') = t(q') - 0 > 0$ while $t(\overline{q}) - \overline{\alpha}(\overline{q}) = 0 - \overline{\alpha}(\overline{q}) < 0$. Thus, by IVT, there exists non-empty $S^+,\, S^- \subset (\underline{q},\, \overline{q})$ such that $t(q) \geqslant \overline{\alpha}(q)$ for $q \,\epsilon\, S^+$ while $t(q) < \overline{\alpha}(q)$ for $q \,\epsilon\, S^-$. The argument is same for case (e) except for replacing q' with $\underline{q}$ and noting that $t(\underline{q}) - \overline{\alpha}(\underline{q}) = q - \overline{\alpha}(\underline{q}) > 0$.

Therefore, for a given $r_e \,\epsilon\, (\overline{r}_e^i,\, \overline{r}_e^s(1))$, we can define $\widehat{C}(r_e) = (\bigcup_{j=1}^{3} C_j) \bigcap \{q \,\epsilon\, (q'',\, 1),\, \alpha \,\epsilon\, (0,\, \overline{\alpha}(q)]\}$ and $\check{C}(r_e) = \bigcup_{j=1}^{3} C_j \backslash \widehat{C}(r_e)$ where,

$$q'' = \begin{cases} q', & \text{if } r_e \,\epsilon\, (\overline{r}_e^s(\underline{q}),\, \overline{r}_e^s(1)) \\ \underline{q}, & \text{if } r_e \,\epsilon\, (\overline{r}_e^i,\, \overline{r}_e^s(\underline{q})] \end{cases}$$

and $(B^*,\, D^*) = (L,\, \overline{r}L)$ for $\theta \,\epsilon\, \widehat{C}(r_e)$ and $B^* < L$ for $\theta \,\epsilon\, \check{C}(r_e)$.

Finally, let $r_{e,l},\, r_{e,h} \,\epsilon\, (\overline{r}_e^s(\underline{q}),\, \overline{r}_e^s(1))$ be such that $r_{e,h} > r_{e,l}$. We show $\widehat{C}(r_{e,h}) \subset \widehat{C}(r_{e,l})$. Suppose $(\alpha,\, q) \,\epsilon\, \widehat{C}(r_{e,h})$. By definition, $(\alpha,\, q) \,\epsilon\, \bigcup_{j=1}^{3} C_j$, $q \,\epsilon\, (q'(r_{e,h}),\, 1)$, and $\alpha \,\epsilon\, (0,\, \overline{\alpha}(q;\, r_{e,h}))$. Since $r_{e,l} < r_{e,h}$, it follows from $\overline{r}_e^s(q)$ increasing in q that $q \,\epsilon\, (q'(r_{e,l}),\, 1)$. Further, by definition of $\overline{\alpha}$, $\overline{r}_e(q,\, \overline{\alpha}(q;\, r_{e,l})) = r_{e,l} < r_{e,h} = \overline{r}_e(q,\, \overline{\alpha}(q;\, r_{e,h}))$ which by Lemma 1.2 implies $\overline{\alpha}(q;\, r_{e,l}) > \overline{\alpha}(q;\, r_{e,h})$ or, $\alpha \,\epsilon\, (0,\, \overline{\alpha}(q;\, r_{e,l}))$. Hence, $(\alpha,\, q) \,\epsilon\, \widehat{C}(r_{e,l})$. The arguments for other cases $r_{e,l},\, r_{e,h} \,\epsilon\, (\overline{r}_e^i,\, \overline{r}_e^s(\underline{q})]$ and $\overline{r}_e^i < r_{e,l} \leqslant \overline{r}_e^s(\underline{q}) < r_{e,h} < \overline{r}_e^s(1))$ are similar. Finally, it is trivial to see that $\widehat{C}(r_{e,l}) \neq \widehat{C}(r_{e,h})$.

$\square$

A1.5.1 Proof of Corollary 1.2

When $B^* < L$, the solution is given by,

$$\frac{\partial V_S(B^*, \overline{r}B^*)}{\partial B} + \overline{r}\frac{\partial V_S(B^*, \overline{r}B^*)}{\partial D} = 0$$

Differentiating above w.r.t. α,

$$\left(\frac{\partial^2 V_S}{\partial B^2} + \overline{r}\frac{\partial^2 V_S}{\partial D \partial B}\right)\frac{dB^*}{d\alpha} + \frac{\partial^2 V_S}{\partial \alpha \partial B} + \overline{r}\left[\left(\frac{\partial^2 V_S}{\partial B \partial D} + \overline{r}\frac{\partial^2 V_S}{\partial D^2}\right)\frac{dB^*}{d\alpha} + \frac{\partial^2 V_S}{\partial \alpha \partial D}\right] = 0 \qquad \Longrightarrow$$

$$\underbrace{\left(\frac{\partial^2 V_S}{\partial B^2} + 2\overline{r}\frac{\partial^2 V_S}{\partial D \partial B} + \overline{r}^2\frac{\partial^2 V_S}{\partial D^2}\right)}_{<0 \text{ by S.O.C}}\frac{dB^*}{d\alpha} + \underbrace{\left(\frac{\partial^2 V_S}{\partial \alpha \partial B} + \overline{r}\frac{\partial^2 V_S}{\partial \alpha \partial D}\right)}_{<0 \text{ by (I1.4)}} = 0$$

The proof of $dB^*/dq > 0$, $dB^*/dr_e < 0$ is similar.

$\square$

A2.1 Proof of Proposition 2.1

We prove the proposition separately for (a) $\tilde{v} \,\epsilon\, [d_m, \overline{v}]$ and (b) $\tilde{v} \,\epsilon\, [0, d_m)$.

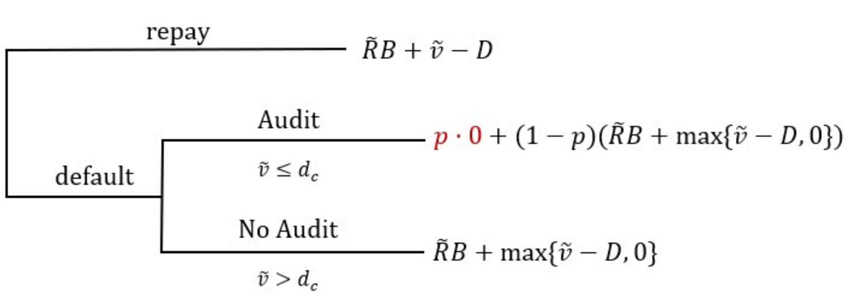
(a) Suppose $\tilde{v} \,\epsilon\, [d_m, \overline{v}]$. PB M strictly prefers an audit iff expected incremental payoff is strictly positive, i.e.,

$$p\pi(D - \tilde{v}) + (1 - p\pi) \cdot 0 - \hat{\alpha}D > 0 \tag{A2.1}$$

Clearly, inequality (A2.1) is always violated if $\pi \leqslant \alpha$ while holds when $\tilde{v} < d_c(\pi) \equiv D(1 - \frac{\alpha}{\pi})$ if $\pi > \alpha$.

Clearly, if $\tilde{R} = 0$, HF cannot repay if $\tilde{v} < D$ and must default. So suppose either $(i)\, \tilde{R} = 0$ and $\tilde{v} \geqslant D$ or, $(ii)\, \tilde{R} = R$. Both cases imply $\tilde{R}B + \tilde{v} - D \geqslant 0$. Payoffs from repayment or default are characterized as follows,

Figure A2.1: Expected payoff for HF at $t = 2$ when $(i)\, \tilde{R} = 0$ and $\tilde{v} \geqslant D$ or, $(ii)\, \tilde{R} = R$.



Since there is no audit when $\tilde{v} \geqslant D$, it is easy to see from Figure A2.1 that HF is indifferent to repayment and default for this range of collateral payoff. We assume HF repays for $\tilde{v} \geqslant D$, $\forall\, \tilde{R} = \{0,\, R\}$. The optimal decision for $\tilde{R} = R$ and $\tilde{v}\,\epsilon$, $[d_m,\, D)$ remains to be characterized. Clearly, defaulting is a (strictly) dominant strategy if an audit is not anticipated upon default. However, if an audit is anticipated upon default, repayment is preferable as long as $\tilde{v} \geqslant D - \overline{r}B$. Hence, $D_i \leqslant \overline{r}B_i \,\forall\, i = m,\, M$ ensures that repayment is preferable whenever audit is anticipated upon default.

Let $u(R,\, \tilde{v}) = 1$ for $\tilde{v}\,\epsilon\, X \subseteq [d_m\, D)$. Then, $\pi(\tilde{v}\,|\,u) = q\,\forall\, \tilde{v}\,\epsilon\, X$. Furthermore, it must be that upon default HF does not anticipate an audit for any $\tilde{v}\,\epsilon\, X$. This implies $X \cap [0,\, d_c(q)] = \varnothing$. There are two possible cases -

(i) $g\,\epsilon\,[1,\, \overline{g})$, which implies $d_c < d_m$ so $X \cap [0,\, d_c(q)] = \varnothing$ implies $X = \varnothing$ or $X = [d_m,\, D)$. It is easy to verify the only the latter is a PBE.

(ii) $g \geqslant \overline{g}$ which implies $d_c \geqslant d_m$ so $X \cap [0,\, d_c(q)] = \varnothing$ implies $X = \varnothing$ or $X = [d_c,\, D)$. Again, it is easy to verify the only the latter is a PBE.

Suppose $g \geqslant \overline{g}$. Is repayment an equilibrium for $\tilde{v}\,\epsilon\,[d_m,\, d_c(q)]$? If it were, then $\pi(\tilde{v}\,|\,u) = 0\,\forall\, \tilde{v}\,\epsilon\,[d_m,\, d_c(q)]$. However, this implies no audit upon default so that deviation to default is strictly preferable by HF. Thus, the only possible PBE for $\tilde{v}\,\epsilon\,[0,\, d_c(q)]$ must have HF following a mixed-strategy. Suppose HF follows a mixed-strategy, given by $u(R,\, \tilde{v}) = 1$ with probability γ and $u(R,\, \tilde{v}) = 0$ with probability $1 - \gamma$. This implies $\pi(\tilde{v}\,|\,u) = \frac{q\gamma}{q\gamma+1-q}$ for $\tilde{v}\,\epsilon\,[0,\, d_c(q)]$. If π is such that the PB follows a pure-strategy to audit, then the HF must follow a pure-strategy to repay since $D \leqslant \overline{r}B$. On the other hand, if π is such that the PB strictly prefers not to audit, then HF strictly prefers to default. Thus, the PB must also follow a mixed-strategy and be indifferent between requesting or not requesting an audit . Therefore, first, it must be that $D(1 - \frac{\alpha}{\pi}) = \tilde{v}$ which pins down $\gamma = \Gamma(\tilde{v},\, D)$. Second, if the PB requests an audit with probability λ, the HF must be indifferent between defaulting or repaying, i.e., $\lambda(p \cdot 0 + (1-p)RB) + (1-\lambda)RB = RB + \tilde{v} - D$. This pins down $\lambda = \Lambda(\tilde{v},\, B,\, D)$.

(b) Suppose $\tilde{v}\,\epsilon\,[0,\, d_m)$. Here, if HF defaults, both PBs have unsecured claims outstanding. Let $u(R,\, \tilde{v}) = 1$ for $\tilde{v}\,\epsilon\, X \subseteq [0,\, d_m)$. Then $\pi(\tilde{v}\,|\,u) = q\,\forall\, \tilde{v}\,\epsilon\, X$. Furthermore, it must be that HF does not an audit by *any* PB for any $\tilde{v}\,\epsilon\, X$. Note that (Audit, No Audit) and (No Audit, Audit) cannot be a NE for the game in Table 2.1. Two cases are possible -

(i) $g \geqslant \overline{g}$ which implies $d_m \leqslant d_c$. Note that, $u(R,\, \tilde{v}) = 1$ for $\tilde{v}\,\epsilon\,[0,\, d_m)$ implies audit is a strictly dominating strategy for PB M so (Audit, Audit) is the unique NE. Therefore, it must be that HF follows a mixed strategy when $\tilde{v}\,\epsilon\,[0,\, d_m)$.

(ii) $g\,\epsilon\,[1,\, \overline{g})$ implies $d_c < d_m$ so (No Audit, No Audit) is indeed the unique NE for $u(R,\, \tilde{v}) = 1$ when $\tilde{v}\,\epsilon\,(d_c,\, d_m)$. For $\tilde{v}\,\epsilon\,[0,\, d_c]$, (Audit, Audit) is the preferred equilibrium over (No Audit, No Audit) (if the latter exists) for both PBs. Therefore, HF must follow a mixed-strategy such that PBs are indifferent between the two equilibria.

In the cases identified in (i) and (ii) as HF following a mixed strategy, it is easy to verify that HF mixed strategies derived in part (a) above form a PBE.

□

A2.2 Proof of Proposition 2.2

Let $B^{**} > 0$ be a competitive equilibrium with $B_i^{**} > 0$ and $B_j^{**} = 0$, $j \neq i$. Since i is the only PB whose offer is accepted, by definition of the equilibrium, it must be that $H_i^{o,**} \geqslant \mu_0$ and $U_i^{o,**} \geqslant 0$. The second inequality is true since otherwise PB i would prefer to offer $B_i^{'} = 0$.

$$\begin{aligned} H_i^{o,**} &= \mu_0 + k_i\bigg(qRb_i^{**} - E\Big[\Big(d_i^{**} + (\tilde{v} - d_i^{**}) \cdot \mathbf{1}\{\tilde{v} \,\epsilon\, (d_{c,i}^{**},\, d_i^{**})\} \\ &\qquad + (1-q)(\tilde{v} - d_i^{**}) \cdot \mathbf{1}\{\tilde{v} \,\epsilon\, [0,\, d_{c,i}^{**}]\}\Big)\Big]\bigg) \\ &\equiv \mu_0 + k_i h(b_i^{**},\, d_i^{**}) \end{aligned}$$

PB j can deviate by offering $(b_j^{'},\, d_j^{'}) = (b_i^{**},\, d_i^{**})$. With the new set offers, $g^{'} = 1$ so that $D^{'} = d_i^{**} = d_j^{'}$ and,

$$\begin{aligned} H^{b'} &= H_i^{o,**} + H^{o'} - \mu_0 \geqslant \max(H_i^{o,**},\, H_j^{o'},\, \mu_0) \quad \text{where,} \\ H^{o'} &= \mu_0 + k_j h(b_j^{'},\, d_j^{'}) = \mu_0 + \frac{k_j}{k_i}(H_i^{o,**} - \mu_0) \end{aligned}$$

Thus, both offers are accepted by the hedge fund. Finally, this deviation is profitable for PB j, as shown below.

$$\begin{aligned} U_j^{b'} &= E\Big[D_j^{'} \cdot \mathbf{1}\{\tilde{v} \,\epsilon\, [D^{'},\, \overline{v}]\} + k_j\tilde{v} \cdot \mathbf{1}\{\tilde{v} \,\epsilon\, [0,\, D^{'})\} + q(1-\gamma)(D_j^{'} - k_j\tilde{v}) \cdot \mathbf{1}\{\tilde{v} \,\epsilon\, [0,\, d_c^{'}]\}\Big] - B_j^{'} \\ &= k_j[\nu(d_j^{'}) - b_j^{'}] = \frac{k_j}{k_i}U_i^{o,**} \geqslant 0 \end{aligned}$$

□

A2.3 Proof of Proposition 2.3

Recall the optimization problem,

$$\begin{aligned} &\max_{B,\,D}\ U^S(B,\,D) = \Big[\overline{p} + \underline{p}\Big(\frac{q-\alpha}{1-\alpha}\Big)\Big]D + \acute{p}\Big(\frac{q-\acute{\pi}}{1-\acute{\pi}}\Big)(D - \acute{v}) + \hat{p}\hat{v} + \acute{p}\acute{v} - B \\ &\text{s.t.}\quad 0 \leqslant B \leqslant D \leqslant \overline{r}B, \quad H \geqslant \mu_0, \quad \acute{v} < d_c \leqslant \hat{v} < D < \overline{v}, \quad \text{where,} \\ &H = \mu_0 + qRB - \Big[D + \hat{p}(\hat{v} - D) + \acute{p}(1-q)(\acute{v} - D) + \underline{p}(1-q)(\underline{v} - D)\Big] \end{aligned}$$

η_i, $i = 1, \cdots, 5$ be the Lagrange multipliers for all constraints. First order conditions w.r.t. B, D respectively are,

$$\eta_1 + \overline{r}\eta_3 + qR\eta_4 = 1 + \eta_2$$
$$\overline{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right) + \acute{p}\left[\frac{q-\acute{\pi}^S}{1-\acute{\pi}^S} + \frac{\alpha(1-q)\acute{v}}{(1-\acute{\pi}^S)^2(D^S-\acute{v})}\right] + \eta_2 = \eta_3 + (\overline{p} + q\acute{p} + q\underline{p})\eta_4 + \left(1 - \frac{\alpha}{q}\right)\eta_5$$

We look for an equilibrium with $0 < B < D$ and $H > \mu_0$ which implies $\eta_1 = \eta_2 = \eta_4 = 0$ and $\eta_3 = 1/\overline{r}$. Suppose $D^S = \overline{D}$ and denote $\partial U^S/\partial D = M(q, \overline{D}(q))$. Note that, (I2.3.1) implies $\lim_{q \to 1} M(q, \overline{D}(q)) \leqslant 1/\overline{r}$. Furthermore, assumption (I2.3.2) implies $\partial^2 U^S/\partial q \partial D > 0 \; \forall \, D > \hat{v}$. Therefore, as long as $\partial^2 U^S/\partial D^2 < 0$,

$$\frac{dM}{dq} = \frac{\partial^2 U^S}{\partial q \partial D} + \frac{\partial^2 U^S}{\partial D^2}\frac{d\overline{D}}{dq} > 0$$

Clearly, this leads to a contradiction in the FOC above. Thus, it must be that $D^S < \overline{D}$ or $\eta_5 = 0$. It remains to be shown that indeed $\partial^2 U^S/\partial D^2 < 0$.

$$G(D) = \frac{q-\acute{\pi}}{1-\acute{\pi}} + \frac{\alpha(1-q)\acute{v}}{(1-\acute{\pi})^2(D-\acute{v})^2}(D-\acute{v}) \equiv f(D) + (D-\acute{v})\frac{\partial f}{\partial D}$$
$$\frac{\partial G}{\partial D} = 2\frac{\partial f}{\partial D} + (D-\acute{v})\frac{\partial^2 f}{\partial D^2} = \left(\frac{q-1}{(1-\acute{\pi})^2}\right)\left[2\frac{\partial \acute{\pi}}{\partial D} + (D-\acute{v})\left(\frac{\partial^2 \acute{\pi}}{\partial D^2} + \frac{2}{1-\acute{\pi}}\left(\frac{\partial \acute{\pi}}{\partial D}\right)^2\right)\right]$$

Substituting $(D-\acute{v})\partial^2\acute{\pi}/\partial D^2 = -2\partial\acute{\pi}/\partial D$ proves the required result, i.e, $\partial^2 U^S/\partial D^2 < 0$.

□

A2.4 Proof of Proposition 2.4

Follows immediately from the fact that social planner's problem coincides with the case of single-prime financing.

□

A2.5 Proof of Proposition 2.5

There are four possible CE - (i) $g \geqslant \overline{\overline{g}}$, (ii) $g \,\epsilon\, [\overline{g}, \overline{\overline{g}})$, (iii) $g \,\epsilon\, [\underline{g}, \overline{g})$, and (iv) $g \,\epsilon\, [1, \underline{g})$. We solve the optimization problems for each of the cases and prove the result.

(i) Suppose $g \geqslant \overline{\overline{g}}$. Best response of PB m solves the problem,

$$\max_{B_m,\, D_m} \left[\overline{p} + \hat{p} + \acute{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right)\right]D_m - B_m$$
$$0 \leqslant B_m \leqslant D_m \leqslant \overline{r}B_m,\ d_M \geqslant \overline{\overline{g}}d_m$$
$$H^b \geqslant H^o_m,\ H^b \geqslant H^o_M,\ H^b \geqslant \mu_0$$
$$d_{c,\,m} < d_m \leqslant \acute{v} < d_c \leqslant \hat{v} < D \leqslant d_{c,\,M} < d_M < \overline{v}$$

Let $\eta_i,\ i = 1, \cdots, 10$ be the Lagrange multipliers for the relevant non-binding constraints. First order conditions w.r.t $B_m,\ D_m$ are,

$$\eta_1 + \overline{r}\eta_3 + qR(\eta_6 + \eta_7) = 1 + \eta_2$$
$$\overline{p} + \hat{p} + \acute{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right) + \eta_2 + \left(\frac{\partial H^b}{\partial D_m} - \frac{\partial H^b}{\partial D_m}\right)\eta_5 + \frac{\partial H^b}{\partial D_m}(\eta_6 + \eta_7) = \eta_3 + \frac{\overline{\overline{g}}}{k_m}\eta_4 + \frac{\eta_8}{k_m} + \left(1 - \frac{\alpha}{q}\right)\eta_9 + \eta_{10}$$

We look for an equilibrium with $0 < B_m < D_m,\ H^b > H^o_m,\ H^b > H^o_M,\ H^b > \mu_0$ so that $\eta_1 = \eta_2 = \eta_5 = \eta_6 = \eta_7 = 0$. D^*_m solves,

$$\overline{p} + \hat{p} + \acute{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right) = \frac{1}{\overline{r}} + \frac{\overline{g}}{k_m}\eta_4 + \frac{\eta_8}{k_m} + \left(1 - \frac{\alpha}{q}\right)\eta_9 + \eta_{10} \tag{A2.5.1}$$

Best response for PB M solves the optimization problem,

$$\max_{B_M,\, D_M} \left[\overline{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right)\right]D_M + \acute{p}\left(\frac{q-\acute{\pi}}{1-\acute{\pi}}\right)(D - \acute{v}) + \acute{p}(\acute{v} - D_m) + \hat{p}(\hat{v} - D_m) - B_M$$
$$0 \leqslant B_M \leqslant D_M \leqslant \overline{r}B_M,\ d_M \geqslant \overline{\overline{g}}d_m$$
$$H^b \geqslant H^o_m,\ H^b \geqslant H^o_M,\ H^b \geqslant \mu_0$$
$$d_{c,\,m} < d_m \leqslant \acute{v} < d_c \leqslant \hat{v} < D \leqslant d_{c,\,M} < d_M < \overline{v}$$

Let $\eta_i,\ i = 1, \cdots, 9$ be the Lagrange multipliers for relevant non-binding constraints. First order conditions w.r.t $B_M,\ D_M$ are,

$$\eta_1 + \overline{r}\eta_3 + qR(\eta_5 + \eta_7) = 1 + \eta_2$$
$$\overline{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right) + \acute{p}\left[\frac{q-\acute{\pi}}{1-\acute{\pi}} + \frac{\alpha(1-q)\acute{v}}{(1-\acute{\pi})^2(D-\acute{v})^2}(D - \acute{v})\right] + \eta_2 + \frac{\eta_4}{k_M} + \left(\frac{\partial H^b}{\partial D_M} - \frac{\partial H^b}{\partial D_M}\right)\eta_6 + \frac{\partial H^b}{\partial D_M}(\eta_5 + \eta_7) + \left(\frac{1-\alpha/q}{k_M} - 1\right)\eta_9 = \eta_3 + \left(1 - \frac{\alpha}{q}\right)\eta_8$$

We look for an equilibrium with $0 < B_M < D_M,\ H^b > H^o_m,\ H^b > H^o_M,\ H^b > \mu_0$ so that $\eta_1 = \eta_2 = \eta_5 = \eta_6 = \eta_7 = 0$. D^*_M solves,

$$\overline{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right) + \acute{p}\left[\frac{q-\acute{\pi}}{1-\acute{\pi}} + \frac{\alpha(1-q)\acute{v}}{(1-\acute{\pi})^2(D-\acute{v})^2}(D - \acute{v})\right] + \frac{\eta_4}{k_M} + \left(\frac{1-\alpha/q}{k_M} - 1\right)\eta_9 = \frac{1}{\overline{r}} + \left(1 - \frac{\alpha}{q}\right)\eta_8 \tag{A2.5.2}$$

Note that, $D^{CE} < D^S$ is not possible since in this case $\eta_8 = 0$ in (A2.5.2) which leads to a contradiction since LHS $> 1/\overline{r}$. Thus, it must be that $D^{CE} \geqslant D^S$.

Suppose $D^{CE} > D^S$. Then, from the fact that LHS in (A2.5.2) is decreasing in D, it must be that $g = \overline{\overline{g}}$. Conversely, $g > \overline{\overline{g}}$ implies $D^{CE} \leqslant D^S < \overline{D}$. In this case, $\eta_4 = \eta_8 = \eta_9 = 0$ and (A2.5.2) becomes identical to (2.3) which in turn implies $D^{CE} = D^S$.

(ii) Suppose $g \,\epsilon\, [\overline{g}, \overline{\overline{g}})$. Best response for PB m solves the problem,

$$\begin{aligned}
&\max_{B_m,\, D_m} \left[\overline{p} + \hat{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right)\right] D_m + \acute{p}\left(\frac{q-\acute{\pi}}{1-\acute{\pi}}\right)(D_m - k_m\acute{v}) + k_m\acute{p}\acute{v} - B_m \\
&0 \leqslant B_m \leqslant D_m \leqslant \overline{r}B_m,\ \overline{g}d_m \leqslant d_M < \overline{\overline{g}}d_m \\
&H^b \geqslant H^o_m,\ H^b \geqslant H^o_M,\ H^b \geqslant \mu_0 \\
&d_{c,m} \leqslant \acute{v} < d_m \leqslant d_c \leqslant \hat{v} < d_{c,M} < D < d_M < \overline{v}
\end{aligned}$$

Let η_i, $i = 1, \cdots, 10$ be the Lagrange multipliers for the relevant non-binding constraints. First order conditions w.r.t B_m, D_m respectively are,

$$\begin{aligned}
&\eta_1 + \overline{r}\eta_3 + qR(\eta_5 + \eta_6) = 1 + \eta_2 \\
&\overline{p} + \hat{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right) + \acute{p}\left[\frac{q-\acute{\pi}}{1-\acute{\pi}} + \frac{\alpha(1-q)\acute{v}}{(1-\acute{\pi})^2(D-\acute{v})^2}(D_m - k_m\acute{v})\right] + \eta_2 + \left(\frac{\partial H^b}{\partial D_m} - \frac{\partial H^o_m}{\partial D_m}\right)\eta_5 \\
&+ \frac{\partial H^b}{\partial D_m}(\eta_6 + \eta_7) = \eta_3 + \frac{\overline{g}}{k_m}\eta_4 + \left(1 - \frac{\alpha}{q}\right)\frac{\eta_8}{k_m} + \left(\frac{1}{k_m} - 1 + \frac{\alpha}{q}\right)\eta_9 + \left(1 - \frac{\alpha}{q}\right)\eta_{10}
\end{aligned}$$

We look for a best response with $0 < B_m < D_m$, $H^b > H^o_m$, $H^b > H^o_M$, $H^b > \mu_0$ so that $\eta_1 = \eta_2 = \eta_5 = \eta_6 = \eta_7 = 0$. D^*_m solves,

$$\begin{aligned}
&\overline{p} + \hat{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right) + \acute{p}\left[\frac{q-\acute{\pi}^*}{1-\acute{\pi}^*} + \frac{\alpha(1-q)\acute{v}}{(1-\acute{\pi})^2(D^*-\acute{v})^2}(D^*_m - k_m\acute{v})\right] \\
&= \frac{1}{\overline{r}} + \frac{\overline{g}}{k_m}\eta_4 + \left(1 - \frac{\alpha}{q}\right)\frac{\eta_8}{k_m} + \left(\frac{1}{k_m} - 1 + \frac{\alpha}{q}\right)\eta_9 + \left(1 - \frac{\alpha}{q}\right)\eta_{10}
\end{aligned} \tag{A2.5.3}$$

The best response for PB M solves,

$$\begin{aligned}
&\max_{B_M,\, D_M} \left[\overline{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right)\right] D_M + \acute{p}\left(\frac{q-\acute{\pi}}{1-\acute{\pi}}\right)(D_M - k_M\acute{v}) + \hat{p}(\hat{v} - D_m) + k_M\acute{p}\acute{v} - B_M \\
&0 \leqslant B_M \leqslant D_M \leqslant \overline{r}B_M,\ \overline{g}d_m \leqslant d_M < \overline{\overline{g}}d_M, \quad H^b \geqslant H^o_m,\ H^b \geqslant H^o_M,\ H^b \geqslant \mu_0 \\
&d_{c,m} \leqslant \acute{v} < d_m \leqslant d_c \leqslant \hat{v} < d_{c,M} < D < d_M < \overline{v}
\end{aligned}$$

Let η_i, $i = 1, \cdots, 9$ be the Lagrange multipliers for the relevant non-binding constraints. First order conditions w.r.t B_M, D_M are,

$$\begin{aligned}
&\eta_1 + \overline{r}\eta_3 + qR(\eta_6 + \eta_7) = 1 + \eta_2 \\
&\overline{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right) + \acute{p}\left[\frac{q-\acute{\pi}}{1-\acute{\pi}} + \frac{\alpha(1-q)\acute{v}}{(1-\acute{\pi})^2(D-\acute{v})^2}(D_M - k_M\acute{v})\right] + \eta_2 + \frac{\eta_4}{k_M} + \frac{\partial H^b}{\partial D_M}(\eta_5 + \eta_7) \\
&+ \left(\frac{\partial H^b}{\partial D_M} - \frac{\partial H^o_M}{\partial D_M}\right)\eta_6 + \left(1 - \frac{\alpha}{q}\right)\eta_8 = \eta_3 + \left(1 - \frac{\alpha}{q}\right)\eta_9
\end{aligned}$$

We look for an equilibrium with $0 < B_M < D_M,\ H^b > H^o_m,\ H^b > H^o_M,\ H^b > \mu_0$ so that $\eta_1 = \eta_2 = \eta_5 = \eta_6 = \eta_7 = 0$. D^*_M solves,

$$\begin{aligned}&\overline{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right) + \acute{p}\left[\frac{q-\acute{\pi}^*}{1-\acute{\pi}^*} + \frac{\alpha(1-q)\acute{v}}{(1-\acute{\pi}^*)^2(D^*-\acute{v})^2}(D^*_M - k_M\acute{v})\right] + \frac{\eta_4}{k_M} + \left(1-\frac{\alpha}{q}\right)\eta_8 \\ &= \frac{1}{\overline{r}} + \left(1-\frac{\alpha}{q}\right)\eta_9 \\ \Longleftrightarrow\ &\overline{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right) + \acute{p}\left[\frac{q-\acute{\pi}^*}{1-\acute{\pi}^*} + \frac{\alpha(1-q)\acute{v}}{(1-\acute{\pi}^*)^2(D^*-\acute{v})^2}(D^* - \acute{v})\right] + \frac{\eta_4}{k_M} + \left(1-\frac{\alpha}{q}\right)\eta_8 \\ &= \frac{1}{\overline{r}} + \frac{\alpha(1-q)\acute{p}\acute{v}}{(1-\acute{\pi}^*)^2(D^*-\acute{v})^2}(D^*_m - k_m\acute{v}) + \left(1-\frac{\alpha}{q}\right)\eta_9 \qquad \text{(A2.5.4)}\end{aligned}$$

In an equilibrium with $d_M > \overline{g}d_m$, we have $\eta_4 = \eta_8 = 0$. Clearly, comparing (A2.5.4) and (2.3) and the fact that LHS in (A2.5.4) is decreasing in D, it must be that $D^{CE}(g\,\epsilon\,(\overline{g},\,\overline{\overline{g}}) < D^S = D^{CE}(g > \overline{\overline{g}}) < \overline{D}$. The last inequality implies $\eta_9 = 0$.

(iii) Suppose $g\,\epsilon\,[\underline{g},\,\overline{g})$. The expected payoff functions for both PBs are the same as in case (ii) above so we omit rewriting the full optimization problem. However, some constraints are different which is given below.

$\underline{g}d_m \leqslant d_M < \overline{g}$ and $d_{c,m} \leqslant \acute{v} < d_c < d_m \leqslant d_{c,M} \leqslant \hat{v} < D < d_M < \overline{v}$. We look for an equilibrium with $0 < B_m < D_m$, slack PCs. FOCs w.r.t B_m, D_m respectively will turn out to be,

$$\begin{aligned}&\overline{r}\eta_3 = 1 \\ &\overline{p} + \hat{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right) + \acute{p}\left[\frac{q-\acute{\pi}^*}{1-\acute{\pi}^*} + \frac{\alpha(1-q)\acute{v}}{(1-\acute{\pi}^*)^2(D^*-\acute{v})^2}(D^*_m - k_m\acute{v})\right] \\ &= \frac{1}{\overline{r}} + \frac{\underline{g}}{k_m}\eta_4 + \left(1-\frac{\alpha}{q}\right)\frac{\eta_8}{k_m} + \frac{\eta_9}{k_m} \qquad \text{(A2.5.5)}\end{aligned}$$

For PB M with $0 < B_M < D_M$, slack PCs, FOCs w.r.t B_M, D_M respectively are,

$$\begin{aligned}&\overline{r}\eta_3 = 1 \\ &\overline{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right) + \acute{p}\left[\frac{q-\acute{\pi}^*}{1-\acute{\pi}^*} + \frac{\alpha(1-q)\acute{v}}{(1-\acute{\pi}^*)^2(D^*-\acute{v})^2}(D^* - \acute{v})\right] + \frac{\eta_4}{k_M} + \left(1-\frac{\alpha}{q}\right)\frac{\eta_8}{k_M} \\ &= \frac{1}{\overline{r}} + \frac{\alpha(1-q)\acute{p}\acute{v}}{(1-\acute{\pi}^*)^2(D^*-\acute{v})^2}(D^*_m - k_m\acute{v}) + \left(1-\frac{\alpha}{q}\right)\frac{\eta_9}{k_M} \qquad \text{(A2.5.6)}\end{aligned}$$

As in part (ii) above, in an equilibrium with $d_M > \underline{g}d_m$, we have $\eta_4 = \eta_8 = 0$. This implies $D^{CE} < D^S < \overline{D}$.

(iv) Suppose $g\,\epsilon\,[1,\,\underline{g})$. Best response for PB m solves the problem,

$$\begin{aligned}&\max_{B_m,\,D_m}\ \left[\overline{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right)\right]D_m + \acute{p}\left(\frac{q-\acute{\pi}}{1-\acute{\pi}}\right)(D_m - k_m\acute{v}) + k_m(\hat{p}\hat{v} + \acute{p}\acute{v}) - B_m \\ &\text{s.t. } 0 \leqslant B_m \leqslant D_m \leqslant \overline{r}B_m,\ d_m \leqslant d_M < \underline{g}d_m,\ H^b \geqslant H^o_m,\ H^b \geqslant H^o_M,\ H^b \geqslant \mu_0 \\ &\acute{v} < d_{c,m} \leqslant d_c \leqslant d_{c,M} \leqslant \hat{v} < d_m \leqslant D \leqslant d_M < \overline{v}\end{aligned}$$

Let η_i, $i = 1, \cdots, 11$ be the Lagrange multipliers for the relevant non-binding constraints. We look for a equilibrium with $0 < B_m < D_m$ and slack PCs. FOCs w.r.t. B_m, D_m respectively are,

$$\overline{r}\eta_3 = 1$$

$$\overline{p} + \underline{p}\Big(\frac{q-\alpha}{1-\alpha}\Big) + \acute{p}\Big[\frac{q-\acute{\pi}^*}{1-\acute{\pi}^*} + \frac{\alpha(1-q)\acute{v}}{(1-\acute{\pi}^*)^2(D^*-\acute{v})^2}(D^*_m - k_m\acute{v})\Big] = \frac{1}{\overline{r}} + \frac{\eta_4}{k_m} + \Big(1-\frac{\alpha}{q}\Big)\Big(\frac{1}{k_m}-1\Big)\eta_8$$
$$+\Big(1-\frac{\alpha}{q}\Big)\eta_9 + \Big(\frac{1}{k_m}-1\Big)\eta_{10} + \eta_{11} \qquad \text{(A2.5.7)}$$

Rewriting (A2.5.7) as below shows that $D^{CE} < D^S < \overline{D}$.

$$\overline{p} + \underline{p}\Big(\frac{q-\alpha}{1-\alpha}\Big) + \acute{p}\Big[\frac{q-\acute{\pi}^*}{1-\acute{\pi}^*} + \frac{\alpha(1-q)\acute{v}}{(1-\acute{\pi}^*)^2(D^*-\acute{v})^2}(D^* - \acute{v})\Big] = \frac{1}{\overline{r}} + \frac{\alpha(1-q)\acute{v}}{(1-\acute{\pi}^*)^2(D^*-\acute{v})^2}(D^*_M - k_M\acute{v})$$
$$+\frac{\eta_4}{k_m} + \Big(1-\frac{\alpha}{q}\Big)\Big(\frac{1}{k_m}-1\Big)\eta_8 + \Big(1-\frac{\alpha}{q}\Big)\eta_9 + \Big(\frac{1}{k_m}-1\Big)\eta_{10} + \eta_{11} \qquad \text{(A2.5.7.1)}$$

The optimization problem for PB M is the same. FOCs with w.r.t B_M, D_M in an equilibrium with $0 < B_M < D_M$ and slack PCs respectively are,

$$\overline{r}\eta_3 = 1$$

$$\overline{p} + \underline{p}\Big(\frac{q-\alpha}{1-\alpha}\Big) + \acute{p}\Big[\frac{q-\acute{\pi}^*}{1-\acute{\pi}^*} + \frac{\alpha(1-q)\acute{v}}{(1-\acute{\pi}^*)^2(D^*-\acute{v})^2}(D^*_M - k_M\acute{v})\Big] + \frac{\eta_4}{k_M} + \Big(1-\frac{\alpha}{q}\Big)\eta_8$$
$$+\Big(1-\frac{\alpha}{q}\Big)\Big(\frac{1}{k_m}-1\Big)\eta_9 + \eta_{11} + \Big(\frac{1}{k_M}-1\Big)\eta_{12} = \frac{1}{\overline{r}} + \Big(1-\frac{\alpha}{q}\Big)\frac{\eta_{10}}{k_M} \qquad \text{(A2.5.8)}$$

□

A2.6 Proof of Proposition 2.6

(i) Suppose an equilibrium with $g \geqslant \overline{\overline{g}}$ with $(i, j) = (m, M)$ exists. For this part, we shall refer to part (i) of the proof of Proposition 2.4.

Suppose $g > \overline{\overline{g}}$. By Proposition 4, $D^{CE} = D^S$. Together, this implies $\eta_4 = \eta_9 = \eta_{10} = 0$ in (A2.5.1) and $D^{CE}_m = k_m\acute{v}$, since by Assumption (I2.3.1), $\overline{p} + \hat{p} + \acute{p} + \underline{p}\Big(\frac{q-\alpha}{1-\alpha}\Big) > 1/\overline{r}$. Finally, we need to verify that $g > \overline{\overline{g}}$ indeed.

$$g = \frac{d_M}{d_m} = \frac{k_m}{k_M}\Big(\frac{D^S - k_m\acute{v}}{k_m\acute{v}}\Big) > \frac{k_m}{k_m - \alpha/q} = \overline{\overline{g}} \implies$$
$$D^S > k_m\acute{v}\Big(\frac{1-\alpha/q}{k_m - \alpha/q}\Big) \qquad \text{(A2.6.1)}$$

Conversely, suppose (A2.6.1) holds. Since $D^{CE}_m \leqslant k_m\acute{v}$, we have $D^S(k_m - \alpha/q)/(1-\alpha/q) > D^{CE}_m$. It is easy to verify that this implies $g > \overline{\overline{g}}\, \forall\, D^{CE} \geqslant D^S$.

(ii) Using the fact that $D^S > \hat{v}$, a sufficient condition for (A2.6.1) to hold for all $q > 1/R$,

$$k_m \acute{v}\left(\frac{1-\alpha/q}{k_m-\alpha/q}\right) \leqslant \hat{v} \iff k_m \geqslant \frac{\alpha\hat{v}/\acute{v}}{\alpha+q(\hat{v}/\acute{v}-1)} \equiv \underline{k}(\alpha,\, q)\,\epsilon\left(\frac{\alpha}{q},\, 1\right) \tag{A2.6.2}$$

Finally, we need to find an $\alpha'(q) < q$ such that $\underline{k}(\alpha,\, q) \leqslant (2-\alpha)^{-1}\,\forall\,\alpha \leqslant \alpha'(q)$. That such a unique $\alpha'(q)$ indeed exists is easiest to see graphically in Figure (A2.2).

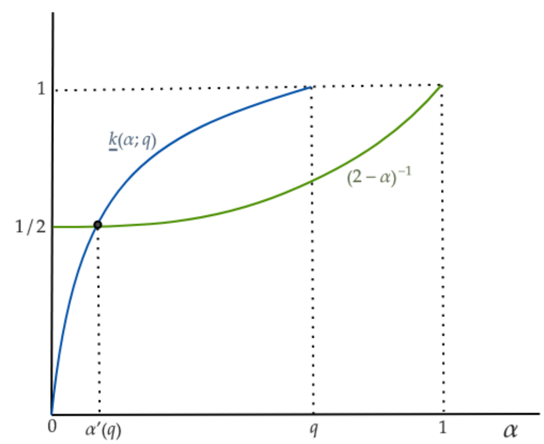


Figure A2.2

(iii) Suppose $(D_i^*,\, D_j^*)$, $(i,\, j) = (m,\, M)$ and $g > \overline{\overline{g}}$ is an equilibrium. First, note that from Proposition 2.4 and equation (A2.5.1), it must be that $D_i^* = k_i\acute{v}$ and $D^* = D^S$. Now, by definition of equilibrium, PB i must not have a profitable deviation by deviating to $D_i^{**} > D_i^*$ such that $g\,\epsilon\,[\overline{g},\, \overline{\overline{g}})$, i.e., $U_i^{b.**} - U_i^{b,*} < 0$.

$$\begin{aligned} U_i^{b.**} - U_i^{b,*} &= \left[\overline{p} + \hat{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right) - \frac{1}{\overline{r}}\right](D_i^{**} - D_i^*) + \acute{p}\left(\frac{q-\acute{\pi}^{**}}{1-\acute{\pi}^{**}}\right)(D_i^{**} - k_i\acute{v}) + \acute{p}(k_i\acute{v} - D_i^*) \\ &= \left[\overline{p} + \hat{p} + \underline{p}\left(\frac{q-\alpha}{1-\alpha}\right) + \acute{p}\left(\frac{q-\acute{\pi}^{**}}{1-\acute{\pi}^{**}}\right) - \frac{1}{\overline{r}}\right](D_i^{**} - D_i^*) \end{aligned}$$

The second equality follows from the above result that $D_i^* = k_i\acute{v}$. Then, it is easy to see that $U_i^{b.**} - U_i^{b,*} < 0$ holds for

$$\begin{aligned} q &< \overline{q} - (1-\alpha)\left(\frac{\acute{p}}{\underline{p}}\right)\left(\frac{q-\acute{\pi}^{**}}{1-\acute{\pi}^{**}}\right) \equiv \underline{q}(q) \quad \text{where,} \\ \overline{q} &= \alpha + \left(\frac{1-\alpha}{\underline{p}}\right)\left(\frac{1}{\overline{r}} - \hat{p} - \overline{r}\right) \end{aligned}$$

This is a fixed-point problem. Sufficient conditions for the existence of a unique fixed-point $q_f > 1/R$ are -

(a) D_i^{**} is increasing in q. This guarantees $\underline{q}$ is decreasing in q.

$$\frac{\partial \underline{q}}{\partial q} = -(1-\alpha)\Big(\frac{\acute{p}}{\underline{p}}\Big)\Big(\frac{1}{1-\acute{\pi}^{**}} + \frac{\alpha\acute{v}(1-q)}{(1-\acute{\pi}^{**})^2(D^{**}-\acute{v})^2}\frac{\partial D_i^{**}}{\partial q}\Big)$$

(b) $\lim_{q \to 1/R} \underline{q} > 1/R$.

Suppose (a) and (b) hold. Consider the function $h(q) = q - \underline{q}(q)$ in the region $[1/R, \overline{q}]$. Clearly, $h(\overline{q}) > 0$ and $h(1/R) \equiv \lim_{q \to 1/R} h(q) < 0$ by (b). Furthermore, since (a) holds, intermediate value theorem guarantees a unique fixed-point $q_f \,\epsilon\, (1/R, \overline{q})$.

As an aside, note that $D^{**} = D_i^{**} + D_j^* = D_i^* + D_j^* + D_i^{**} - D_i^* > D^S$. This will be useful in the proof of Proposition 2.7 below.

□

A2.7 Proof of Proposition 2.7

Let (D_i^h, D_j^h) be an equilibrium with $(i, j) = (m, M)$ and $g \,\epsilon\, [\overline{g}, \overline{\overline{g}})$ and (D_i^*, D_j^*) be an equilibrium with $(i, j) = (m, M)$ and $g > \overline{\overline{g}}$. Comparing payoffs of PB i,

$$\begin{aligned} U_i^{b,h} - U_i^{b,*} &= (D_i^h - D_i^*)\Big[\overline{p} + \hat{p} + \underline{p}\Big(\frac{q-\alpha}{1-\alpha}\Big) + \acute{p}\Big(\frac{q-\acute{\pi}^h}{1-\acute{\pi}^h}\Big) - \frac{1}{\overline{r}}\Big] \\ &= (D_i^h - D_i^*)\Big[\overline{p} + \hat{p} + \underline{p}\Big(\frac{q-\alpha}{1-\alpha}\Big) + \acute{p}\Big(\frac{q-\acute{\pi}^{**}}{1-\acute{\pi}^{**}}\Big) - \frac{1}{\overline{r}} + \acute{p}\Big(\frac{q-\acute{\pi}^h}{1-\acute{\pi}^h}\Big) - \acute{p}\Big(\frac{q-\acute{\pi}^{**}}{1-\acute{\pi}^{**}}\Big)\Big] \\ &< (D_i^h - D_i^*)\Big(\frac{U^{b,**} - U^{b,*}}{D_i^{**} - D_i^*}\Big) < 0 \end{aligned}$$

where D_i^{**} is the deviation by PB i to $g, \epsilon\, [\overline{g}, \overline{\overline{g}})$, as in the proof of Proposition 2.7 (iii) above. The first inequality follows from the fact that $D^{**} > D^* = D^S > D^h$ and the second inequality follows from the fact that $g > \overline{\overline{g}}$ is an equilibrium. The argument is exactly the same for an equilibrium with $g \,\epsilon\, [\underline{g}, \overline{g})$. For an equilibrium with $(i, j) = (m, M)$, (D_i^l, D_j^l) and $g \,\epsilon\, [1, \underline{g})$ with $D_i^* < k_i\hat{v} < D_i^l$,

$$\begin{aligned} U_i^{b,l} - U_j^{b,*} &= \Big[\overline{p} + \underline{p}\Big(\frac{q-\alpha}{1-\alpha}\Big)\Big](D_i^l - D_i^*) + \hat{p}(k_i\hat{v} - D_i^*) + \acute{p}\Big(\frac{q-\acute{\pi}^l}{1-\acute{\pi}^l}\Big)(D_i^l - k_i\acute{v}) + \underbrace{\acute{p}(k_i\acute{v} - D_i^*)}_{=0} \\ &\quad - \frac{1}{\overline{r}}(D_i^l - D_i^*) \\ &= \underbrace{\Big[\overline{p} + \hat{p} + \underline{p}\Big(\frac{q-\alpha}{1-\alpha}\Big) + \acute{p}\Big(\frac{q-\acute{\pi}^l}{1-\acute{\pi}^l}\Big) - \frac{1}{\overline{r}}\Big]}_{<0}(D_i^l - D_i^*) + \hat{p}\,\underbrace{(k_i\hat{v} - D_i^l)}_{<0} \end{aligned}$$

The first inequality follows from a similar argument as above. □

Appendix B

Multi-tasking model for Chapter 3

In this section, we provide a stylized model of multi-tasking in effort s made by bank boards. The objective of this section is to guide the interpretation of and intuition for our empirical results.

Bank boards exert effort along three dimensions: (i) regulation and compliance; (ii) strategy creation; and (iii) risk management. Effort s in compliance and regulation includes complying with all the regulations and legal requirements faced by banks. Because regulators would be concerned about systemic risk in the banking sector, regulations would focus on limiting risk as well. How- ever, by modelling efforts in regulation and compliance, on the one hand, and risk mitigation, on the other hand, we distinguish be- tween risk mitigation in letter done by the board to satisfy the regulator, i.e. efforts that primarily focus on "box ticking," and risk mitigation in *spirit*. Specifically, dimensions of effort in risk mitigation that the bank board undertakes as part of compliance and regulation correspond to risk mitigation in *letter* as opposed to risk mitigation in *spirit*, which the board's effort in risk captures.

B1 Setting

Consider a single period principal-agent setting where there are two principals and one agent. The collection of shareholders of the bank represent the first principal. The regulator represents the second principal. The board of directors of the bank represent the agent. The board provides unobservable effort e_i on three tasks indexed by $i = C, S, R$, where e_C, e_S and e_R represent efforts in regulation and compliance, strategy creation, and risk management respectively. Greater e_C and e_S enhance the bank's regulation & compliance and its strategy respectively. In contrast, greater e_R reduces the bank's risk. Effort exerted by the board in task i costs the board $0.5e_i^2$.

We assume firm value of the bank V , which equals the sum of bank's equity E and its debt D , is given by:

$$V = E + D = e_S + e_C + e_R \tag{B1}$$

Assumption 1: As residual claimants, equityholders' payoff E is convex and, therefore, increases disproportionately more with board effort in strategy creation than with effort s in compliance and risk. We capture this dependence by specifying the equityholders' payoff as follows:

$$E = \alpha e_S + \beta(e_C + e_R) \tag{B2}$$
$$0 < \beta < \alpha < 1$$

Assumption 2: In contrast to the equityholders' payoff, debtholders' payoff is concave and so increases disproportionately more with board efforts in risk mitigation and compliance than board effort in strategy creation:

$$D = (1-\alpha)e_S + (1-\beta)(e_C + e_R) \tag{B3}$$

Assumption 3: We assume that boards have finite time and resources. Therefore, the cumulative effort in strategy creation, risk mitigation, and compliance is bounded:

$$e_S + e_R + e_C \leqslant a, \quad a > 0 \tag{B4}$$

B2 Prudential supervision by the regulator

Because all governments provide some form of a safety net for the banking system, whether it is explicit or implicit, they need to take steps to limit the moral hazard and adverse selection that the safety net creates. Otherwise, banks will have such a strong incentive to take on excessive risks that the safety net may do more harm than good and promote banking crises rather than prevent them. Prudential supervision involves (i) the regulator establishing regulations to reduce risk-taking, and (ii) supervising banks to en- sure that they are complying with the regulations. Thus, as part of the prudential supervision undertaken by the regulator, the regulator requires a minimum level of compliance with the laws and regulations.

Assumption 4: We therefore assume that the bank board's effort in compliance and regulation has to be above a minimum threshold:

$$e_C \geqslant \underline{e} \tag{B5}$$

B3 First-best

We specify the first-best benchmark level of efforts, e_S^{FB}, e_R^{FB} and e_C^{FB} as one where the bank board maximizes firm value.

Proposition B1. [First-best level of efforts] Under the first-best benchmark, where the bank board chooses to maximize firm value V, the bank board exerts equal efforts in strategy creation, risk mitigation and in compliance.

$$e_S^{FB} = e_R^{FB} = e_C^{FB} = \frac{a}{3} \tag{6}$$

Proof. See Appendix B7.1.

Because the bank's firm value is equally sensitive to the efforts in each of the three dimensions and the costs of efforts are identical, the first-best level of efforts are identical across the three tasks.

B4. Analysis of the second-best

Ideally, the board would maximize shareholder value subject to keeping the regulator happy and ensuring that the debtholders break even.

However, debtholders in a bank primarily comprise of depositors who are quite dispersed. As a result, monitoring by the debtholders suffers from the free-rider problem, where the marginal benefit of monitoring by any individual debt holder is significantly dominated by the marginal cost incurred in doing the same. Moreover, deposit insurance - implicit or explicit - reduces the incentives of depositors to monitor banks. As well, deposit insurance induces banks to rely less on uninsured creditors with incentives to monitor and more on insured depositors with no incentives to monitor. Finally, unlike debtholders in industrial firms that can impose a check on the firm's shareholders and managers by exercising their covenants, debtholders in a bank do not contract on any covenants ex-ante that they can exercise ex-post. Therefore, under the second-best, we assume:

Assumption 5: Ex-post, i.e. once liabilities are already created, the board can costlessly violate the constraint that the debtholders have to break even.

Under the second-best, the objective function of the bank board can be stated as:

$$\max_{e_C, e_S, e_R} E \text{ such that} \tag{B7}$$

$$e_C \geqslant \underline{e} \tag{B8}$$

$$e_C + e_S + e_R \leqslant a \tag{B9}$$

To solve this optimization problem, we set up the Lagrangian as follows:

$$£ = E + \lambda_C(e_C - \underline{e}) + \lambda_e(a - e_S - e_R - e_C) \tag{B10}$$

where λ_C and λ_e denote respectively the shadow prices associated with violating the regulators' constraint and the effort boundary.

Proposition B2. [Second-best level of efforts] The bank board's efforts in strategy creation, risk mitigation and compliance are given by:

$$e_S^* = e_S^{FB} + \frac{2(\alpha - \beta) - \lambda_C}{3}, \tag{B11}$$

$$e_R^* = e_R^{FB} - \frac{(\alpha - \beta) + \lambda_C}{3}, \tag{B12}$$

$$e_C^* = e_C^{FB} + \frac{2\lambda_C - (\alpha - \beta)}{3} \tag{B13}$$

Proof. See Appendix B7.2.

The next three propositions characterize under- and over-investments by the board, when compared to the economically optimal levels, in strategy creation, risk mitigation and compliance.

B5. Results from the model

Proposition B3. [Both compliance & strategy always dominate risk-mitigation] Irrespective of the level of regulatory pressure, bank boards always exert lower effort in risk mitigation than in strategy creation or in compliance:

$$e_S^* > e_R^*;\ e_C^* > e_R^*\ \forall\ \alpha,\ \beta,\ \lambda_C \tag{B14}$$

The proof is easily obtained by using equations (B11) to (B13) and using $\alpha > \beta$ and $\lambda_C > 0$. This result is quite intuitive given the assumption that bank boards can costlessly violate the debtholders' break-even constraint while maximizing shareholder value and ensuring a minimum level of effort in compliance.

Proposition B4. [Under-investment in risk-mitigation] A bank board always under-invests in risk mitigation when compared to the efficient level. Formally:

$$e_R^* < e_R^{FB} \tag{B15}$$

Intuitively, first, shareholders care more about the upside, which is created by efforts in strategy creation, than about the downside, which is created by effort s in risk mitigation in its spirit. Second, the cost of violating the debtholders constraint is low in banks. Third, the regulator emphasizes compliance, which may result in "box ticking" with those aspects of regulation that deal with risk. As a result, the costs from the board investing in risk mitigation in its spirit significantly dominate the benefits, which causes the under-investment when compared to the optimal.

Proposition B5. [Compliance and regulation versus strategy creation] If the regulatory pressure is high, then bank boards exert greater effort in regulation and compliance than on strategy creation. Formally:

$$\lambda_C \geqslant \alpha - \beta \implies e_C^* \geqslant e_S^* \tag{B16}$$

$$\lambda < \alpha - \beta \implies e_C^* < e_S^* \tag{B17}$$

The proof is easily obtained by using equations (B11) to (B13). Because bank boards maximize shareholder value subject to the constraint that the regulator is kept happy, bank boards exert greater effort in compliance and regulation than on strategy creation only if the regulatory pressure is high.

Proposition B6. [Under- or over-investment in strategy and in compliance] (i) If regulatory pressure is low, i.e. $\lambda_C < 0.5(\alpha - \beta)$, the board over-invests in strategy creation but under-invests in compliance and regulation:

$$\lambda_C < 0.5(\alpha - \beta) \iff e_S^* > e_S^{FB};\ e_C^* \leqslant e_C^{FB} \tag{B18}$$

(ii) If regulatory pressure is moderate, i.e. $0.5(\alpha-\beta) \leqslant \lambda_C \leqslant 2(\alpha-\beta)$, the board over-invests in strategy creation and in compliance and regulation:

$$0.5(\alpha - \beta) \leqslant \lambda_C < 2(\alpha - \beta) \iff e_S^* > e_S^{FB};\ e_C^* > e_C^{FB} \tag{B19}$$

(iii) If regulatory pressure is high, i.e. $\lambda_C \geqslant 2(\alpha - \beta)$, the board under-invests in strategy creation and over-invests in compliance and regulation:

$$\lambda_C \geqslant 2(\alpha - \beta) \iff e_S^* \leqslant e_S^{FB};\ e_C^* > e_C^{FB} \tag{B20}$$

The marginal benefit of an increase in the effort in any task stems directly from an increase in equity value. In addition, the marginal benefit of an increase in the effort in compliance and regulation also stems from keeping the regulator happy as captured in assumption 4 (equation B5). Apart from the direct costs of effort ($= 0.5e_i^2$), indirect costs of effort in a task stem from the efforts being substitutes at the margin. The effort in regulation and compliance increases with regulatory pressure, which we define as the cost of not meeting the minimum level of compliance and regulation. Therefore, when regulatory pressure is very low, the board under-invests in regulation and compliance and thereby over-invests in strategy creation. Conversely, when regulatory pressure is very high, the board over-invests significantly in compliance and regulation and thereby under-invests in strategy creation. When regulatory pressure is moderate, the board over-invests in regulation and compliance as well as in strategy creation.

As the combined value of all stakeholders V represents the best proxy to capture economic efficiency, we examine how it varies with differing levels of regulatory pressure.

Proposition B7. [Effect of regulatory pressure on value of all stakeholders] If regulatory pressure is low, i.e. $\lambda_C < 0.5(\alpha-\beta)$, an increase in regulatory pressure increases the aggregate value to all stakeholders. However, if regulatory pressure is not low, i.e. $\lambda_C \geqslant 0.5(\alpha - \beta)$, an increase in regulatory pressure decreases the aggregate value to all stakeholders:

$$\lambda_C \lesseqgtr 0.5(\alpha - \beta) \iff \frac{dV}{d\lambda_C} \gtreqless 0 \tag{B21}$$

Proof. See Appendix B7.3.

Figure B1 combines the results from all the propositions above and describes the ordinal ranking of the efforts in the various tasks and their implication for economic efficiency in four regions of regulatory pressure:

1. If regulatory pressure is very high, i.e. $\lambda_C \geqslant 2(\alpha - \beta)$, then bank boards will devote maximum attention to issues pertaining to compliance and regulation. Strategy creation would receive the next level of attention. Risk mitigation would receive the minimum level of attention among these three categories. Thus, the ordinal ranking would be compliance and regulation, strategy creation followed by risk mitigation. In this case, bank boards under-invest both in strategy creation and in risk mitigation and over-invest in compliance and regulation and firm value decreases with an increase in regulatory pressure.

2. If regulatory pressure is moderately high, i.e. $(\alpha - \beta) \leqslant \lambda_C < 2(\alpha - \beta)$, then again the ordinal ranking would be compliance and regulation, strategy creation followed by risk mitigation. In this case, however, bank boards under-invest in risk mitigation and over-invest both in strategy creation and in compliance and regulation and firm value decreases with an increase in regulatory pressure.

3. If regulatory pressure is moderately low, i.e. $0.5(\alpha - \beta) \leqslant \lambda_C < \alpha - \beta$, then the ordinal ranking is would be strategy creation, compliance and regulation followed by risk mitigation. In this case as well, bank boards under-invest in risk mitigation and over-invest both in strategy creation and in compliance and regulation and firm value decreases with an increase in regulatory pressure.

4. If regulatory pressure is very low, i.e. $\lambda_C < 0.5(\alpha - \beta)$, then again the ordinal ranking would be strategy creation, compliance and regulation followed by risk mitigation. In this case, however, bank boards under-invest both in risk mitigation and in compliance and regulation and over-invest in strategy creation. Only in this case firm value increases with an increase in regulatory pressure.

B6 Interpreting our key empirical findings

B6.1 Relating the ordinal ranking to theoretical predictions

The theoretical model suggests that board effort in risk mitigation is always dominated by its efforts in strategy creation and in regulation and compliance. This is consistent with our key empirical finding: bank boards pay high attention to matters relating to compliance and regulation but pay low attention to matters relating to risk. This pattern is observed both with respect to tabling of issues as well as the detailed deliberation of the tabled issues. The model throws light on the incentive mechanisms that explain this finding. Among their various stakeholders, bank boards care least about the depositors due to the combination of (i) free-rider problem in monitoring by dispersed depositors, (ii) deposit insurance and the resultant moral hazard, and (iii) absence of contractual mechanisms for depositors, such as loan covenants. In contrast, bank boards do not want to be on the wrong side of regulators. Given the limited time and attention that bank boards have to devote across strategy creation, risk mitigation and compliance and regulation, the skewed incentives of bank boards motivate them to invest lower effort in risk mitigation than in strategy creation and in compliance and regulation.

The model suggests that a bank board exerts more effort in regulation and compliance than in strategy creation when the pressure exerted by the regulator on compliance is high. Conversely, a bank board exerts lower effort in compliance and regulation than in strategy creation when the pressure exerted by the regulator on compliance is low. Our test of means for the issues tabled revealed that the attention paid by bank boards to compliance and regulation is on average greater than the attention paid to strategy creation. This pattern is also observed when we examine the medians. Based on the means and medians of the issues tabled, we can infer that bank boards in our sample may be paying greater attention to compliance and regulation than to strategy creation.

B6.2 Interpreting under- or over-investment

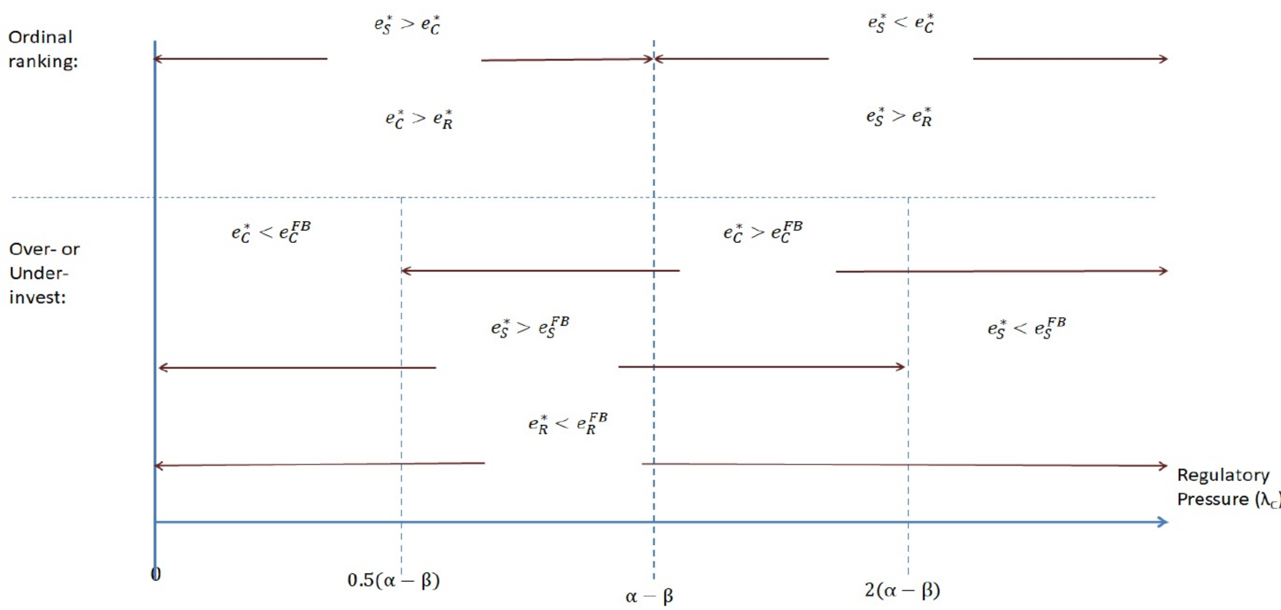
Because the (first-best) optimal level of effort cannot be ob- served empirically, inferences about under- or over-investment by bank boards in the various categories (strategy creation, risk mitigation, and regulation and compliance) can only be inferred by appealing to the theoretical arguments above. The model suggests that bank boards under-invest in risk mitigation. However, whether the bank board over- or under-invests in compliance and regulation and strategy creation depends upon the level of regulatory pressure. As regulatory pressure is not directly observed either, we infer under- or over-investment by relating the predictions to the observed ordinal ranking.

As Figure B1 shows, the ordinal ranking that we find seems to convey that the bank boards in our sample under-investing in risk mitigation and over-investing in compliance and regulation. These results are consistent with anecdotal evidence in several multilateral and national reports, which have highlighted failure of bank boards in effectively assessing risks as well as in excessively conforming with laid down procedures.

The under-investment in risk related matters is especially pertinent given policymaker concerns following the financial crisis that bank boards did not assess risks effectively. Walker (2009) mentions that "the overriding strategic objective of a bank/financial institution is the successful management of financial risk." The supervision manual of the Federal Reserve states that "The board of directors is responsible to the bank's depositors, other creditors, and shareholders for safeguarding their interests" (see section 5000.1). Moreover, although the penalties from losses in shareholder value is immediate, they are not as severe as in the case of losses arising from poor risk management (Mongiardino and Plath, 2010b).

However, following Figure B1, we cannot use the ordinal ranking that we find to infer whether the attention paid by bank boards in our sample to matters pertaining to strategy is consistent with over- or under-investment (compared to the optimal level). This is be- cause while the ordinal ranking is consistent with regulatory pres- sure being either moderately high or very high, using this ranking, we cannot distinguish between regimes where regulatory pressure is extremely high and those where regulatory pressure is moderately high. Over-investment in strategy creation is obtained only if the regulatory pressure is extremely high. Therefore, we cannot infer whether the attention paid to strategy creation in our sample is consistent with over- or under-investment by bank boards in strategy creation.

Figure B1: Menu to observe attention given to various issues by the board and make inferences from the same



B7 Proofs

B7.1 Proof of Proposition B1

Since greater effort adds to firm value, the constraint (B4) would be binding. Else, the firm value can be increased without violating the constraint. Therefore, the maximization problem transforms into

$$\max_{e_S, e_R, e_C} a - 0.5(a - e_S - e_R)^2 - 0.5e_S^2 - 0.5e_R^2 \tag{B22}$$

The first-order conditions for e_S^{FB}, e_R^{FB} are therefore given by,

$$a - e_S^{FB} - e_R^{FB} = e_S^{FB} \tag{B23}$$
$$a - e_S^{FB} - e_R^{FB} = e_R^{FB} \tag{B24}$$

Therefore,

$$e_S^{FB} = e_R^{FB} = e_C^{FB} = \frac{a}{3} \tag{B25}$$

$\square$

B7.2 Proof of Proposition B2

Using the fact that constraint (B4) would be binding in the equation for the Lagrangian (B10), we get

$$\pounds = \alpha e_S + \beta(a - e_S) + \lambda_C(e_C - \underline{e}) - 0.5e_S^2 - 0.5e_C^2 - 0.5(a - e_S - e_C)^2 \tag{B26}$$

The first-order conditions for e_S^*, e_R^* are therefore given by,

$$2e_S^* + e_C^* = \alpha - \beta + a \tag{B27}$$
$$e_S^* + 2e_C^* = \lambda_C + a \tag{B28}$$

Therefore using equations (B25) and solving, we get:

$$e_S^* = e_S^{FB} + \frac{2(\alpha - \beta) - \lambda_C}{3} \tag{B29}$$
$$e_R^* = e_R^{FB} - \frac{(\alpha - \beta) + \lambda_C}{3} \tag{B30}$$
$$e_C^* = e_C^{FB} + \frac{2\lambda_C - (\alpha - \beta)}{3} \tag{B31}$$

$\square$

B7.3 Proof of Proposition B7

Differentiating equation (B1) after using equation (B4), we get

$$\frac{dV}{d\lambda_C} = (\alpha - \beta) - 2\lambda_C$$

$\square$