Essays On The Macroeconomics Of Financial Markets

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Abstract
This dissertation consists of four essays on the macroeconomics of financial markets. Chapter 1 presents a theoretical framework to study the rise of securitization and secondary markets for financial assets. I show that the interplay of banks and the non-bank financial intermediary sector can lead to credit booms that end in financial crises, much like the financial boom and bust observed in the U.S. from 1990 to 2008. In line with empirical evidence, I show that low risk-free interest rates driven by expansionary monetary policy or a large inflow of savings can trigger such booms. I end by proposing regulatory tools to manage the credit cycle.

Chapter 2, co-authored with Harold L. Cole and Guillermo Ordonez, is a theoretical study of international sovereign default crises. We propose a framework in which risk-averse investors can spend resources to learn about the default probabilities of sovereign countries. Sovereign bond price volatility increases when some investors acquire information because prices now more closely reflect default probabilities. This force induces other investors to learn, further increasing volatility and raising the specter of a crisis. When investors are exposed to the default risk of multiple countries, these crises events spill over across borders.

Chapters 3 and 4, co-authored with Farzad Saidi, analyze the impact of universal banking on the performance of bank-dependent firms. Our basic argument, laid out in Chapter 3, is that universal banks, who are able to concurrently offer both loans and underwriting products, are better informed about their borrower firms, and thus can more efficiently provide external funds to these borrowers. We show empirically that the advent of universal banking after the repeal of the Glass-Steagall Act led to an increase in both the volatility and productivity of borrower firms, suggesting that more informed lenders allow firms to invest in productive ventures further along the risk-return frontier than was previously possible. In light of recent proposals to limit the scope of banking and re-establish the Glass-Steagall Act, our evidence suggests that there may be firm-level efficiency gains from concurrent lending and underwriting of corporate securities that should be balanced against the risks associated with banks becoming too big to fail and other concerns of macroeconomic fragility.

In Chapter 4, we trace out the importance of universal banking for the structure of loan syndicates, one of the dominant sources of corporate borrowing. Loan syndicates typically assign one member to be the prime monitor of the borrower firm, with the other members taking a passive role. We show that universal banks are more likely to be chosen as lead arrangers, but take smaller lead arranger shares conditional on doing so. This result is driven only by the superior monitoring ability of universal banks and does not lead to worse firm-level outcomes. Our findings contrast with the previous literature that argued that falling lead arranger shares prior to 2008 were indicative of weak bank monitoring, and provides a deeper view of intermediary-firm interactions in the modern financial system.

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To Garima, the love of my life.

Without you, I would have never started this journey, nor would I have been able to complete it.
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Daniel Neuhann

Philadelphia, PA

April 20, 2016
ABSTRACT

ESSAYS ON THE MACROECONOMICS OF FINANCIAL MARKETS

Daniel Neuhann

Harold L. Cole

This dissertation consists of four essays on the macroeconomics of financial markets. Chapter 1 presents a theoretical framework to study the rise of securitization and secondary markets for financial assets. I show that the interplay of banks and the non-bank financial intermediary sector can lead to credit booms that end in financial crises, much like the financial boom and bust observed in the U.S. from 1990 to 2008. In line with empirical evidence, I show that low risk-free interest rates driven by expansionary monetary policy or a large inflow of savings can trigger such booms. I end by proposing regulatory tools to manage the credit cycle.

Chapter 2, co-authored with Harold L. Cole and Guillermo Ordoñez, is a theoretical study of international sovereign default crises. We propose a framework in which risk-averse investors can spend resources to learn about the default probabilities of sovereign countries. Sovereign bond price volatility increases when some investors acquire information because prices now more closely reflect default probabilities. This force induces other investors to learn, further increasing volatility and raising the specter of a crisis. When investors are exposed to the default risk of multiple countries, these crises events spill over across borders.

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In Chapter 4, we trace out the importance of universal banking for the structure of loan syndicates, one of the dominant sources of corporate borrowing. Loan syndicates typically assign one member to be the prime monitor of the borrower firm, with the other members taking a passive role. We show that universal banks are more likely to be chosen as lead arrangers, but take smaller lead arranger shares conditional on doing so. This result is driven only by the superior monitoring ability of universal banks and does not lead to worse firm-level outcomes. Our findings contrast with the previous literature that argued that falling lead arranger shares prior to 2008 were indicative of weak bank monitoring, and provides a deeper view of intermediary-firm interactions in the modern financial system.
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Chapter 1: Macroeconomic Effects of Secondary Market Trading

1.1 Introduction

Starting around 1990, financial intermediaries in the United States increasingly began to sell, rather than hold to maturity, many of the loans that they provided to households and firms. The rise of such secondary market trading of financial assets was accompanied by a credit boom that ended in the financial crisis of 2008. In the aftermath of the crisis, policymakers and academics alike have argued that growing secondary markets were a crucial driver of both the credit boom and eventual bust.\footnote{Typically, secondary market trading occurs through the \textit{securitization} of financial assets. While financial intermediaries issued less than $100 billion in securitized assets in 1900, they issued more than $3.5 trillion in 2006. Gorton and Metrick (2012) survey the development of secondary markets and securitization in the United States. Mian and Sufi (2009) and Ivashina and Sun (2011) provide evidence of a credit boom for households and firms. Brunnermeier (2009), Shin (2009), and the Report of the U.S. Financial Crisis Inquiry Commission (2011) review the role of secondary markets and securitization in the boom and bust.} Yet, the underlying mechanisms are not fully understood. This paper offers a theory in which the \textit{endogenous growth} of secondary markets generates a macroeconomic credit cycle. I use the theory to understand why secondary market credit booms arise, why they eventually lead to financial crises, and how policy affects their macroeconomic consequences.

In this theory, secondary markets allow financial intermediaries to sell off risk exposure to other intermediaries. This has two conflicting effects: first, a more efficient allocation of risk can increase the borrowing capacity of intermediaries and allow for the expansion of
credit volumes. Second, asset sales reduce intermediaries’ incentives to screen or monitor investment opportunities ex-ante, hampering the efficiency of investment. The adverse incentive effect arises only if secondary market volumes are high and intermediaries sell off a sufficiently large fraction of their investments. Credit cycles arise because the two effects are linked over time. The transfer of risk leads secondary market volumes to grow during macroeconomic expansions because the wealth of those intermediaries who buy risky assets grows when this risk pays off. Growing secondary market volumes in turn lead to deteriorating lending incentives. Financial fragility grows during upturns because capital increasingly flows to low-quality investments. Ultimately, a negative shock leads to a simultaneous collapse of secondary markets and credit volumes. Booms are triggered by low interest rates – due to, for example, expansionary monetary policy or saving gluts – because cheap funding increases the value of increased borrowing capacity to intermediaries.

I study a segmented-markets economy in which risk-neutral financial intermediaries make risky investments on behalf of risk-averse outside investors subject to moral hazard. Krishnamurthy and Vissing-Jorgensen (2012) provide evidence that investors pay a safety premium for risk-free financial assets, while Gorton and Pennacchi (1990) and Krishnamurthy and Vissing-Jorgensen (2015) argue that the production of safe assets is a key function of the financial sector. Intermediaries thus borrow by issuing risk-free debt. As a result, their funding ability is constrained by their net worth and risk exposure, and secondary market sales serve to reduce risk exposure in order to increase borrowing. But, who buys risk exposure? When investments are subject to aggregate risk, there are no gains from trade among symmetric intermediaries – when one intermediary’s risk decreases, another’s increases. Yet Coval, Jurek, and Stafford (2009) show that the financial assets traded on secondary markets typically carry strong exposure to aggregate risk. I therefore study an economy with two types of intermediaries: bankers, who have the requisite skill to access

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2My results generalize to any setting in which financial intermediaries are constrained by their risk exposure. This may be the case even when all outside investors are, in principle, willing to hold risk exposure. In Hebert (2015), debt is the optimal security in settings that includes flexible moral hazard, i.e. an effort choice that affects average returns and volatility. In the Diamond (1984) model of delegated monitoring, the efficiency of financial intermediation improves when intermediaries can offload aggregate risk exposure.
investment opportunities in the real economy, and financiers, who cannot access these opportunities directly and instead purchase assets on secondary markets. Bankers represent commercial banks or mortgage originators who directly provide loans to households and firms. Financiers represent investors with an appetite for risk, such as hedge funds, broker dealers, and asset managers.

Financiers are willing to take on aggregate risk exposure precisely because they do not make investments directly and thus do not face the same funding constraints as bankers. Rather, financiers earn intermediation rents because their risk-taking behavior allows bankers to expand borrowing and lending. This is socially valuable: bankers are less likely to engage in moral hazard when they are less exposed to risk. Indeed, when total intermediary net worth is scarce, a financial system with both financiers and bankers allows for more borrowing and lending than one of equal size featuring only bankers. Secondary markets thus boost credit volumes through the transfer of risk away from bankers. Greenlaw, Hatzius, Kashyap, and Shin (2008) estimate that financial institutions who purchased mortgage-backed securities on secondary markets were more exposed to mortgage default risk than commercial banks during the 2008 financial crisis. Mian and Sufi (2009) and Ivashina and Sun (2011) provide evidence that growing secondary markets were associated with increased credit to households and firms.

The balance sheets of financial institutions are hard to monitor in real time. Moreover, bankers typically trade with many financiers at the same time, and they are more informed about the quality of the assets they produce than potential buyers. That is, secondary markets are non-exclusive and hampered by asymmetric information. When trade is non-exclusive, Attar, Mariotti, and Salanié (2011) and Kurlat (forthcoming) argue that buyers cannot screen sellers by restricting the quantity of assets that is sold. As in Bigio (2015) and Kurlat (2013), secondary market assets thus trade at a marginal price that is independent of (i) how many assets the originating banker sells and (ii) the quality of the underlying asset. This creates a pernicious motive for secondary market trading. Rather than selling assets to alleviate funding constraints, bankers may opt to produce low-quality, high-risk
assets just to sell them. In equilibrium, bankers find it optimal to “shirk and sell” when the secondary market price is sufficiently high and financiers purchase a large number of assets.\(^3\) Strong demand for secondary market assets therefore affords bankers the opportunity to sell off low-quality assets under the guise of borrowing capacity-enhancing risk transfer. Investment efficiency falls.

The secondary market price is determined endogenously by the net worth of financiers and bankers. When financiers have small net worth, the secondary market price is low and bankers sell assets only to increase their borrowing capacity. When instead financiers have large net worth, the secondary market price is sufficiently high that some bankers begin originating low-quality assets, even as financiers earn positive returns on average. Investment efficiency falls and financial fragility grows in the aggregate. The root cause of this inefficiency is a pecuniary externality. Individual financiers do not internalize that they worsen the pool of all assets by buying more assets on secondary markets. The welfare consequences may be severe. A partial destruction of financier wealth can lead to a Pareto-superior allocation. Policy that limits the accumulation of financier net worth or hampers financiers’ ability to purchase excess amounts of loan-backed assets may therefore be welfare-enhancing. Notably, this motive for regulation is independent of the financial structure of financiers. Indeed, it applies to zero-leverage financial institutions, such as asset managers, who have traditionally been outside the scope of financial regulation precisely because their lack of leverage was thought to eliminate financial fragility and agency frictions.

The model’s key dynamic is the evolution of the intermediary net worth distribution. Be-

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\(^3\)One concern is why bankers ever sell high-quality assets on secondary markets, given that all assets trade at a pooling price. I circumvent this problem in reduced form by assuming that the banker must produce either only high-quality assets or only low-quality assets. This assumption is without loss of generality if financiers are always guaranteed to receive at least the average quality of all assets produced by a banker when purchasing claims on secondary markets. Under this restriction, bankers optimally monitor either all of their investments or none of their investments. In practice, secondary markets are structured to eliminate excessive “cream-skimming” by bankers. Sellers typically offer a whole portfolio of loans for sale, and buyers select the subset of loans they want to purchase. Buyers can guarantee themselves at least the average portfolio quality by using a random selection rule. The assumption can also be rationalized by fixed costs in the monitoring or screening of borrowers.
cause financiers buy aggregate risk exposure on secondary markets, their net worth typically grows faster than that of bankers during macroeconomic expansions. Credit volumes initially increase as financier net worth grows because bankers are able to sell off more risk exposure. Over time, however, rising secondary market prices induce a growing fraction of bankers to produce low-quality assets, leading to excess risk exposure in the financial system. Ultimately, a negative aggregate shock is enough to trigger sharp collapses in secondary market trading and credit. Financier net worth falls because financiers end up holding a large fraction of low-quality assets. Credit volumes fall because bankers can no longer manage risk on secondary markets. Secondary markets recover slowly because financiers need time to rebuild their net worth. As a result, bankers grow vulnerable to negative shocks, and prolonged crises also harm bank balance sheets. Longer crises thus lead to slower recoveries. Because credit quality deteriorates gradually over the course of the boom, longer booms similarly lead to sharper crises. Gorton and Metrick (2012) and Krishnamurthy, Nagel, and Orlova (2014) provide evidence that the fragility of leveraged secondary market traders was at the heart of the 2008 financial crisis, and that the migration of risk back onto bank balance sheets was an important determinant of the larger credit crunch to follow. Adrian and Shin (2010b) estimate that the combined balance sheet size of hedge funds and broker-dealers was smaller than that of bank holding companies before 1990 but almost twice as large by 2007. Keys, Mukherjee, Seru, and Vig (2010) and Piskorski, Seru, and Witkin (2015) provide empirical evidence of falling credit standards and growing moral hazard over the course of the 2000-2007 U.S. credit boom. Bigio (2014) provides evidence of the slow recovery of bank equity and interbank markets in the aftermath of the 2008 crisis. Schularick and Taylor (2012), Mendoza and Terrones (2012), and Reinhart and Rogoff (2009a) provide evidence that longer credit booms predict sharper crises.

Credit booms driven by growing secondary markets can emerge even when bankers and financiers receive the same equilibrium return on equity. Indeed, financiers earn rents precisely because they take on aggregate risk exposure. As a result, they grow faster during
booms even when earning the same average return. Moreover, there are asymmetries in how financiers and bankers achieve these (same) returns. When total intermediary net worth is scarce and funding interest rates are low, financiers employ more leverage than bankers, and earn disproportionately high returns when this risk-taking behavior pays off. Indeed, because bankers highly value increased borrowing capacity when interest rates are low, financiers earn large rents by taking on risk-exposure when funding is cheap. As a result, secondary market booms are triggered by strong demand for financial assets and low interest rates. Bernanke (2005), Caballero and Krishnamurthy (2009), and Caballero, Farhi, and Gourinchas (2008) argue that the early 2000s were characterized by a “global saving glut” that led to a large inflow of global savings in search of safe assets produced by the U.S. financial system. In my model, such inflows generate gradually falling asset quality because they trigger growing imbalances between financiers and bankers. To the extent that expansionary monetary policy leads to falling funding costs for intermediaries, the theory also generates a novel risk-taking channel of monetary policy that operates through the dynamics of financial intermediary net worth. Caballero and Krishnamurthy (2009) argue that monetary policy was indeed expansionary during the early stages of the U.S. credit boom.

Finally, I find that tight leverage constraints on bankers may lead origination incentives to deteriorate sooner than in their absence. Bankers use secondary markets to increase their leverage. When leverage is limited, secondary market supply falls and prices increase. Increasing prices in turn tempt bankers into shirking, with adverse aggregate consequences. The effects of policy must therefore be studied in the context of the aggregate financial system.

**Related Literature.** Beginning with Bernanke and Gertler (1989) and Kiyotaki and Moore (1997), a rich literature in macroeconomics has emphasized the role of borrower net worth and credit constraints in the amplification and persistence of macroeconomic fluctuations. Recent contributions include Brunnermeier and Sannikov (2014), Gertler and Kiyotaki (2010), Gertler and Karadi (2011), He and Krishnamurthy (2011) and Di Tella
A common theme is that borrower or financial intermediary net worth serves to alleviate financial frictions and facilitates more efficient financial intermediation. I emphasize the distribution of net worth, and show how endogenous imbalances in this distribution can harm the efficiency of investment even when net worth increases in the aggregate. Adrian and Shin (2010b) and Adrian and Shin (2014) argue that intermediary leverage, rather than net worth alone, is a key determinant credit conditions. My paper is complementary to theirs in that I show how intermediary leverage is determined in the aggregate of the financial system. Lorenzoni (2008), Bianchi (2011), and Bianchi and Mendoza (2012) study pecuniary externalities during credit booms. Excessive leverage leads to inefficient fire sales during the ensuing bust. I show how pecuniary externalities can generate falling investment efficiency during the boom phase. Bigio (2014), Bigio (2015), and Kurlat (2013) study interbank market shutdowns during macroeconomic downturns, while Rampini and Viswanathan (2010) study risk management among heterogeneous agents. I study how excessive trade among intermediaries during upturns leads to falling asset quality.

A growing literature in macroeconomics and finance emphasizes that there is strong demand for safe assets and that safe assets are a key output of the financial system. The seminal paper in this literature is Gorton and Pennacchi (1990). Krishnamurthy and Vissing-Jorgensen (2012), Krishnamurthy and Vissing-Jorgensen (2015), and Gorton, Lewellen, and Metrick (2012) provide evidence of a safety premium and the role of the financial system in producing such assets. Gorton and Ordoñez (2013) provide a theoretical analysis of safe asset production. Caballero and Farhi (2014) study how safe asset shortages can lead to stagnation, while Caballero and Krishnamurthy (2009) link the demand for safe assets to financial intermediary leverage.

Gorton and Ordoñez (2014) propose a dynamic model of credit booms and busts based on the desire of agents to trade informationally-insensitive assets. Booms and busts occur due to the evolution of beliefs, with busts being triggered by shocks that induce information acquisition. I emphasize the evolution of net worth and the deterioration of investment efficiency over the credit cycle. Gennaioli, Shleifer, and Vishny (2013) study role of secu-
ritization within the shadow banking sector in driving aggregate outcomes. Securitization allows for improved sharing of idiosyncratic risk, and is efficient unless agents neglect aggregate risk. I study the re-allocation of aggregate risk via securitization, and show that excessive secondary market trading can have deleterious effects even in a fully rational framework. Moreover, I explicitly model the dynamics of secondary markets and thus give a reason why booms endogenously lead to financial fragility.

A rich literature in financial economics emphasizes the role of risk in shaping intermediation incentives. Early examples are the risk shifting model of Jensen and Meckling (1976) and the model of delegated monitoring in Diamond (1984). I build on these micro-foundations by explicitly studying the process by which intermediaries diversify risk. The seminal study of loan sales by bankers is Gorton and Pennacchi (1995). In their model, banks must retain a fraction of any loan to ensure monitoring incentives, and do so in equilibrium. I differ in that I allow for shirking on the equilibrium path and focus the aggregate consequences of loan sales. More recently, Parlour and Plantin (2008) and Vanasco (2014) have studied the effects of secondary market liquidity on moral hazard and information acquisition in primary markets in static partial equilibrium settings. I differ in that I study the macroeconomic dynamics of secondary markets and emphasize the endogenous evolution of intermediary net worth. Chari, Shourideh, and Zetlin-Jones (2014) show how secondary markets may collapse suddenly in the presence of adverse selection. I study how growing secondary markets can lead to falling asset quality.

Adrian and Shin (2010a), Adrian and Shin (2009), and Stein (2012) study the role of monetary policy in shaping financial stability. In Adrian and Shin (2010a) and Adrian and Shin (2009), the emphasis is on the role of the short-term interest rate in driving the risk appetite and leverage of financial intermediaries and, thus, credit conditions and risk-taking. In Stein (2012), the main role of policy is to restrict the issuance of private money that relies excessively on short-term debt. I focus instead on how short-term interest rates shape the dynamics of intermediary net worth. By emphasizing the effects of asymmetrically regulating different classes of intermediary, my paper is also related to Plantin (2015), who
discusses the role of differential regulation between a core banking system and a lightly regulated shadow banking sector and shows how relaxing core leverage requirements may make the financial system as a whole safer.

**Layout.** Section 1.2 presents a static model of financial intermediation in which the distribution of net worth is fixed. I use the static model to establish the key channels through which secondary market trading affects credit volumes and investment efficiency. In Section 1.3, I embed the static model into an overlapping generations framework to study the endogenous evolution of net worth. Section 1.4 studies policy. Section 1.5 concludes. All proofs are in Appendix A.

### 1.2 A Static Model of Secondary Markets

I begin my analysis by studying a static model of financial intermediation with secondary markets. The distinguishing feature of this static model is that the net worth of all agents is fixed. I use this setting to characterize the role of secondary market trading for financial intermediation and to study comparative statics with respect to the net worth distribution. The key friction in the model is that the funding ability of intermediaries is limited by their risk exposure. In Section 1.3 I then embed the model into a dynamic framework to study the endogenous evolution of net worth.

#### 1.2.1 Environment

There is a single period, comprising of multiple stages. The economy is populated by three types of agents, each of unit mass: depositors indexed by $d$, bankers indexed by $b$ and financiers indexed by $f$. Depositors are outside investors that lend money to intermediaries to invest on their behalf. The key friction is that depositors have a strong preference for safe assets. As a result, all aggregate risk exposure must be held within the financial system.\(^4\)

\(^4\)All my results generalize to any setting in which financial intermediaries are constrained by their risk exposure. This may be the case even when depositors are, in principle, willing to hold risk exposure. In
Krishnamurthy and Vissing-Jorgensen (2012) and Krishnamurthy and Vissing-Jorgensen (2015) provide empirical evidence of this safety premium. I use the name “depositors” to indicate the risk-aversion of outside investors. Mapped into the real world, they may represent both individual depositors and financial institutions with a strong preference for safe assets, such as money market funds or pension funds. Bankers are unique in that only they can lend money to households and firms directly. Financiers purchase financial securities produced by bankers on secondary markets. Bankers and financiers partially finance their investments by borrowing from depositors, and are protected by limited liability. Because depositors are infinitely risk-averse, bankers and financiers borrow by issuing risk-free bonds subject to an endogenous risk-weighted borrowing constraints. Because financiers do not lend money to households and firms directly, they face a different borrowing constraint than bankers. These asymmetric borrowing constraints constitute the basic motive for trade on secondary markets.

1.2.2 Technology

There is a single good that can be used for consumption and investment. An agent of type $j \in \{d, b, f\}$ receives an endowment $w_j$ at the beginning of the period. At the end of the period, an aggregate state of the world $z \in \{l, h\}$ is realized. The probability of state $z$ is $\pi_z$. All agents derive utility from consumption at the end of the period. The consumption of agent $i$ of type $j$ in state $z$ is $c^i_j(z)$. To capture depositors’ preference for safe assets as simply as possible, I follow Gennaioli, Shleifer, and Vishny (2013) and Caballero and Farhi (2014) and assume that depositors are infinitely risk-averse and evaluate consumption streams according to $U^i_d(c^i_d) = \min_z c^i_d(z)$. Bankers and financiers are risk-neutral and evaluate consumption streams according to $U^i_b(c^i_b) = \mathbb{E}_z c^i_b(z)$ and $U^i_f(c^i_f) = \mathbb{E}_z c^i_f(z)$, respectively. This allows me to isolate how the risk exposure of intermediaries affects the efficiency of investment even when intermediaries are, in principle, indifferent towards holding risk.

Hebert (2015), debt is the optimal security in settings that includes flexible moral hazard, i.e. an effort choice and risk shifting. In the Diamond (1984) model of delegated monitoring, the efficiency of financial intermediation improves when intermediaries can offload aggregate risk exposure.
Endowments can be invested into two constant-returns-to-scale investment opportunities: a *risky* technology indexed by $R$ and a *safe* technology indexed by $S$. There are no capacity constraints – an infinite amount of capital can be invested either technology. The safe technology represents investment opportunities that do not require intermediation. For example, all agents in the economy can purchase treasury bills and widely traded AAA-rated corporate bonds. However, I assume that intermediaries may receive a higher return on the safe technology than depositors. Specifically, the safe technology yields a return of $\bar{y}_S$ per unit of investment in every state of the world when bankers or financiers invest, and a return of $y_S \leq \bar{y}_S$ when depositors invest. Here $\bar{y}_S - y_S \geq 0$ can be viewed as a cost advantage accruing to specialized financial intermediaries when investing in the safe technology. This could be due to economies of scale or informational costs. In the model, I will use $\bar{y}_S - y_S$ to parametrize the *intermediation premium* that depositors are willing to pay for financial services. For simplicity, I normalize the safe technology’s return to intermediaries to one: $\bar{y}_S = 1$. Agent $i$ of type $\tau$ invests $k_{S,\tau}^i$ in the safe technology.

The risky technology represents investment opportunities in the real economy, such as lending to households and firms. Only bankers can invest in this technology. The assumption here is that bankers have the requisite expertise to appropriately evaluate prospective borrowers and the technology to interact directly with households and firms. Banker $i$ invests $k_{R,b}^i$ in the risky technology. The risky technology requires costly effort at the time of investment to operate efficiently. This assumption is motivated by the notion that bankers may have to engage in costly screening and monitoring to make sure that borrowers are likely to repay their loans and behave so as to maximize the expected returns on investment as in Holmstrom and Tirole (1997). For simplicity, I refer to all costly actions undertaken by the banker as *monitoring*, and to the absence of monitoring as *shirking*.

Monitoring has a utility cost of $m$ per unit of investment. If monitored, the risky technology yields a return $y_R(z)$ per unit of investment in state $z$. If it is not monitored, it yields $y'_R(z)$ in state $z$. To simplify notation, I write $\hat{y}_R = \mathbb{E}_z y_R(z)$ and $\hat{y}'_R = \mathbb{E}_z y'_R(z)$ Monitoring is efficient, and shirking increases the downside risk: $\hat{y}_R > \hat{y}'_R + m$ and $y'_R(l) < y_R(l) < y'_R(h)$. 

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When it is monitored, the risky technology yields a higher expected return but a lower worst-case return than the safe technology: \( \hat{y}_R > \bar{y}_S \) but \( y_R(l) < y_S \). I let \( e \in \{0, 1\} \) denote the monitoring effort exerted by the bank, with \( e = 1 \) if the bank monitors. The bank’s monitoring decision is private information. Financiers and depositors thus do not know whether the claims on investment produced by bankers are of high-quality (monitored) or low-quality (unmonitored). Hence, there is moral hazard – monitoring occurs only if it is in the private interest of bankers to do so. Moreover, the monitoring decision applies to the banker’s entire investment. That is, the banker produces either high-quality claims or low-quality claims but not both. This assumption is without loss of generality if financiers are always guaranteed to receive at least the average quality of all assets produced by a banker when purchasing claims on secondary markets. Under this restriction, bankers optimally monitor either all assets or on none. In the real world, secondary markets are structured to eliminate excessive “cream-skimming” by bankers. Sellers typically offer a whole portfolio of loans for sale, and buyers select the subset of loans they want to purchase. Buyers can guarantee themselves at least the average portfolio quality by using a random selection rule. The assumption can also be rationalized by fixed costs in the monitoring or screening of borrowers.

### 1.2.3 Asset Markets and Investment

Agents trade two financial assets: a risk-free bond and a risky claim. The risky claim is a direct claim on the output of the risky technology: it pays out \( y_R(z) \) in state \( z \) if monitoring occurs, and \( y_R'(z) \) otherwise. The banker’s investment splits into a continuum of identical risky claims that can be traded individually. The risk-free bond is zero coupon bond with face value one. Bankers and financiers use the bond market to borrow funds from depositors. Bankers use risky claims trade risk exposure to financiers. Both financial assets are in zero net supply. I refer to bond market as the funding market, and the market for risky claims as the secondary market. The two markets open sequentially: the funding market closes before the secondary market opens. Investment occurs after the funding market has closed,
but before the secondary market opens. All investment choices are not contractible: each agent makes individually rationally investment choices conditional on the bond holdings determined in the funding market.

The role of secondary markets is to allow to bankers to sell off risk exposure in order to increase borrowing. To simplify the timing of the model, I assume that bankers can issue a commitment to sell at least \( a_b \) claims when secondary markets open. In this manner, the banker can expand borrowing through secondary market sales even though markets open sequentially. Yet, I also allow bankers to sell more than \( a_b \) claims should they find it optimal to do so ex-post. This captures the idea that bankers can credibly promise to sell to sell a given amount of loans – for example, by offloading credit risk from a previous origination round – while always being able to return to secondary markets at a later date.\(^5\)

Given these assumptions, I now detail the market structure in each market. I summarize the timing of events in Figure 1 below.

**Funding Market Structure**

In the funding market, financiers and bankers issue risk-free zero-coupon bond with face value one to depositors in order to fund investment and risky claim purchases. They do so subject to a solvency constraint – to be specified below – that ensures that all bonds are indeed risk-free. Before bond trading commences, each banker posts a commitment to sell at least \( a_b \) risky claims when the secondary market opens. As I will show below, these asset sale commitments will affect the tightness of the banker’s solvency constraint. Given that the solvency constraint must hold for every banker and every financier, all bonds are identical. I therefore model the bond market as perfectly competitive, with price \( Q_b \) and return \( R_b = \frac{1}{Q_b} \). Depositor \( i \) purchases \( b^i_d \) units of the bond, and intermediary \( i \) of type \( \tau \)

\(^5\)Bankers may find it optimal ex-post to shirk and sell a large fraction of his assets to financiers. If bankers do so, however, depositor payoffs are not adversely affected. As a result, there is no incentive for depositors to require bankers to commit to not selling more than \( a_b \), even if doing so were possible. Such ex-post shirking will affect financier’s payoffs in secondary markets, however. I discuss this issue in detail below.
issues $b_i^t$ units of the bond subject to the solvency constraint.

The key simplifying assumptions of this funding market structure are that (i) financiers do not fund bankers by buying bonds and (ii) bankers do not issue equity to financiers. I show below that these assumptions are immaterial to the main results of the paper. Specifically, credit booms can arise even when financiers achieve weakly higher returns on equity than bankers – so that bankers would not want to issue equity, even if doing so were costless – and the return on secondary market assets strictly dominates the return on bonds. Moreover, market segmentation is consistent with the data. Ivashina and Sun (2011) provide evidence that tranches of loans sold in secondary markets had lower yields than those held via direct claims on bankers.

**Secondary Market Structure**

The secondary market opens after the funding market closes and is organized in two stages: bidding and trading. Banker $i$ enters the bidding stage having issued $b_i^t$ bonds and a promise to sell at least $a_i^t$ risky claims. Financiers observe the pair $\mu \equiv (a_i, b_i)$ associated with every risky claim that is sold. That is, each financier knows the bond position and asset-sale promises made by the banker issuing the risky claim. Because bankers can sell assets to many financiers at the same time, trade is non-exclusive. Financiers thus cannot directly observe either the quality of the claims or the total quantity of risky claims sold given banker. The motivation for this assumption is as follows. First, bankers have better information about their own actions. Second, secondary markets are typically large and opaque. Indeed, many financial securities are traded in over-the-counter markets that are hard to monitor in real time. Attar, Mariotti, and Salanié (2011) and Kurlat (forthcoming) show that buyers cannot screen sellers by restricting the quantity of assets that is sold when trade is non-exclusive. That is, bankers cannot signal that they engaged in costly monitoring by promising to retain a fraction of their assets. I thus restrict the contract

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6One way to overcome such “anonymity” in financial markets is to allow for reputations. Yet reputations are typically fragile – see Ordoñez (2013) – and may even serve to sustain pooling equilibria in which both low-quality and high-quality assets are sold in dynamic settings (Chari, Shourideh, and Zetlin-Jones (2014)).
space in secondary markets to menus consisting of a *per-unit* price $Q_a(\mu)$ and a quantity $a_f(\mu)$ that the financier is willing to purchase at $Q_a(\mu)$. These bids are conditional on $\mu$ because financiers can use $\mu$ to make inferences about the quality of risky claims. Bankers then sell risky claims to the highest bidder.

This market structure allows me to tackle two concerns that would arise in a standard competitive market. The first is that financiers are able to form inferences about asset quality as a function of bankers funding market choices. As a result, multiple asset qualities can trade simultaneously. The second is that I can accommodate secondary market shutdowns. That is, there exist equilibria in which no claims are traded on secondary markets. This feature will turn out to be useful to guarantee equilibrium existence more generally. The structure nevertheless preserves an appealing feature of competitive markets. Specifically, financiers act as *price takers* for any given $\mu$ when assets are traded on secondary markets. The result is that the intermediation rents on secondary markets are split according to secondary market prices, with market prices in turn being determined by the relative wealth of bankers and financiers.

At the commencement of the bidding stage, each financier $j$ posts a pair $(Q_{ja}(\mu), a_{ja}(\mu))$ for all possible pairs of banker asset sale promises and bond issuances $\mu$. Note that I require financiers to post prices and quantities for *any* $\mu$, regardless of whether any banker posts such a $\mu$ in equilibrium. Since financier offers are a function of $\mu$, I refer to all trades with bankers who post $\mu$ as occurring on a sub-market $\mu$. Naturally, banker $i$ can only trade in sub-market $\mu^i$. I denote the set of bankers who post $\mu$ by $I_b^\mu$, and the set of financiers who trade in sub-market $\mu$ by $I_f^\mu$. A sub-market is **active** if a strictly positive mass of bankers and financiers makes strictly positive bids in this sub-market. The set of active secondary sub-markets is defined as $\mathcal{M}$.

In the trading stage, banker $i$ in sub-market $\mu^i$ offers to sell $a_{b}^{i,j}$ units of the risky claim to financier $j$ at the posted price $Q_{ja}(\mu^i)$. Given bankers’ offers $\{a_{b}^{i,j}\}_{i \in I_b^\mu}$ to financier $j$, as a result, they may attenuate, but don’t eliminate, the potential for harmful hidden trading in secondary markets. I thus abstract from reputational concerns for simplicity.
risky claims are allocated as follows. If \( \hat{a}_{b}^j(\mu) \geq \int_{i \in \mathcal{I}} b \hat{a}_{b}^i,j \), so that there is excess demand for risky claims, then each banker sells exactly \( a_{b}^{i,j} \) risky claims to financier \( j \) at price \( Q_{d}^j(\mu) \). If \( \hat{a}_{b}^j(\mu) > \int_{i \in \mathcal{I}} b \hat{a}_{b}^i,j \), so that there is excess supply of risky claims, then each fraction of risky claim supplied is sold to the financier with equal probability, with the total amount of claims sold equal to financier \( j \)’s demand. Financier \( j \) therefore receives exactly \( a_{b}^j \equiv \min \left\{ \int_{i \in \mathcal{I}} b \hat{a}_{b}^i,j, \hat{a}_{b}^j \right\} \) units of the risky claim at price \( Q_{d}^j(\mu) \), while banker \( i \) sells

\[
\hat{a}_{b}^{i,j} = \min \left\{ \left( \frac{\hat{a}_{b}^{i,j} \int_{i' \in \mathcal{I}} b \hat{a}_{b}^{i',j}}{\hat{a}_{f}^j, \hat{a}_{b}^{i,j}} \right) \hat{a}_{f}^j, \hat{a}_{b}^{i,j} \right\}
\]

risky claims to financier \( j \). I refer to these as realized quantities. Across all financiers, the banker sells \( a_{b}^i = \int_{j \in \mathcal{I}^i} b \hat{a}_{b}^{i,j} \) risky claims and receives \( \int_{j \in \mathcal{I}^i} Q_{d}^j(\mu^i) a_{b}^{i,j} \) in revenue. By the law of large numbers, these quantities are not random variables. Finally, banker \( i \)’s stage-2 bidding strategy must satisfy \( a_{b}^i \geq a_{b}^j \). Whenever multiple financiers make identical bids in a given sub-market, each financier receives a representative slice of all risky claims in that market. Specifically, if both high and low-quality loans are traded in a given sub-market then the fraction of low-quality loans received is the same for every financier. When bidding, the financier must therefore form beliefs only about the average quality risky claims in sub-market \( \mu \). A sufficient statistic is, of course, the fraction of low-quality loans. I denote financiers’ beliefs about this fraction by \( \phi(\mu) \). Throughout, I require that financier beliefs satisfy Bayes’ rule wherever possible. In equilibrium, furthermore, beliefs must be correct – they must coincide with the true fraction of low-quality loans. To economize on notation, I take this condition as given and use \( \phi(\mu) \) to denote the equilibrium fraction of low-quality loans in sub-market \( \mu \).

When turning to the characterization of equilibrium, I will also require that financier bids satisfy a regularity condition across sub-markets. In particular, I impose that the terms of trade offered by financiers must not “decrease” in beliefs.

**Definition 1** (Bid Consistency). The bidding behavior of financiers satisfies **bid consistency** if for all sub-markets \( \mu \in (a_{b}, b_{b}) \in \mathbb{R}^2_{+} \) and \( \mu' \in \mathbb{R}^2_{+} \), if \( \phi(\mu') \leq \phi(\mu) \) then...
Bid consistency requires that financier bids be conditioned on the quality of risky claims only: whenever the financier believes assets to be of weakly higher quality in one of two sub-markets, he cannot offer worse terms in the sub-market where he believes the quality to be higher. I impose this restriction to prevent “collusive” equilibria in which financiers coordinate to punish bankers for deviating from some $\mu$ to a $\mu'$ by offering low prices when doing so does not change the quality of claims. It is directly linked to my assumption that secondary markets are anonymous: financiers must make offers conditional on their beliefs regarding the quality of the assets rather than the identity or balance sheet characteristics of the issuer. Note that bid consistency is not a constraint on the bidding behavior in active sub-markets since it is implied by a no-arbitrage condition stating that financiers do not achieve strictly higher returns in one active sub-market than in another. This no-arbitrage condition must hold in equilibrium whenever there are multiple active sub-markets. Bid consistency thus only constrains financier bids in currently inactive sub-markets to be consistent with those in active sub-markets. It is in this manner that the restriction rules out the aforementioned collusive equilibria.

The next result simplifies the analysis by showing that each active sub-market behaves as if it were a competitive market.

**Lemma 1 (Secondary Market Prices and Rationing).** If every sub-market $\mu$, there exists a unique marginal price $Q_a(\mu)$ such that $Q_a^j(\mu') = Q_a^j(\mu)$ for all $j$. No individual banker or financier is rationed at $Q_a(\mu)$ in any sub-market $\mu$.

The proof is standard and follows from all financiers being infinitesimally small and holding the same beliefs. Since no agent can impact market quantities in the aggregate, no agent can acquire risky claims below the marginal price. Yet no agent must pay more to acquire as many claims as he wants. This line of reasoning also accommodates the requirement that financier bids must satisfy bid consistency. The reason is that bid-consistency is implied by a no-arbitrage condition for financier’s across active sub-markets – a condition that must
hold when there are multiple active sub-markets – while bids on inactive sub-markets are irrelevant for financier utility because they are never accepted on the equilibrium path. Going forward, I thus assume that financiers take the set of active sub-markets and the market price within that sub-market as given. Accordingly, I write all decision problems in terms of market prices rather than bid prices, and realized quantities $a_b$ and $a_f$ rather than bid quantities $\hat{a}_b$ and $\hat{a}_f$. Note that all financiers receive a representative slice of all claims traded in all sub-markets in which they trade because all financiers bid the same marginal price in that sub-market.

Figure 1 summarizes the timing of events. In stage 1, all agents receive their endowments. In stage 2, bankers post a commitment to sell at least $a_b$ units of the risky asset in secondary markets, and risk-free bonds are traded in the funding market. Once the funding market closes, we move on to stage 3. Here, bankers make investments in the risky technology using their own net worth and the proceeds from bond issuances in the funding market, and all agents make their investments in the safe technology. Moreover, bankers make their monitoring decision. The secondary market opens in stage 4. Financiers post bids for risky claims and bankers choose which financier to sell to, subject to the constraint that they must sell at least $a_b$ units in total. To simplify notation, I take as given that the proceeds from risky asset sales are automatically invested in the storage technology, and thus yield a sure return of $\bar{y}_S \equiv 1$. Once the secondary market closes, we move on to stage 5. In this stage, the productivity shock $z$ is realized, returns on investment accrue, accounts are settled, and all agents consume.

1.2.4 Decision Problems

I begin the equilibrium characterization by discussing the decision problem of each type of agent. Given that the decision problems are symmetric for all agents of type $j$, I simplify notation by dropping the superscript $i$. Every agent takes the bond price, the set of active secondary sub-markets $\mathcal{M}$, and the marginal prices in each secondary sub-market as
The Depositor’s Problem

The return on a risky claim purchased on secondary markets can never be higher than the direct return on investment on the risky technology. Hence, the worst-case return of a secondary market claim is always below that of the safe technology, and depositors invest only in the safe technology and/or risk-free bonds. Let \( k_{S,d} \) and \( b_d \) denote the depositor’s investment in the safe technology and bond purchases, respectively. Then the depositor’s problem is

\[
\max_{k_{S,d}, b_d} \min_z (c_d(z)) \\
\text{s.t. } c_d(z) = u_S \cdot k_{S,d} + b_d \text{ for } z \in \{l, h\} \\
k_{S,d} + Q_b b_d \leq w_d.
\]

The first constraint determines the depositor’s consumption in state \( z \). Since both investments are risk-free, consumption is independent of the state of the world. The second constraint is the budget constraint stating that the depositor cannot spend more than his endowment \( w_d \) on bonds and investment. This problem has a simple solution. In particular,
the budget constraint binds and

\[
b_d(w_d, Q_b) = \begin{cases} 
\frac{w_d}{Q_b} & \text{if } Q_b < \frac{1}{y_S} \\
[0, \frac{w_d}{Q_b}] & \text{if } Q_b = \frac{1}{y_S} \\
0 & \text{if } Q_b > \frac{1}{y_S}
\end{cases}
\]

Equilibrium bond prices are thus bounded above by \( \bar{Q}_b \equiv \frac{1}{y_S} \).

The Financier’s Problem

To discuss the financier’s problem, I first establish some additional notation. Recall that all financiers receive a representative risky claim in each sub-market, and that the fraction of low-quality claims sold in sub-market \( \mu \) is \( \phi(\mu) \). The state-\( z \) payoff of the representative claim in sub-market is \( y_{R,\mu}(z) \equiv (1 - \phi(\mu))y_R(z) + \phi(\mu)y'_R(z) \). The expected payoff is \( \bar{y}_{R,\mu} \equiv (1 - \phi(\mu))\bar{y}_R + \phi(\mu)\bar{y}'_R \). Financiers chooses investment in the safe technology \( k_{S,f} \), a quantity of bonds to issue in funding markets \( b_f \), and the number of risky claims to bid \( a_f(\mu) \) for every \( \mu \in \mathbb{R}_+^2 \). Taking prices and the set of active secondary sub-markets \( \mathcal{M} \) as given, the financier’s problem is

\[
\max_{k_{S,f}, b_f \geq 0, a_f(\mu)} \mathbb{E}_z \left[ \bar{y}_S k_{S,f} + \int_{\mathcal{M}} y_{R,\mu}(z)a_f(\mu)d\mu - b_f \right]
\]

s.t. \( k_{S,f} + \int_{\mathcal{M}} Q_o(\mu)a_f(\mu)d\mu \leq w_f + Q_b b_f \)

\[
\bar{y}_S k_{S,f} + \int_{\mathcal{M}} y_{R,\mu}(z)a_f(\mu)d\mu \geq b_f \text{ for all } z.
\]

The first constraint is the budget constraint. It states that sum of the expenditures on risky assets in all active sub-markets and the safe investment cannot exceed the sum of his net worth \( w_f \) and bond issuances \( b_f \). The second constraint is a solvency constraint that ensures that the all debts are paid in full in every state of the world.

There are two main decisions: whether to purchase risky claims, and, if so, whether to issue bonds to do so. These decisions depend on the expected return of risky claims and
their collateral capacity. In particular, financiers can issue more bonds more when the sub-
market they are buying in has a higher proportion of high-quality claims. The reason is that
the worst-case payoff of a highly-quality claim is strictly higher than that of a low-quality
claim. As a result, it is of better use as collateral. Depending on prices and asset quality,
financiers may issue less bonds than the solvency constraint allows them to. For example,
the bond price may be so low that it is not profitable for the financier to issue bonds to
invest in risky claims. I summarize the financier’s optimal borrowing decision by $\gamma$ in the
pseudo-solvency constraint

$$b_f = \gamma \left[ \bar{y}_{SKS,f} + \int_M y_{R,\mu}(z) a_f(\mu) d\mu \right].$$

(1)

Here, $\gamma \in [0, 1]$ is a decision variable determining the degree to which the financier exhausts
his borrowing capacity. When $\gamma = 0$, the financier does not issue any bonds. When
$\gamma = 1$, the financier issues as many bonds as he can. I also make use of the following
definition.

**Definition 2** (Return on Investment in Secondary Markets). The unlevered expected re-
turn on investment in sub-market $\mu$ is $\hat{R}_{\text{unlev}}(\mu) \equiv \frac{\hat{y}_{R,\mu}}{Q_a(\mu)}$. The fully levered expected return on investment in sub-market $\mu$ is $\hat{R}_{\text{lev}}(\mu) = \frac{\hat{y}_{R,\mu} - y_{R,\mu}(l)}{Q_a(\mu) - Q_b y_{R,\mu}(l)}$. The maximal expected return in sub-market $\mu$ is $\hat{R}_{\text{max}}(\mu) \equiv \max \left\{ \hat{R}_{\text{unlev}}(\mu), \hat{R}_{\text{lev}}(\mu) \right\}$.

The unlevered return is achieved by purchasing the risky claim using own net worth only.
The fully levered return is achieved by purchasing claims using own net worth and the full
amount of bonds that can be issued. The following corollary states the condition under
which leverage is beneficial to the financier.

**Corollary 1.** In sub-market $\mu$, the maximum expected return is equal to the fully levered
expected return if and only if $Q_b \hat{y}_{R,\mu} \geq Q_a(\mu)$.

**Proof.** Follows directly from comparing the rates of return. \qed

I now turn to the financier’s optimal portfolio. If there are no active secondary sub-markets,
the solution is trivial. Specifically, the financier invests all his wealth in the safe technology. He issues bonds to do so only if \( Q_b \geq \bar{y}_S = 1 \). To the extent that this condition holds, it is easy to verify that the solvency constraint is never binding. As a result, every financier can issue an infinite amount of bonds. Hence \( Q_b \leq \bar{y}_S \) when secondary markets are inactive, and financiers issue bonds only when there is excess demand at \( Q_b = \bar{y}_S \).

Next, turn to financier portfolios when there are active secondary markets. For simplicity, take as given that only one sub-market, \( \mu^* \) say, is active – this will be the case in equilibrium. For secondary markets to be active, financiers must be willing to purchase risky claims. Hence the return on risky claims must not be lower than that of the safe technology. That is, \( \hat{r}^{\text{unlev}}(\mu^*) \geq \bar{y}_S \). The first question is whether financiers will invest in the safe technology.

**Lemma 2** (Financier Safe Investment with Active Secondary Markets.). *Assume that \( \hat{r}^{\text{unlev}}(\mu^*) \geq \bar{y}_S \). Then financiers are indifferent between the safe and the risky technology if \( \hat{r}^{\text{unlev}}(\mu^*) = \bar{y}_S \) and \( b_f \leq \frac{y_R(l)w_f}{Q_a(\mu^*) - Q_b y_R(l)} \), and strictly prefer to invest in the risky technology otherwise.*

**Proof.** See appendix. \( \square \)

A corollary of this result is that the financier’s solvency constraint can be written as a borrowing constraint that is independent of whether the financier invests in risky claims or the safe technology.

**Corollary 2** (Financier Borrowing Constraint). *The financier solvency constraint is equivalent to the borrowing constraint*

\[
b_f \leq \frac{y_R(l)w_f}{Q_a(\mu^*) - Q_b y_R(l)}.
\]

**Proof.** Suppose that the financier invests in risky claims only. Then the result follows directly from re-arranging the solvency constraint. Suppose instead that the financier invests in the safe technology. By Lemma 2, the stated condition must hold. \( \square \)
When secondary markets are active, financiers thus face a borrowing constraint even when investing in the safe technology. The reason is that secondary markets allow the financier to engage in risk-shifting. Given that risky claims always offer a weakly higher return than the safe technology, and that the financier’s borrowing capacity is independent of his investment strategy, I proceed under the presumption that the banker invests in the risky technology only. I later verify this presumption. The pseudo-solvency constraint allows me to write the financier’s bond issuances as

$$b_f = \frac{\gamma y_R(l)w_f}{Q_a(\mu^*) - \gamma Q_b y_R(l)}.$$  

for some $\gamma \in [0,1]$.

The optimal degree of borrowing then follows directly from Corollary 1: the financier lever[s] fully when the levered return is strictly higher than the unlevered return. Specifically, the optimal $\gamma$ is given by

$$\gamma^* = \begin{cases} 
1 & \text{if } \frac{\hat{y}_{B,\mu^*}}{Q_a} > \frac{1}{Q_b} \\
[0,1] & \text{if } \frac{\hat{y}_{B,\mu^*}}{Q_a} = \frac{1}{Q_b} \\
0 & \text{if } \frac{\hat{y}_{B,\mu^*}}{Q_a} < \frac{1}{Q_b}.
\end{cases}$$

Under the presumption that secondary markets are active and financiers strictly prefer risky claims to the safe technology, the financier optimally chooses the following asset allocation:

$$a_f(\mu^*) = \frac{w_f}{Q_a(\mu^*) - \gamma Q_b y_{R,\mu^*}(l)} \quad \text{and} \quad b_f^* = \frac{\gamma y_{R,\mu^*}(l)w_f}{Q_a(\mu^*) - \gamma Q_b y_{R,\mu^*}(l)}.$$  

Accounting for bid consistency then only requires that the financier makes weakly better bids in all inactive sub-markets in which beliefs are weakly higher than in the active sub-market, i.e. $\hat{a}_f(\mu) \geq a_f(\mu^*)$ for all $\mu$ such that $\phi(\mu) \geq \phi(\mu^*)$.  

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The Banker’s Problem

I now turn to the banker’s problem. I assume throughout that bankers receive strictly positive intermediation rents from investing depositors’ money on their behalf. As a result, bankers want to issue as many bonds as possible. I will show that it may not always be feasible to sustain monitoring in equilibrium for all bankers. I therefore begin by characterizing the decision problem for a given action \( e \in \{0, 1\} \). I denote the realized private benefit associated with \( e \) by \( m^*(e) = (1 - e)m \), and the associated return on the risky technology by \( y^*_R(z, e) = ey_R(z) + (1 - e)y'_R(z) \). The banker’s state-\( z \) consumption \( c_b(z) \) is the sum of payoffs from investments in the safe technology, payoffs from the risky technology net of asset sales, proceeds from asset sales, and bond repayments. By limited liability, consumption is bounded below by zero. That is,

\[
c_b(z, a, b, k, b_b, e) \equiv \max \{y_S k_S, b_b + y^*_R(e, z) (k_R - a) - b_b + Q_\mu(a_b, 0)\},
\]

where \( \mu = (a_b, b_b) \). Since the banker is risk-neutral, the banker’s utility in state \( z \) is

\[
u_b(z, a, b, k, b_b, e) \equiv c_b(z, a, b, k_R, b_S, b_b, e) + m^*(e)k_R.
\]

The banker’s optimal monitoring choice conditional on \((a_b, k_R, k_S, b_b)\) is:

\[
e^*(a, b, k_R, k_S, b_b) = \arg \max_{e' \in \{0, 1\}} \mathbb{E}_z u_b(z, a, b, k_R, k_S, b_b, e')
\]

Secondary markets open after the bond market closes and investment has taken place. The banker’s asset sales must therefore be ex-post optimal given \((a, k_R, k_S, b_b)\). Note that the banker must sell at least \( a_b \) claims but can sell no more than \( k_R \). When deciding on how many assets to sell, the banker takes into account that he will adjust his monitoring decision optimally. For example, a banker that sells a large fraction of his portfolio may
decide to stop monitoring. As a result, asset sales are ex-post optimal if and only if

\[ a_b^*(a_b, k_{R,b}, k_{S,b}, b_b) = \arg \max_{k_{R,b} \geq a' \geq 2} \mathbb{E}_z \left[ \max \left\{ \bar{y}_S k_{S,b} + y_R^*(e', z) (k_{R,b} - a_b') - b_b + Q_a(\mu)a_b', 0 \right\} \right] \]

\[ + m^*(e') k_{R,b} \]

where \( e' = e^*(a_b, a_b', k_{R,b}, k_{S,b}, b_b). \)

Taking prices and action \( e \) as given, the banker thus solves the problem:

\[
\max_{k_{S,b}, k_{R,b}, b_b, \tilde{a}} \mathbb{E}_z \left[ \max \left\{ \bar{y}_S k_{S,b} + y_R^*(e, z) (k_{R,b} - a_b) - b_b + Q_a(\mu)a_b, 0 \right\} \right] + m^*(e) k_{R,b} \\
(\text{P}_B(e))
\]

s.t.

\[ k_{S,b} + k_{R,b} \leq w_b + Q_b b_b, \]

\[ b_b \leq \bar{y}_S k_{S,b} + y_R^*(e, z) (k_{R,b} - a_b) + Q_a(\mu)a_b \quad \text{for all} \quad z, \]

\[ e = e^*(a_b, a_b', k_{R,b}, k_{S,b}, b_b), \]

\[ a_b = a_b^*(a_b, k_{R,b}, k_{S,b}, b_b). \]

The first constraint is the budget constraint, stating that total investment in the safe and the risky technology cannot exceed net worth and the proceeds from bond issuances. The second constraint is the solvency constraint that guarantees that all debts are repaid in full in every state of the world. The third constraint is the incentive compatibility constraint that ensures that action \( e \) is privately optimal. The fourth constraint ensures that asset sales are ex-post optimal. A helpful result is that bankers will never invest in the safe technology in equilibrium. I impose this result going forward.

**Lemma 3** (No Safe Investment by Bankers). *Bankers never invest in the safe technology: \( k_{S,b}^* = 0 \) in any equilibrium.*

**Proof.** See appendix.

I characterize the solution to the banker’s problem in two steps. I first discuss ex-post
optimal asset sales and the monitoring decision *conditional* on bond issuances, investment, and asset-sale promises. I then discuss optimal bond issuances, investment, and asset-sale promises, given that asset-sales and the monitoring decision are chosen optimally ex-post.

**Ex-Post Optimal Asset Sales.** The secondary market opens once the funding market has closed. As a result, bond issuances $b$, investment in the risky technology $k_{R,b}$, and the asset-sale promise $a$ are all sunk. The banker makes his asset sale decision with the associated optimal monitoring decision in mind. Specifically, the banker chooses $e = e^*(a, b, k_{R,b}, b)$ when he sells $a$ risky claims. Two observations simplify the analysis. First, the banker’s objective function is linear because the banker is risk-neutral and he is required to be solvent in all states of the world. As a result, the solution is bang-bang. That is, the banker either sells everything or just as much as he initially promised, $a^* \in \{a, k_{R,b}\}$. Second, the banker will certainly shirk when he sells his entire portfolio because asset quality is irrelevant to the banker’s utility when $a = k_{R,b}$. That is, $e^*(k_{R,b}, a, k_{R,b}, b) = 0$.

For there to be monitoring in equilibrium, it must therefore be the case that bankers monitor when they sell just as much as they had promised. Assume for now that this is the case. Bankers then either sell $a$ and monitor or sell $k_{R,b}$ and shirk. The payoffs of these two action profiles are as follows.

Shirk and Sell: $Qa k_{R,b} - b + mk_{R,b}$

Effort and Hold: $\hat{y}_R (k_{R,b} - a) - b + Qa a$

Comparing payoffs yields a simple decision rule in the secondary market price.

**Proposition 1** (Ex-Post Optimal Asset Sales and Monitoring). Assume that monitoring is optimal at $a$. Then the banker sells $a$ assets and monitors only if

$$Qa \leq \tilde{Q}_a(k_{R,b}, a) \equiv \hat{y}_R - m \left( \frac{k_{R,b}}{k_{R,b} - a} \right)$$

(IMP)
That is, bankers will choose to sell everything and shirk if the asset price is too high. Because \( \tilde{Q}_a(k_{R,b}, a_b) \leq \tilde{y}_R - m < \hat{y}_R \), this may be the case even as financiers continue to make receive rents on secondary market assets. It is for this reason that there is scope for ex-post shirking when financiers are well-capitalized and bid up prices. Going forward, I will refer to this upper bound on the secondary market price as the *implementation constraint*. Monitoring occurs in equilibrium only if this constraint is satisfied for a some bankers.

If instead bankers shirk even when they sell just as many claims as they had promised (that is, \( e^*(a_b, a_b, k_{R,b}, b_b) = 0 \)), then bankers always shirk. In this case, the optimal asset sales follow an even simpler decision rule: sell as many claims as promised if the secondary market price \( Q_a \) is below the expected return on a low-quality claim \( \hat{y}_R \), and sell all claims otherwise.

**Borrowing Constraints.** The next step is to characterize the banker’s optimal choice of bonds \( b_b \), investment \( k_{R,b} \), and asset-sale promises \( a_b \). I do so under the presumption that monitoring is optimal. The previous section showed that monitoring can only be sustained if it is ex-post optimal to sell just as many claims as promised. I therefore presume that \( a_b^* = a_b \). I then derive the borrowing constraint that ensures that bankers monitor when they do indeed sell as many claims as promised. When turning to competitive equilibrium, I compute the competitive equilibrium under this presumption and then verify whether \( a_b^* = a_b \) in equilibrium.

There are two constraints that limit bankers’ ability to issue bonds. The first is the solvency constraint that states the banker must be able to repay his debts in full in every state of the world. The second is the incentive compatibility constraint that ensures bankers prefer to monitor. This takes the form

\[
\mathbb{E}_z \left[ y_R(z) \left( k_{R,b} - a_b \right) - b_b + Q_a a_b \right] \geq \mathbb{E}_z \left[ \max \left\{ y_R(z) \left( k_{R,b} - a_b \right) - b_b + Q_a a_b, 0 \right\} \right] + m k_{R,b}.
\]

It is straightforward to see that the incentive constraint binds before the solvency constraint. The reason is that the banker is less sensitive to downside risk when he shirks than when
monitors because the limited-liability constraints binds earlier under shirking. I refer to bankers as collateral-constrained if the limited-liability constraint binds in the low state conditional on shirking. The banker is collateral-constrained at \((k_{R,b}, b_b, Q_a)\) if and only if

\[
\bar{a}_b \leq \bar{a}_b(k_{R,b}, b_b, Q_a) \equiv \frac{b_b - y'_R(l)k_{R,b}}{Q_a - y'_R(l)}.
\]

When the banker is collateral-constrained, the incentive-compatibility constraint can be rewritten as a borrowing constraint of the form:

\[
b_b \leq \left[\frac{\pi_h}{\pi_l} (y_R(h) - y'_R(h)) + y_R(l) - \frac{m}{\pi_l} k_{R,b} + \left[Q_a - y_R(l) - \frac{\pi_h}{\pi_l} (y_R(h) - y'_R(h))\right]\right] a_b
\]

\[\equiv \text{Banker borrowing capacity } b_b(k_{R,b}, Q_a, a_b)\]

The next result shows that bankers can relax this borrowing constraint by selling risky claims on secondary markets if the moral hazard problem is a sufficiently severe risk-shifting problem (Jensen and Meckling (1976)).

**Lemma 4 (Risk-shifting Problem).** There is scope for secondary market sales \((a_b > 0)\) to increase banker borrowing capacity if and only if

\[
y'_R(h) > \mathbb{E}_z y_R(z).
\]

**Proof.** Since the secondary market price cannot be higher than the return on the risky technology (that is, \(Q_a \leq \hat{y}_R\)) there exists a \(Q_a\) such that the coefficient on \(a_b\) in the borrowing constraint is positive if and only if \(y'_R(h) > \mathbb{E}_z y_R(z)\). \qed

Lemma 4 states that the losses from shirking must be sufficiently concentrated in the low state. The intuition is that secondary market sales serve as a form of insurance – the banker has more capital in the low state but less in the high state. For this insurance to be valuable, the banker must be constrained by lack of capital in the low state. This is the case when the returns of the risky technology are poor in the low state of the world, and particularly so when shirking. I will impose this condition throughout. In order to simplify the exposition,
I use the following special case.

**Assumption 1.** *The returns of the risky technology in the high state are the same under shirking and monitoring:*

\[ y_R'(h) = y_R(h) \]

This assumption allows me to write the borrowing constraint purely in terms of low-state payoffs. As will become clear, the assumption is innocuous in terms of the main results of the paper.\(^7\) In order to obtain easily interpretable closed-form solutions for equilibrium prices and trading behavior, I also sometimes specialize the shirking technology as follows.

**Assumption 2.** *The risky technology yields zero payoff in the low state conditional on shirking: \( y_R'(l) = 0 \).*

I summarize the severity of the moral hazard problem by

\[ \tilde{m} \equiv 1 - \frac{m}{\pi_l y_R(l)} \in (0, 1). \]

This reduced-form statistic is close to one when the moral hazard problem is not severe (\( m \) is close to zero) and close to zero when the moral hazard problem is severe (\( m \) is close to \( \pi_l y_R(l) \), the output loss from shirking). High values of \( \tilde{m} \) therefore indicate a loose banker moral hazard problem. Under Assumption 1, the banker’s borrowing constraint can then be written as

\[ b_b \leq \frac{y_R(l) \tilde{m} k_{R,b}}{\text{Collateral Capacity of Risky Investment}} + \left( Q_a - y_R(l) \right) a_p. \]

The banker can back his bonds with the worst-case payoff of the risky technology – appropriately discounted by \( \tilde{m} \) to account for moral hazard – or with proceeds from secondary market sales. Exploiting the budget constraint \( k_{R,b} = w_b + Q_b b_b \) reveals a constraint on

\(^7\)A caveat applies if I were to allow for *tranching* on secondary markets. If tranching were allowed, then my results go through as long as the high-state payoffs are different \( y_R(h) \neq y_R'(h) \).
investment that can be relaxed by net worth and risky claim sales:

\[ k_{R,b} \leq \frac{w_b + Q_a(Q_a - y_R(l))a_b}{1 - Q_by_R(l)\tilde{m}} \]  

(2)

What happens when the banker is not collateral-constrained – that is, when asset sales \( a_b \) exceed the collateral shortfall \( \bar{a}_b(k_{R,b}, b_b, Q_a) \)? In this case, the limited-liability constraint does not bind conditional on shirking. As a result, the incentive-compatibility constraint becomes a skin-in-the-game constraint:

\[ a_b \leq \tilde{m}k_{R,b} \]  

(3)

Secondary market sales no longer boost borrowing capacity. Indeed, selling too many assets now induces shirking. As a result, a banker will never issue a promise to sell more than a fraction \( \tilde{m} \) of his portfolio. As the previous section has shown, of course, the fact that he does not promise more does not mean he will not sell more ex-post.

The impact of secondary market sales on borrowing capacity is therefore as follows. If bankers are collateral-constrained (that is, \( a_b < \bar{a}_b(k_{R,b}, b_b, Q_a) \)), asset sales alleviate the borrowing constraint by improving the bank’s collateral position. When instead bankers are not collateral-constrained (that is, \( a_b > \bar{a}_b(k_{R,b}, b_b, Q_a) \)), then asset sales reduce the stake of the banker outcome of his risky investment and do not boost borrowing capacity.

But do bankers find it optimal to sell assets to alleviate borrowing constraints? It depends on the secondary market price. By selling a risky claim, the bank is able to issue \( Q_a - y_R(l) \) additional bonds. Upon investing this cash, each unit of investment can be used to back another \( y_R(l)\tilde{m} \) in bonds. By issuing \( \frac{(Q_a - y_R(l))}{1 - Q_by_R(l)\tilde{m}} \) in new bonds, the banker can thus increase investment by \( \frac{Q_a(Q_a - y_R(l))}{1 - Q_by_R(l)\tilde{m}} \). The cost is that the banker receives a return of \( Q_a \) rather than
the expected value $\hat{y}_R$. Bankers thus sells risky claims only if

$$
\begin{bmatrix}
\frac{Q_b \hat{y}_R - 1}{1 - Q_b \hat{y}_R(l) \hat{m}} \\
\text{Levered Return - Bond Repayment}
\end{bmatrix}
\cdot
\begin{bmatrix}
\frac{Q_a - y_R(l)}{\text{Debt Capacity of Risky Claim}}
\end{bmatrix}
\geq
\begin{bmatrix}
\hat{y}_R - Q_a
\end{bmatrix}
\begin{bmatrix}
\text{Secondary Market Discount}
\end{bmatrix}
$$

This condition implies a lower bound on the price of risky assets for trade to occur in secondary markets:

$$Q_a \geq Q_a(Q_b) \equiv \frac{\hat{y}_R - y_R(l) + y_R(l)(1 - \hat{m})\hat{y}_R Q_b}{Q_b [\hat{y}_R - y_R(l) \hat{m}]}.$$  \hfill (4)

Note that $Q_a(Q_b)$ is strictly decreasing in $Q_b$ and $Q_a(\frac{1}{y_R}) = \hat{y}_R$. That is, when $Q_b$ is high, borrowing capacity is valuable and banks sell claims at a discount; when $Q_b$ is at its lowest, bankers are willing to sell claims only at par. Going forward, it will be useful to distinguish two degrees of secondary market liquidity.

**Definition 3** (Secondary Market Liquidity). *Secondary market liquidity is high if $Q_a^* > Q_a(Q_b)$ and low if $Q_a^* = Q_a(Q_b)$.*

That is, secondary market liquidity is low if prices are such that bankers are exactly indifferent toward selling assets to increase borrowing. In this case, financiers receive all intermediation rents from secondary market trading. If instead secondary market liquidity is high, bankers strictly prefer to sell assets to increase borrowing capacity, and receive intermediation rents from doing so. As a result, bankers sell exactly $a_b^* = \tilde{a}_b(k_{R,b}, b_b, Q_a)$ claims. I fully characterize the optimal banker portfolio in the next section, where I study competitive equilibria.

### 1.2.5 Competitive Equilibria in the Static Model

I now turn to characterizing competitive equilibria in the static model. Because monitoring is socially efficient, I look for equilibria in which as many bankers as possible monitor. A complication is that the implementability constraint (IMP) cannot be verified ex-ante
because $Q_a$ is a function of the optimal banker portfolio. I therefore use a guess-and-verify approach to computing equilibria. Specifically, I first conjecture that the equilibrium secondary market price $Q^*_a$ does not exceed the upper bound $\bar{Q}_a$. Given this conjecture, all bankers monitor. I then compute the resulting equilibrium allocations, and verify whether $Q^*_a$ does indeed satisfy the implementability constraint (IMP). If the constraint is violated, I construct equilibria in which some bankers shirk.

**Benchmark Without Secondary Markets**

To understand the role of secondary markets, I begin by establishing a benchmark without secondary market trading. It is straightforward to show that bankers must always monitor in the absence of secondary markets. If bankers were to shirk on the equilibrium path, the solvency constraint would guarantee that the banker is exposed to all downside risk. Since shirking is inefficient, the banker elects to monitor. The key upshot is that secondary market trading is a necessary condition for shirking: investment efficiency falls only if bankers have an opportunity to sell off assets ex-post. Given that no banker shirks, the optimal portfolios of bankers and depositors are

$$k_{0R,b} = \frac{w_b}{1 - Q^0_b y_R(l) \tilde{m}}, \quad b^0_b = \frac{y_R(l) \tilde{m}' w_b}{1 - Q^0_b y_R(l) \tilde{m}}, \quad b^0_d = \frac{w_d}{Q^0_b}.$$  

Imposing the market clearing condition $b_b = b_d$ yields the equilibrium price

$$Q^0_b = \min \left\{ \frac{w_d}{(w_d + w_b) y_R(l) \tilde{m}}, \frac{1}{y_s} \right\}.$$  

Here, the min operator stems from a boundary constraint on the equilibrium price. In particular, depositors are indifferent between bonds and the safe technology when $Q_b = \frac{1}{y_s}$. Aggregate investment is

$$k^0_{R,b} = \min \left\{ W_d + W_b, \frac{y_s W_b}{y_s - y_R(l) \tilde{m}} \right\}.$$  

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An equilibrium without secondary markets always exists. Bankers do post asset-sale promises if they do not expect financiers to buy assets; financiers do not bid if bankers do not post promises. Active secondary markets thus require some degree of coordination between bankers and financiers.

**Proposition 2 (Existence of Equilibrium without Secondary Markets).** There always exists an equilibrium without trade on secondary markets.

*Proof.* See appendix.

I will show below that an equilibrium with active secondary markets may fail to exist. The above proposition above thus guarantees the existence of competitive equilibrium more generally. To focus on the role of secondary markets in financial intermediation, I assume that the equilibrium with active secondary markets is selected whenever it exists.

**Active Secondary Markets**

I now study competitive equilibria with active secondary markets. For ease of exposition, I focus on pure-strategy equilibria but allow different groups of bankers to pursue different strategies. There are, potentially, two groups of bankers: those who monitor and those who shirk. I refer to bankers who monitor as the *high type* and bankers who shirk as the *low type*. I denote the fraction of shirking bankers by $\Phi \in [0, 1]$. The definition of competitive equilibrium is as follows.

**Definition 4 (Competitive Equilibrium With Active Secondary Markets).** A pure-strategy competitive equilibrium with active secondary markets is a bond price $Q_b$, a set of quantities and bidding strategies for financiers $\{k_{S,f}, b_f, \{Q_a(\mu), a_f(\mu)\}_{\mu \in \mathbb{R}^2}\}$, a set of quantities for depositors $\{b_d, k_{S,b}\}$, a set of quantities and a monitoring decision for bankers $\{a_b, b_b, k_{S,b}, k_{R,b}, e, a_b\}$, a non-empty set of active secondary sub-markets $\mathcal{M}$, beliefs $\hat{\phi}(\mu)$ for each sub-market, and a fraction of shirking bankers $\Phi$ such that:

---

8Bankers that did not post a promise only sell (high-quality) assets at the expected value $\hat{y}_R$. As a result, financiers are indifferent between buying risky claims and investing in the safe technology. Moreover, bankers find it optimal to shirk and sell at this price because $\hat{y}_R > Q_a$. 

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(i) All agents optimize given prices, the set of active sub-markets, and the bidding behavior of all other agents.

(ii) Financier bids satisfy bid consistency in accordance with Definition 1.

(iii) Prices are such that the bond market and all active secondary sub-markets clear.

(iv) The monitoring decision of bankers is individually optimal.

(v) Beliefs are correct.

(vi) The competitive equilibrium is a called “full-monitoring equilibrium” if $\Phi = 0$ and a “shirking equilibrium” if $\Phi \in (0, 1]$. A “pooling equilibrium” is a shirking equilibrium in which high-type bankers and low-type bankers pool in the funding market. That is, they issue the same quantity of bonds $b$ and asset-sale promises $a$, and make the same investment $k$.

(vii) In a shirking equilibrium, bankers who monitor obtain the same expected utility as bankers who shirk.

In Appendix A.13 I show that there do not exist separating equilibria in which high-type bankers sell assets on secondary markets. The intuition for the result is as follows. If bankers who monitor were to trade on secondary markets, then by no-arbitrage financiers must offer a higher price in the high-type’s sub-market. By bid consistency, financiers offer the same high price to any banker posting a $\mu$ consistent with monitoring incentives. Low-type bankers can then profitably deviate to a slightly lower asset-sale promise and sell assets at the higher price. For this reason, I focus on pooling equilibria going forward.

I also distinguish equilibria by the degree to which the financial system is borrowing constrained.

**Definition 5 (Highly Constrained Financial System).** The financial system is **highly constrained** if the equilibrium bond price $Q_b^*$ satisfies $Q_b^* = \frac{1}{\tilde{y}_s}$ and $b_j(Q_b^*, Q_a^*) + b_b(Q_a^*, Q_b^*) < \frac{w_j}{Q_b^*}$.

The financial system is thus highly constrained when (i) depositors are exactly indifferent
between investing in risk-free bonds produced by intermediaries and directly investing in the safe technology, and (ii) the financial system nevertheless cannot absorb the entire wealth of depositors. This is the case when wealth of depositors is large relative to that of financiers and bankers.

Given these preliminaries, the goal is to characterize how secondary markets influence the volume and efficiency of investment in competitive equilibrium. I proceed in steps. I begin by characterizing optimal banker portfolios in both full-monitoring equilibrium and shirking equilibrium. I then study how changes in financier net worth affect equilibrium outcomes within in each class of equilibrium. Finally, I show that only shirking equilibria exist when financier net worth is above an endogenously determined threshold.

Consider the full-monitoring equilibrium first. The first step is to characterize the optimal bank portfolio. Because all bankers are symmetric and are presumed to monitor, is without loss of generality to focus on symmetric equilibrium strategies. As a result, there is a unique active sub-market and a unique marginal secondary market price $Q_a$. I denote equilibrium strategies and outcomes under full monitoring by the superscript $\ast$. To derive particularly simple expressions, I impose Assumption 2 from now on and let $y_{R}^l(l) = 0$. The main upshot is that the collateral shortfall now takes the form $\bar{a}_b(k_{R,b}, b_b, Q_a) = \frac{b_b}{Q_a}$. That is, to maximize borrowing capacity, the bankers sells assets until his secondary market revenue is exactly equal to his debt burden.

**Proposition 3** (Banker Portfolio in the Full-monitoring Equilibrium). *If secondary market liquidity is high, the optimal banker portfolio is*

\[
k_{R,b} = \frac{w_b}{1 - Q_bQ_a m}, \quad b_b = Q_a \tilde{m} k_{R,b}, \quad a_b = \tilde{m} k_{R,b}^\ast.
\]
If secondary market liquidity is low, the optimal banker portfolio satisfies

\[
k_{R,b} = \frac{w_b + Q_b(Q_a - y_R(l))a_b}{1 - Q_by_R(l)\bar{m}}, \quad b_b = \frac{y_R(l)\bar{m}w_b + (Q_a - y_R(l))a_b}{1 - Q_by_R(l)\bar{m}}
\]

and \( a_b = a_b \in [0, \bar{a}_b(k_{R,b}, b_b, Q_a)] \).

**Proof.** The banker promises to sell \( a_b = \bar{a}_b(k_{R,b}, b_b, Q_a) \) assets when secondary market liquidity is high so as to maximize borrowing capacity. Moreover, the borrowing constraint binds: \( b_b = \bar{b}_b(k_{R,b}, Q_a, \bar{a}_b) \). When instead secondary market liquidity is low, the banker is indifferent between issuing claims on secondary markets and retaining his entire portfolio. Hence, any asset sale between zero and the collateral shortfall \( \bar{b}_b(k_{S,b}, k_{R,b}, Q_a, \bar{a}_b) \) is consistent with banker optimality. The result then follows from imposing the budget constraint.

The degree of secondary market liquidity is a function of the relative net worth of bankers and financiers. In particular, secondary market liquidity is high if

\[
a_f(Q_b^{**}) > \frac{\bar{m}w_b}{1 - Q_b^{**}Q_a(Q_b^{**})\bar{m}};
\]

where \( Q_b^{**} \) is the bond price that clears the funding market given \( Q_a = Q_a(Q_b^{**}) \). That is, secondary market liquidity is high when there is excess secondary market demand when \( Q_a \) is at its lower bound. Since \( a_f \) is strictly increasing in \( w_f \), secondary market liquidity is high when \( w_f \) is large relative to \( w_b \). An implication is that financiers receive all rents from secondary markets when they are small relative to bankers, while bankers and financiers share secondary market rents when financiers are large. I show below that the allocation of intermediation rents across bankers and financiers will crucially determine the evolution of net worth.

To determine whether bankers will monitor in equilibrium, the key question is whether the equilibrium secondary market price is below the upper bound given in Proposition 1. Given that \( \bar{Q}_a(k_{R,b}, a_b) = \bar{y}_R - m \frac{k_{R,b}}{k_{R,b} - a_b} \) is a function of the banker’s portfolio, the optimal bank...
portfolio places bounds on $Q_a$.

**Corollary 3 (Bounding the Upper Bound).** $\bar{Q}_a(k_{R,b}, a_b) \in [\hat{y}^*_R, \hat{y}_R - m]$ in any equilibrium.

**Proof.** No banker promises to sell more claims than is optimal when secondary market liquidity is high. Moreover, bankers never short-sell risky assets. Hence $0 \leq a_b \leq \tilde{m} k_{R,b}$. Evaluating $\bar{Q}_a(k_{R,b}, a_b) = \hat{y}_R - m \frac{k_{R,b}}{k_{R,b} - a_b}$ at $(k_{R,b}, \tilde{m} k_{R,b})$ and $(k_{R,b}, 0)$ gives the result. □

Bankers thus shirk for sure when the secondary market price exceeds $\hat{y}_R - m$. The crucial implication is that $\frac{\hat{y}_R}{\hat{y}_R - m} > \hat{y}_S$. That is, the return on a high-quality claim purchased on secondary markets is strictly higher than the return of the safe technology even if the secondary market price is high enough to induce shirking. But this means that sufficiently wealthy financiers may bid up secondary market prices enough to render full-monitoring equilibria unsustainable. The next step therefore is to characterize shirking equilibria.

There are two types of bankers in a shirking equilibrium – those who shirk and those who monitor. Equilibrium strategies are now symmetric within type. I denote the equilibrium portfolio of the high type by superscript $H$ and that of the low type by $L$. Because the equilibrium features pooling in the funding market, high-type and low-type bankers issue the same amount of bonds, make the same asset-sale promises and invest the same amount of capital in the risky technology. Moreover, all bankers are symmetric in terms of their investment opportunities and net worth. The only way to sustain the coexistence of the two types is for all bankers to be indifferent between shirking and monitor. As a result, the secondary market price must exactly equal the upper bound $\bar{Q}_a$ defined in Proposition 1. Shirking equilibria can therefore also be interpreted as bankers’ playing a mixed strategy.

**Lemma 5 (Secondary Market Price in Shirking Equilibrium).** In a shirking equilibrium, the implementability constraint is just binding and the secondary market price satisfies

$$Q_a = \bar{Q}_a(k_{R,b}^H, a_b^H) = \hat{y}_R - m \left( \frac{k_{R,b}^H}{k_{R,b}^H - a_b^H} \right).$$

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The upper bound $\overline{Q}_a$ is a function of the high-type’s portfolio. In particular, it is decreasing in $a_b$. This leaves open the possibility that the high-type banker will withdraw assets from secondary markets so as to receive a higher price. Yet precisely because prices are bounded above by a continuous function of $a_b$, any such deviation cannot lead to a discrete price increase, even if the banker receives the highest possible price after the deviation. Moreover, withdrawing assets from secondary markets will typically lead to higher excess demand on secondary markets. As will become clear, higher excess demand implies more shirking in equilibrium, and thus strengthens the key results. For simplicity, I therefore focus on shirking equilibria in which the high-type banker chooses the same portfolio as in an effort equilibrium. This can be supported in an equilibrium by financiers offering the same $Q_a$ in all sub-markets with $a_b \leq a^*_b$. Because the low type differs only in the amount of assets sold ex-post and the monitoring decision, equilibrium portfolios are therefore as follows.

**Proposition 4** (Optimal Banker Portfolios in Shirking Equilibrium). The high type’s optimal portfolio is

$$k^H_{R,b} = k^*_R, \quad b^H_b = b^*_b, \quad a^H_b = a^*_b = a^*_L.$$

The low type’s optimal portfolio is

$$k^L_{R,b} = k^H_{R,b}, \quad b^L_b = b^H_b, \quad a^L_b = a^H_b = a^*_b, \quad a^L_b = k^L_{R,b}.$$  

The fraction of low-quality claims traded on secondary markets is

$$\phi = \frac{\Phi a^L_b}{\Phi a^L_b + (1 - \Phi)a^H_b},$$

where $\phi \geq \Phi$ because the low type sells more assets than the high type.

The optimal portfolios of all agents are linear in net worth. This permits straightforward aggregation. The market clearing conditions are as follows.

---

9More generally, an open question is how prices are constructed upon deviations to inactive sub-markets. In the model, prices are determined by market tightness. Yet because there is no free entry, off-equilibrium market tightness cannot be determined by a zero-profit condition as in Guerrieri, Shimer, and Wright (2010). I sidestep this issue by focusing on the benchmark equilibrium that appropriately minimizes the degree of equilibrium shirking, and thus understates the key results of the paper.
(i) In a full-monitoring equilibrium with high secondary market liquidity, the market clearing conditions are:

Primary Market: \[
\frac{Q_a \tilde{m} w_b}{1 - Q_b Q_a \tilde{m}} + \frac{\gamma y_R(l) w_f}{Q_a - Q_b \gamma y_R(l)} = \frac{w_d}{Q_b}
\]

Secondary Market: \[
\frac{\tilde{m} w_b}{1 - Q_b Q_a \tilde{m}} = \frac{w_f}{Q_a - Q_b \gamma y_R(l)}
\]

(ii) In a full-monitoring equilibrium with low secondary market liquidity, the market clearing conditions are:

Primary Market: \[
\frac{y_R(l) \tilde{m} w_b + (Q_a - y_R(l)) a_b}{1 - Q_b y_R(l) \tilde{m}} + \frac{\gamma y_R(l) w_f}{Q_a - (1 - \phi) Q_b \gamma y_R(l)} = \frac{w_d}{Q_b}
\]

Secondary Market: \[
a_b = \frac{w_f}{Q_a - (1 - \phi) Q_b \gamma y_R(l)}, \quad \text{where} \quad Q_a = Q_a(Q_b).
\]

(iii) In a shirking equilibrium with high secondary market liquidity, the market clearing conditions are:

Primary Market: \[
\frac{Q_a \tilde{m} w_b}{1 - Q_b Q_a \tilde{m}} + \frac{\gamma (1 - \phi) y_R(l) w_f}{Q_a - (1 - \phi) Q_b \gamma y_R(l)} = \frac{w_d}{Q_b}
\]

Secondary Market: \[
\Phi w_b + (1 - \Phi) \tilde{m} w_b = \frac{w_f}{1 - Q_b Q_a \tilde{m}} \frac{Q_a - (1 - \phi) Q_b \gamma y_R(l)}{Q_a - (1 - \phi) Q_b \gamma y_R(l)}
\]

(iv) In a shirking equilibrium with low secondary market liquidity, the market clearing conditions are:

Primary Market: \[
\frac{y_R(l) \tilde{m} w_b + (Q_a - y_R(l)) a_b}{1 - Q_b y_R(l) \tilde{m}} + \frac{\gamma y_R(l) w_f}{Q_a - (1 - \phi) Q_b y_R(l)} = \frac{w_d}{Q_b}
\]

Secondary Market: \[
\Phi \left( \frac{w_b + Q_b (Q_a - y_R(l)) a_b^H}{1 - Q_b y_R(l) \tilde{m}} \right) + (1 - \Phi) a_b^H = \frac{w_f}{Q_a - (1 - \phi) Q_b \gamma y_R(l)}, \quad \text{where} \quad Q_a = Q_a(Q_b) = \tilde{Q}_a(k_{R,b}^H, a_b^H).
\]

The fraction of shirking bankers \( \Phi \) affects market clearing in two ways. First, it impacts the
number of assets sold on secondary markets because low-type bankers sell more risky claims than high-type bankers. All else equal, increased shirking thus pushes down secondary market prices. Second, because \( y'_R(l) = 0 \), financiers cannot use low-quality claims as collateral for bonds. They thus borrow only against the fraction of high-type loans \((1 - \phi)\) that they receive on secondary markets. This effect reduces the demand for risky assets and shrinks the supply of risk-free bonds. To economize on notation going forward, I use the following definition.

**Definition 6 (Aggregate Leverage Ratios).** The aggregate leverage ratios of financiers and bankers are, respectively,

\[
\lambda_f \equiv \frac{1}{Q_a - (1 - \phi)Q_b \gamma} \quad \text{and} \quad \lambda_b \equiv \frac{\Phi + (1 - \Phi)\tilde{m}}{1 - Q_b Q_a \tilde{m}}
\]

The next step is to characterize equilibrium outcomes. I focus on how the distribution of net worth shapes the volume and efficiency of investment. Throughout, I denote the distribution of net worth by \( w \equiv (w_d, w_b, w_f) \), the relative net worth of financiers by \( \tilde{w} = \frac{w_f}{w_b} \), and expected output by \( \hat{Y} \equiv [\Phi y'_R + (1 - \Phi)\hat{y}_R]k_{R,b} \). I first show how changes in financier net worth affect output and investment within each class of equilibrium. I then show that only shirking equilibria exist when financier net worth exceeds a threshold. A large financier sector therefore leads to falling investment efficiency.

**Proposition 5 (Financier Net Worth and Equilibrium Outcomes).** Assume that \((w_d, w_b)\) is such that investment is inefficient in the absence of secondary markets. Then:

(i) In a full-monitoring equilibrium with high secondary market liquidity, the secondary market price \( Q_a \), total investment \( k_{R,b} \) and expected aggregate output \( \hat{Y} \) are increasing in financier net worth \( w_f \).

(ii) In a full-monitoring equilibrium with low secondary market liquidity, the secondary market price is increasing in \( w_f \). Aggregate investment \( k_{R,b} \) and aggregate expected output \( \hat{Y} \) are strictly increasing in \( w_f \) if the financial system is highly constrained.

(iii) In a shirking equilibrium, the share of shirking bankers \( \Phi \) is strictly increasing in \( w_f \).
Aggregate expected output is strictly decreasing in $w_f$ if the financial system is highly constrained, or if financiers weakly prefer to not borrow.

Proof. See appendix.

The intuition behind the first part of the proposition is straightforward. As financier net worth increases, so does the demand for secondary market assets. Secondary market prices appreciate. When prices increase, bankers receive more collateral per risky claim sold. Borrowing and investment increase. Since all bankers monitor, expected aggregate output also increases. The difference between the first and the second part of the proposition is that, in a low-liquidity equilibrium, financiers receive all rents from secondary market trading. In this region of the state space, increases in financier wealth may increase the total supply of bonds more than banker’s borrowing capacity, leading to drop in bond prices that crowds out banker borrowing. Nevertheless, increased secondary market demands leads to increase in the secondary market price and, as financiers grow even larger, investment volumes grow again. As the next proposition shows, the social benefits of increased financier net worth can be large.

**Corollary 4** (The Social Value of Financier Net Worth). Fix a full-monitoring low-liquidity equilibrium with a highly constrained financial system. Then if $y_S < \bar{y}_S$ there exists a $\Delta > 0$ such that re-allocating $\Delta$ units of net worth from bankers to financiers strictly increases investment and expected output.

Proof. See appendix.

Reallocations of net worth towards financiers spur investment disproportionately when the financial sector is highly constrained ($Q^*_b = \frac{1}{y_S}$) and when intermediation is very valuable to depositors ($y_S < \bar{y}_S = 1$). Financiers are able to lever more than bankers when bond prices are high because they are not subject to the moral hazard problem at the investment stage. This advantage more than outweighs the direct costs of reducing bank net worth when bond prices are high. As a result, putting net worth in the hands of financiers allows
for more investment in the aggregate than putting it in the hands of bankers. Growing secondary market volumes can thus trigger a credit boom that is larger than if bank net worth were to grow instead. This social value of financier net worth is reflected in the returns on equity earned by financiers and bankers.

**Proposition 6 (Expected Return on Intermediary Equity).** Fix a full-monitoring equilibrium with low-liquidity. The expected return on equity earned by bankers and financiers, respectively, is

\[
\hat{\text{ROE}}_b = \frac{\hat{y}_R - y_R(l)\hat{m}}{1 - Q_b^* y_R(l)\hat{m}} \quad \text{and} \quad \hat{\text{ROE}}_f = \frac{\hat{y}_R - y_R(l)}{Q_a(\hat{Q}_b^*) - Q_b y_R(l)}
\]

Moreover, \(\hat{\text{ROE}}_f > \hat{\text{ROE}}_b\) if \(Q_b^* > 1\) and \(\text{ROE}_f \leq \text{ROE}_b\) if \(Q_b^* \leq 1\).

**Proof.** See appendix. \qed

That is, financiers receive higher returns on equity than bankers when the financial system is highly constrained and depositors pay a premium for intermediation services. This is the case even though financiers cannot invest in the risky technology directly, and thus are technologically inferior to bankers. In the dynamic model in Section 1.3, I show that the large rents earned by financiers when the aggregate net worth of intermediaries is low leads financiers to grow disproportionately when they are small initially.

The downside of increased financier net worth is that appreciating secondary market prices eventually induce some bankers to shirk.

**Corollary 5 (Excessively Large Financier Net Worth).** Suppose that the net worth of depositors and bankers \((w_d, w_b)\) is such that bond price in the absence of secondary market \(Q_b^0\) is such that \(Q_a(\hat{Q}_b^0) < \hat{y}_R - \hat{m}\). Then there exists a threshold level of financier net worth \(\hat{w}_f(w_d, w_b) \geq 0\) such that the competitive equilibrium is a full-monitoring equilibrium if \(w_f \leq \hat{w}_f(w_d, w_b)\) and a shirking equilibrium if \(w_f > \hat{w}_f(w_d, w_b)\).

Why does the price adjustment mechanism break down in a shirking equilibrium? The implementability constraint (IMP) now restricts the appreciation of secondary market prices.
Banker would prefer to sell and shirk if $Q_a$ were to grow further. But if all bankers continue to monitor, $Q_a$ cannot stay constant either – financier wealth is increasing, and so secondary markets would no longer clear. The solution is to have an increasing number of bankers shirk. Because low-type bankers sell more claims than high types, markets can clear at a constant price. This is the intuition behind the third part Proposition 5. Note that equilibrium shirking occurs even there is no financier irrationality or differential beliefs. Because financiers earn intermediation rents when purchasing assets from high-type bankers, they continue to earn rents even when some bankers shirk.

Why the caveat that $Q_a(Q^0_b) < \hat{y}_R - m$? If this inequality were not satisfied, then bankers would never sells assets at a price that does not induce shirking if secondary markets were active. But if bankers shirk as soon as there is trade on secondary markets, then financiers do not buy assets in the first place. To see why, recall that bankers only sell assets if $\bar{Q}_a \geq Q_a(Q_b)$, while $\bar{Q}_a \leq \hat{y}_R - m$. Because $Q^0_b$ is decreasing in $w_b$ and $Q_a(Q_b)$ is decreasing in $Q_b$, this implies that there are no equilibria with secondary market trading when $w_b$ is large relative to $w_d$. That is, bankers use secondary markets only if there is sufficiently strong depositor demand.

The next result shows that the harmful effects of excessive financier net worth may be severe in equilibria with active secondary markets.

**Corollary 6** (Pareto-improving Reductions in Financier Net Worth). Consider a shirking equilibrium in which either (i) financiers do not borrow, or (ii) the financial system is highly constrained. Then a partial destruction of financier net worth $w_f$ is Pareto-improving.

**Proof.** See appendix. □

A pecuniary externality is at work. Increased financier wealth grows secondary market demand, but secondary market prices cannot appreciate beyond the upper bound $\bar{Q}_a$. When prices reach this upper bound, markets clear through quantities, inducing some bankers to shirk. Financiers impose an externality on each other by contributing to a decline in the average quantity of assets traded on secondary markets. This negative externality is severe.
enough that financiers can be made better off by a uniform destruction of their wealth. Moreover, falling asset quality exposes the financial system to more risk, creating financial fragility.

Figure 2 provides a numerical illustration of the equilibrium effects of $w_f$. Growing financier net worth initially increases investment and expected output, but gradually induces bankers to shirk. As a result, investment efficiency falls. Throughout the figure, red corresponds to a shirking equilibrium, and blue to a full-monitoring equilibrium. The top left panel depicts asset prices, with the upper line representing the risky claim price $Q_a$ and the lower the bond price $Q_b$. As financier net worth increases, the secondary market price increases. In the full-monitoring equilibrium, this leads to a boom in investment and increases in expected output. As $Q_a$ continues to rise, however, the full-monitoring equilibrium can no longer be
sustained. In the shirking equilibrium, investment is now flat but expected output declines, as a larger fraction of bankers begins to shirk. This can be seen in the figure on the bottom left. The top right panel also shows the increase in aggregate risk, with the dotted lines depicting aggregate output after a good and a bad shock. Given that low-quality assets are more exposed to downside risk, increases in financier wealth lead to poorer worst-case outcomes. The two last figures in the bottom row show the risk exposure of both classes of financial intermediary. The solid line depicts the expected net worth of an intermediary at the end of the period, with the dotted lines corresponding to a high and low aggregate shock, respectively. As \( w_f \) increases, financiers take on more and more risk. Ultimately, financiers are the only agents in the economy exposed to any risk. For financiers, expected net worth is equivalent to expected utility. In a shirking equilibrium, increased financier wealth therefore reduces expected financier utility.

Overall, secondary markets play a dual role. If financier wealth is not too large, then secondary market trading expands investment by more than banker net worth. If instead financier wealth is large, then secondary market trading leads to deteriorating investment efficiency with potentially severe welfare consequences. The question is whether financier net worth might end up large enough to harm investment efficiency. The next question provides an affirmative answer in a dynamic framework.

### 1.3 A Dynamic Model of Secondary Markets

I now incorporate the static model into a dynamic setting to study the endogenous evolution of the net worth distribution. The key question is whether the net worth distribution moves towards regions of the state space in which only shirking equilibria can be sustained, even when starting out in the full-monitoring region.

Time is discrete and runs from 0 to \( T \leq \infty \). A generic period is indexed by \( t \). The model economy is populated by overlapping generations of financiers and bankers, each of whom
lives for two periods, and short-lived depositors, each of whom lives one period. I refer to intermediaries in the first period of their life as the young, and to those in the second period as the old. There are two goods: a consumption good and an intermediary net worth good. Only the consumption good can be consumed. Intermediary net worth is special in that bankers and financiers must use net worth in order to intermediate and invest. Every generation of agents is born with an endowment of the consumption good. Only the initial generation of intermediaries are born with an endowment of net worth. When young, intermediaries and depositors play the intermediation game described in the static model. Before consuming their end-of-period net worth, they have the opportunity to sell it to the young. In this intergenerational net worth market, young intermediaries pool their endowment and instruct a market maker to purchase the old intermediaries’ equity capital. The market maker then approaches each old intermediary individually and bargains over the equity capital. If a trade is agreed, the old consume the proceeds from the sale and the market maker distributes the equity capital evenly to all young intermediaries. If no trade is agreed, the old consume their equity capital and the young do not receive any equity capital from the old.\(^{10}\) I assume that young generation makes a take-it-or-leave to the old. The old therefore always receive the consumption value of their equity capital.\(^{11}\)

This construction implies that the objective function of a young intermediary is to maximize expected end-of-life net worth. The dynamic model then is equivalent to repeating the static model period-by-period, with the evolution of the net worth distribution linking equilibrium outcomes across periods. This allows me to parsimoniously illustrate the key forces that shape the evolution of net worth. In Appendix A.14 I consider a variant of the model in which the old make take-it-or-leave-it offers to the young, and show that it can generate the same qualitative dynamics as the baseline model. I use the following definitions.

**Definition 7** (Credit Booms). A credit boom of length \(t\) is a sequence of \(t\) periods in which

\(^{10}\)The role of the market maker is solely to make sure that each intermediary in every generation starts out with the same net worth. As a result, I do not have to keep track of a wealth distribution for the same type of agents. All results go through without this assumption.

\(^{11}\)I assume that if a generation of intermediaries has zero net worth at the end of their life, then the new generation receives start-up funds of \(\epsilon_0\). This ensures that both types of intermediaries are always active.
the total net worth of the financial sector $w_f + w_b$ and the total amount of risky investment $k_{R,b}$ increases every period. A secondary market credit boom is a credit boom in which the relative net worth of financiers $\hat{w}$ increases in every period. A destabilizing secondary market credit boom is a secondary market credit boom in which the economy transitions from a full-monitoring equilibrium to a shirking equilibrium.

A necessary condition for credit booms to arise is a sequence of good aggregate shocks. Only when the net worth of the financial system grows can credit volumes increase. Whether the relative size of financiers increases – giving rise to a secondary market credit boom – will depend on the equilibrium allocation of risk. The next proposition characterizes the equilibrium evolution of relative financier net worth.

**Proposition 7** (Equilibrium Evolution of Relative Net Worth). Let $\hat{w}'(z|w)$ denote relative net worth of financiers tomorrow conditional on productivity shock $z$ and today’s wealth distribution $w$.

(i) The net worth of financiers and bankers increases upon a good aggregate shock and decreases upon a bad aggregate shock in any equilibrium.

(ii) If $w$ is such that today’s equilibrium is *full monitoring* with high secondary market liquidity, then:

$$
\hat{w}'(h|w) = \left[ \frac{\hat{m}(y_R(h) - \gamma(w)y_R(l))}{(1 - \hat{m})y_R(h)} \right].
$$

(iii) If $w$ is such that today’s equilibrium is *full monitoring* with low secondary market liquidity, then:

$$
\hat{w}'(h|w) = \frac{(y_R(h) - \gamma(w)y_R(l))\lambda_f(w)\hat{w}}{y_R(h) - y_R(l)\hat{m} - (1 - \hat{m})y_R(l)(y_R(h) - \hat{y}_R)}.
$$

(iv) If $w$ is such that today’s equilibrium is *shirking* with high secondary market liquidity, then:

$$
\hat{w}'(h|w) = \left[ \frac{\Phi y_R(h) + (1 - \Phi)\hat{m}(y_R(h) - \gamma(w)y_R(l))}{(1 - \hat{m})(\Phi y'_R + (1 - \Phi)y_R(h))} \right].
$$
(v) If \( w \) is such that today’s equilibrium is shirking with low secondary market liquidity, then:

\[
\tilde{w}'(h|w) = \frac{\left( \phi y_R(h) + (1 - \phi)\left( y_R(h) - \gamma(w)y_R(l) \right) \right)}{\Phi \tilde{m} y_R(l)} \lambda_f(w) \tilde{w} - \frac{(1 - \tilde{m})y_R(l)}{y_R - y_R(l)\tilde{m}} \lambda_f(w) \tilde{w}
\]

Proof. Follows directly from the optimal intermediary portfolios and exploiting the secondary market clearing condition to cancel out \( k_{R,b} \) when liquidity is high.

It is easy to verify that the evolution of net worth in a full-monitoring equilibrium is equal to that in shirking equilibrium when \( \Phi = 0 \). Moreover, the relative net worth of financiers grows faster after a good shock in a shirking equilibrium, holding secondary market liquidity fixed. The reason is that bankers sell off more risk exposure in a shirking equilibrium. The next examples provide some intuition as to these results.

Example 1 (High Liquidity and No Borrowing by Financiers). In a full-monitoring equilibrium in which secondary market liquidity is high and financiers do not borrow, the law of motion for relative net worth is:

\[
\tilde{w}'(z|w) = \frac{\tilde{m}}{1 - \tilde{m}} \quad \text{and} \quad g(\tilde{w}) = 0.
\]

When secondary market liquidity is high and financiers do not borrow, the relative wealth of financiers is fully pinned down by the severity of the banker’s moral hazard problem. Specifically, financiers take on a fraction of \( \tilde{m} \) of aggregate risk exposure, and bankers take on the remaining \( (1 - \tilde{m}) \). A given aggregate shock therefore scales the wealth of bankers and financiers up or down while leaving relative net worth unaltered. Perhaps contrary to intuition, financiers end up being relatively wealthy when the banker’s moral hazard problem is not too tight. The intuition is that collateral is valuable when bank’s can issue a large quantity of bonds per dollar of collateral. Bankers thus have strong incentives to sell assets to financiers so as to increase borrowing capacity.

Example 2 (High Liquidity and Fully Leveraged Financiers). In a full-monitoring equilib-
rium in which secondary market liquidity is high and financiers are fully levered, the law of motion for relative net worth is:

$$\ddot{w}'(z|w) = \frac{\bar{m}(y_R(z) - y_R(l))}{(1 - \bar{m})y_R(z)}$$

and

$$g(\bar{w}) = 0.$$

When financiers are fully leveraged, they are exposed to more risk. To borrow, they pledge $y_R(l)$ to bondholders, and must repay this amount in any state of the world. As a result, their relative net worth is lower than when they are not levered. Because bond prices decrease during booms, financier leverage declines as well. Hence, the relative net worth of financiers grows during credit booms given that secondary market liquidity is high. Of course, secondary market liquidity is high only when financiers are sufficiently large to begin with. The question then is whether financiers may grow to be large even when they are small at first. To this end, I now characterize conditions under which relative financier net worth grows in a low-liquidity equilibrium.

**Corollary 7** (Growth Rate of Relative Financier Net Worth With Low Liquidity). When secondary market liquidity is low, the growth rate of relative financier net worth in a full-monitoring equilibrium is strictly positive upon a positive shock if and only if

$$
\frac{(1 - \bar{m})y_R(l)}{\bar{m}(y_R(h) - y_R(l)1 - \frac{\bar{m}y_R(l)}{1 - Q_by_R(l)m})} - \frac{\gamma(s)y_R(l)}{1 - \bar{m}} = ROE_b(h)
$$

This inequality holds strictly for any $\bar{w}$ if $Q_b \geq 1$.

**Proof.** Follows directly from Proposition 6. \qed

The left-hand side of the inequality is the degree of risk transfer from bankers to financiers. It is increasing in relative financier net worth and financier leverage because the ability of financiers to take on credit is risk is limited by their wealth scaled by leverage. The right hand side is the difference between the state-$h$ return on equity achieved by bankers and financiers, respectively. Proposition 6 showed that the right-hand side is strictly negative.
Moreover, the left-hand side is strictly positive. No matter how small $w_f$ is initially, the relative net worth of financiers thus grows as long as $Q_b$ is sufficiently large.

More generally, relative financier net worth thus grows in a low-liquidity equilibrium when the aggregate net worth of the financial system is small relative to depositor net worth, or when financiers are not too small to begin with. Moreover, the relative net worth of financiers grows even when $w_f$ is vanishingly small so long as interest rates are sufficiently low. The reason is that financiers can leverage more than bankers when interest rates are low. A financier can pledge the full worst-case payoff a risky loan $y_R(l)$, while a banker can only pledge $\tilde{m}y_R(l)$. This borrowing advantage translates into a disproportionate advantage for financiers in acquiring aggregate risk exposure. For any $(w_f, w_b)$, there exists a $w_d$ large enough such that $Q_b \geq 1$ in equilibrium. Increased demand for financial intermediation may therefore spur secondary market booms. Caballero, Farhi, and Gourinchas (2008) and Krishnamurthy and Vissing-Jorgensen (2015) argue that this pressure existed in the run-up to the 2008 financial crisis. Figures 3 and 4 depict the importance of initial conditions graphically. I plot the evolution of financier and banker net worth after a sequence of positive aggregate shocks. In both figures, the left panel depicts a baseline scenario in which financier net worth is smaller than bank net worth initially, but grows to be larger over time. The right panel depicts deviations from this baseline. Figure 3 shows the effect of a reduction in initial financier wealth. This reduction leads to less risk being transferred to financiers. As a result, financier net worth no longer catches up with banker net worth.

Figure 3 shows the effect of a reduction in depositor net worth. Lower depositor net worth causes a fall in the equilibrium bond price. The resulting decrease in financier leverage induces a disproportionate fall in financiers’ return on equity and total purchases of risky assets. Given suitable initial conditions, the model can therefore give rise to secondary market credit booms — period of credit growth during which financier net worth grows disproportionately. Furthermore, starting out in an equilibrium in which financiers borrow and moving to one in which they do not, relative net worth must grow upon a good shock. It follows that a series of good shocks pushes the economy towards the shirking region, with
Figure 3
REDUCTION IN $w_f^0$

Baseline

Low Initial $w_f$

Notes: Baseline parameter values: $\pi_h = 0.8$, $y_R(l) = 0.5$, $y_R(h) = 1.2$, $\tilde{m} = 0.82$. Initial net worth distribution: $(w_d, w_b^0, w_f^0) = (25, 0.5, 0.35)$. Comparative static: $w_f^0$ from 0.3 to 0.15.

Figure 4
REDUCTION IN $w_d$

Baseline

Low $w_d$

Notes: Baseline parameter values: $\pi_h = 0.8$, $y_R(l) = 0.5$, $y_R(h) = 1.2$, $\tilde{m} = 0.82$. Initial net worth distribution: $(w_d, w_b^0, w_f^0) = (25, 0.5, 0.35)$. Comparative static: $w_d$ from 25 to 5.
growing secondary market prices leading credit standards to deteriorate, even when starting out in the full-monitoring region. That is, given appropriate initial conditions, the model admits secondary market credit booms.

The next question is whether the model admits destabilizing secondary market credit booms. To answer this question, the next proposition provides conditions under which a positive shock to the net worth of both bankers and financiers leads to an increase in secondary market prices and/or the fraction of shirking bankers. The general theme is that this is the case when the growth rate of relative financier net worth \( g(\tilde{w}) \) is sufficiently large.

**Proposition 8** (Relative Net Worth and Equilibrium Outcomes). Let \( Q^*_b(\Phi, Q_a, w) \) denote the bond pricing function that clears bond markets for a given fraction of shirking bankers \( \Phi \), secondary market price \( Q_a \) and net worth distribution \( w \). Consider a positive shock \( \xi \) to financier and banker net worth.

1. If secondary market liquidity is high and financiers are fully levered, then \( Q_a \) (in a full-monitoring equilibrium) and \( \Phi \) (in a shirking equilibrium) are increasing in \( \xi \) if and only if
   \[
g(\tilde{w}) \geq \left( \frac{Q^*_b}{\partial \xi} \right) \lambda_f (Q^*_a \tilde{w} - y_R(l)) .
\]

2. If secondary market liquidity is high and financiers do not borrow, then \( Q_a \) (in a full-monitoring equilibrium) and \( \Phi \) (in a shirking equilibrium) are increasing in \( \xi \) if and only if
   \[
g(\tilde{w}) \geq \left( \frac{Q^*_b}{\partial \xi} \right) \tilde{w} .
\]

3. \( \frac{Q^*_b}{\partial \xi} \leq 0 \) in any full-monitoring equilibrium.

4. If secondary market liquidity is low, \( Q_a \) is increasing in \( \xi \) in any full-monitoring equilibrium. If secondary market liquidity is low and the financial system is highly constrained, then \( \Phi \) is increasing in \( \xi \) if
   \[
g(\tilde{w}) \geq 0 .
\]
Proof. See appendix.

Because $Q^*_b \leq 0$ the secondary market price appreciates during booms with high-liquidity as long as the relative net worth grows weakly and $\tilde{w} \geq \frac{w_0(x)}{Q^*_a} \in (0, 1)$. When secondary market liquidity is low, in turn, the secondary market price always appreciates. Secondary markets may thus be destabilizing in that the economy transitions into a shirking equilibrium over time.

1.3.1 Characteristics of Credit Booms

The last section showed that the model admits destabilizing secondary market credit booms. I characterize the properties of such booms in this section. I do so by computing equilibrium outcomes as a function of a time path for the exogenous shock $z$ and the initial wealth distribution $w^0 = (w^0_d, w^0_b, w^0_f)$. I simulate the economy for $T$ periods. The initial $T_{boom}$ shocks are good shocks. The next $T_{crisis}$ shocks are negative. The remaining shocks are good.

Figure 5 depicts a destabilizing secondary market credit boom. I simulate the economy for 11 periods – an initial period, 8 positive shocks, a single negative shock, and then another positive shock. Financiers and bankers each start out with 0.5 units of net worth. Initial conditions are such that the economy starts out in a full-monitoring equilibrium. The left panel plots the evolution of net worth over time. There is a rapid build-up of net worth in the aggregate, with financiers growing faster. When a negative shock occurs, financier net worth collapses sharply because financiers are disproportionately exposed to risk. Banker net worth drops only moderately because financiers provide partial insurance to bankers. The middle panel plots the evolution of investment – equivalently, credit – over time. The blue line depicts total investment and the red line depicts the fraction of investment that goes to low-quality projects because bankers do not monitor. Initially all bankers monitor and there is no investment in low-quality projects. Over time, however, continued financier growth pushes the economy into a shirking equilibrium. As a result,
the fraction of investment that flows to low-quality increases and grows steadily during
the boom. In the aftermath of the crisis, investment falls. Yet because banker net worth
only falls some, credit volumes recover quickly. The right panel plots the evolution of
output. The solid line depicts actual output in the model economy. The dashed line depicts
output in a fictitious economy in which capital accumulation is unaltered but all bankers
are forced to monitor. During the boom phase, output increases steadily. During the crisis,
output collapses sharply. As the comparison between the solid and dashed lines shows,
almost one third of the drop is accounted for by falling credit quality over the course of the
boom. Growing secondary markets can therefore generate credit booms that end in sharp
crisis.

Figure 5
SECONDARY MARKET CREDIT BOOM WITH LOW $\tilde{m}$

![Figure 5](image)

Notes: Parameter values: $\pi_h = 0.65, y_R(l) = 0.4, y_R(h) = 1.5, \tilde{m} = 0.82$. Initial net worth distribution: $(w^0_b, w^0_f) = (0.5, 0.5)$. Depositor wealth: $w_d = 450$.

Figure 6 shows the importance of the moral hazard parameter $\tilde{m}$ for the dynamics of
secondary market booms. While I set $\tilde{m} = 0.82$ in Figure 5, I now set $\tilde{m} = 0.85$. Recall
that larger values of $\tilde{m}$ mean that the banker’s moral hazard problem is less severe and
bankers can leverage each unit of net worth more. The time path of aggregate shocks and
initial conditions are the same for both simulations. Three observations stand out. First,
financier net worth grows faster when $\tilde{m}$ is large. This is perhaps counterintuitive given
that increases in $\tilde{m}$ principally allow bankers to lever more. In equilibrium, however, the
portfolios of bankers and financiers are intertwined. When $\tilde{m}$ is high, the shadow value
of collateral is high for bankers. When banker net worth is scarce, bankers increase their collateral position by selling claims on secondary markets. Increases in $\tilde{m}$ thus boost supply and reduce prices in secondary markets. This allows financiers to lever more and purchase more risk exposure on secondary markets. In equilibrium, increased scope for bank may lead actual financier leverage to increase by more than actual bank leverage. Conditional on a good shock, financiers thus grow faster than bankers.

**Figure 6**

**SECONDARY MARKET CREDIT BOOM WITH HIGH $\tilde{m}$**

Second, aggregate investment also increases faster because bankers can lever each unit of collateral acquired on secondary markets by more. Third, increased supply of secondary market assets means that the fraction of low-quality loans is lower and so investment efficiency is higher. Moreover, financiers borrow *more* when $\tilde{m}$ is high because secondary market prices are relatively low. Because bankers sell off more risk exposure when $\tilde{m}$ is high, they suffer less in a crisis, and financier net worth declines disproportionately. Nevertheless, looser banker constraints allow output and investment efficiency to increase throughout even as volatility grows.

Next, I turn to the effects of boom *duration*. Figure 7 plots two simulated time paths for identical parameters and initial conditions. The only difference being the timing of the negative shock. Solid lines depict the case where the negative shock hits in period 9,
while dashed lines depict the case where the negative shock hits in period 8. The left panel shows the evolution of intermediary net worth. The middle panel plots total investment and low-quality investment. The right panel plots output. Two observations stand out. First, the fraction of low-quality investment is increasing in the duration of the boom, as is the relative net worth of financiers. Second, the decline in output is increasing in duration—the peak is higher and the trough is lower. Longer booms generate deeper recessions because of increased origination of low-quality credit.

Finally, I study how the dynamics of aggregate productivity during a crisis episode shape the evolution of net worth and the recovery from a crisis. Specifically, Figure 8 plots two simulations that differ only in the number of negative aggregate shocks that hit the economy. The solid line depicts a simulation in which a single negative shock hits in period 8. The dashed line depicts a simulation in which there are negative shocks in period 8 and 9. The left panel depicts the evolution of net worth, and shows how the model generates the migration of risk exposure back onto bank balance sheets once the initial negative shock has depleted financier net worth. In particular, the second negative shock leads to a dramatic fall in bank net worth, even as total investment falls. This is consistent with the evidence in Krishnamurthy, Nagel, and Orlov (2014) that credit conditions were poor in the aftermath of the 2008 financial crisis because bankers had to carry more risk exposure.
on their balance sheets. The second negative shock can be thought as representing the endogenous amplification of the initial shock through the real side of the economy. This could be due to foreclosure externalities in housing markets or deteriorating labor market conditions that force increased defaults among outstanding loans.

**Returns on Equity during Secondary Market Credit Booms**

Destabilizing secondary market credit booms are driven by a growing imbalance in the net worth of bankers and financiers. Do bankers and financiers have incentives to “correct” these imbalances by re-allocating equity across intermediaries? If issuing (inside) equity were costless, this would be the case whenever the equilibrium return on financier equity is below that of bankers. The next proposition shows that the model can generate destabilizing secondary market credit booms even when financiers always receive higher returns on equity than bankers.

**Proposition 9** (Secondary Market Booms with High Financier ROE). *There exist parameters such that (i) the model economy transitions from a full-monitoring equilibrium to a shirking equilibrium after a sequence of good shocks, (ii) relative financier net worth \( \tilde{w} \) grows throughout, and (iii) \( \hat{\text{ROE}}_f > \hat{\text{ROE}}_f \) throughout.*
Proof. See appendix.

The intuition is that the harmful effects of secondary markets arise as a function of the imbalance between bankers and financiers, while the rents accruing to both intermediaries are partially determined by depositor’s demand for financial services. Because financiers benefit disproportionately from low interest rates, one can always find a level of depositor net worth \( w_d \) such that financiers receive higher rents than bankers. As a result, the model’s results are robust to allowing for endogenous equity issuances.

1.4 Policy

In this section, I ask how policy shapes the likelihood and evolution of secondary market credit booms. Rather than characterizing optimal policy, I evaluate three extant policies – monetary policy as a determinant of short-term interest rates, leverage requirements, and equity injections to kick-start lending in a crisis – from a positive perspective. I then propose a simple tool to eliminate pecuniary externalities in secondary markets.

1.4.1 Monetary Policy

I begin by studying the role of the monetary policy. I do so in reduced form. Specifically, I assume that monetary policy determines the depositor’s investment opportunities outside of the financial system. That is,

\[
y_S = M(\rho),
\]

where \( \rho \) denotes the monetary policy environment and \( M'(\rho) > 0 \). Monetary policy thus works through affecting the required return on deposits. This is in line the evidence in Krishnamurthy and Vissing-Jorgensen (2012) that treasuries are valued for their safety by risk-averse investors and are thus a substitute for safe assets produced by the financial system. Since \( Q_b \leq \frac{1}{y_S} \) in equilibrium, the monetary policy environment places a lower
bound on funding market interest rates:

\[ R_b \geq R_b(\rho) \equiv \frac{M(\rho) - 1}{M(\rho)}, \]

Since \( R'_b(\rho) > 0 \), I use \( \rho \) to denote the tightness of monetary policy. To the extent that equilibrium interest rates are at their lower bound, tight monetary policy raises interest rates.

For monetary policy to have bite, bond prices must be at their lower bound. I therefore assume that the financial system is highly constrained. To understand whether expansionary monetary policy leads to a growth in financier net worth even when it is initially small, I assume that secondary market liquidity is low initially. The combination of these two assumptions implies that all bankers monitor.

**Proposition 10** (Monetary Policy and Secondary Market Booms). *Fix a full-monitoring equilibrium with low secondary market liquidity. Then a loosening of monetary policy (a reduction in \( \rho \)) increases investment and the growth rate of relative financier net worth after a good shock.*

*Proof. See Appendix.*

Due to asymmetric leverage constraints, loose monetary policy biases the growth rates of intermediary net worth towards financiers, even as both bankers and financiers can borrow at cheaper rates. As a result, expansionary monetary policies can contribute to the build-up of financial fragility over time by encouraging imbalances in the distribution of net worth in the financial system, leading to a *dynamic* risk-taking channel of monetary policy. The reason is that initially low interest rates set the economy on a path towards excessive growth in relative financier net worth, which ultimately manifests itself in deteriorating monitoring incentives and increased risk-taking. Altunbas, Gambacorta, and Marques-Ibanez (forthcoming) provide evidence for these precise dynamics: extended periods of loose monetary policy are associated with increased risk-taking and higher default risk.
among financial institutions, but with a lag.

The monetary authority may find it difficult to reign in a secondary market boom once it is underway. Corollary 7 showed that the growth rate of relative financier net worth is increasing in relative net worth itself: financiers grow faster when they are already large. An initial monetary policy boost to financier net worth may then mean that financiers continue to grow when the crutch of low interest rates is removed. Halting a secondary market boom by “taking away the punch bowl” is difficult if financiers have already stashed away the punch.

1.4.2 Capital Requirements

Now consider capital requirements. Specifically, assume that the government puts in place leverage limits $\bar{\lambda}_b$ and $\bar{\lambda}_f$ such that total investment by bankers and financiers cannot exceed a multiple of their net worth,

$$k_{R,b} \leq \bar{\lambda}_b w_b \quad a_f \leq \bar{\lambda}_f w_f.$$  

To the extent that leverage constraints can be chosen contingent on the state of the economy and are freely enforceable, it is clear that a social planner can enforce any upper bound on market quantities by setting the appropriate capital requirements. Instead of characterizing optimal leverage requirements in such settings, I focus on another extreme: leverage requirements must be set once and for all, and financier leverage constraints cannot be meaningfully enforced. The latter concern arises may arise because financiers are amorphous institutions that may be relatively hard to regulate effectively, such as those operating in the shadow banking sector. I therefore set $\bar{\lambda}_f = \infty$, and study the implications on binding capital requirements on bankers. For simplicity, I focus on regions of the state space where secondary market liquidity is high in the absence of capital requirements.

Define bank leverage to be $\lambda_b = \frac{k_{R,b}}{w_b}$. Bank leverage in the absence of secondary markets
and capital requirements is

\[ \lambda_b^0 = \frac{k_{R,b}^0}{w_b} = \frac{1}{1 - Q_{b}^0 y_{R}(l) \bar{m}}. \]

Bank leverage with highly liquid secondary markets and without capital requirements is

\[ \lambda_b^* = \frac{k_{R,b}^*}{w_b} = \frac{1}{1 - Q_b^* Q_a^* \bar{m}}. \]

For leverage requirements to influence equilibrium outcomes without shutting down secondary markets altogether, we must therefore have

\[ \lambda_b^0 < \bar{\lambda}_b < \lambda_b^*. \]

I maintain this assumption going forward.

I now turn to the banker’s problem in the presence of leverage constraint. The key observation is that, since banks are prohibited from levering as much as they would like, they sell just enough risky claims to exactly hit the leverage requirement. Recall from Section 1.2.4 that the collateral short-fall of the banker for a given quantity of bonds issued \( b_b \) was defined as

\[ \bar{a}_b(k_{R,b}, b_b, Q_a) = \frac{b_b}{Q_a}. \]

Risky claim sales relax borrowing constraints by covering this shortfall. In the absence of capital requirements, the banker’s optimal portfolio is such that they sell off exactly the amount of risky claims that maximizes their borrowing capacity: \( a_b^* = \bar{a}_b \). When capital requirements bind, however, bankers are no longer permitted to exhaust their entire borrowing capacity. Because risky claims trade below par, bankers therefore withdraw assets from secondary markets until the capital requirement just binds. I summarize the degree to which bankers exhaust their borrowing capacity by \( \gamma_b \in [0, 1] \). The secondary
market supply of bankers can then be written as

\[ a_b = \gamma_b \left( \frac{b_b}{Q_a} \right). \]

Since the borrowing and budget constraints continue to bind, the optimal portfolio for given prices is

\[
k_{R,b} = \left[ \frac{(1 - \gamma_b)Q_a + \gamma_b y_R(l)}{(1 - \gamma_b)Q_a + \gamma_b y_R(l) - Q_a Q_b y_R(l) \tilde{m}} \right] w_b
\]

and

\[
b_b = \left[ \frac{Q_a y_R(l) \tilde{m}}{(1 - \gamma_b)Q_a + \gamma_b y_R(l) - Q_a Q_b y_R(l) \tilde{m}} \right] w_b.
\]

Accordingly, bank leverage for a given \( \gamma_b \) is

\[
\lambda_b(\gamma) = \frac{(1 - \gamma_b)Q_a + \gamma_b y_R(l)}{(1 - \gamma_b)Q_a + \gamma_b y_R(l) - Q_a Q_b y_R(l) \tilde{m}}.
\]

Setting \( \lambda_b(\gamma) = \bar{\lambda}_b \) reveals that the degree to which the banker exhausts his borrowing capacity under capital requirements is

\[
\gamma^*_b(\bar{\lambda}_b) = \left( \frac{Q_a}{Q_a - y_R(l)} \right) \left[ 1 - \left( \frac{\bar{\lambda}_b}{\lambda^*_b - 1} \right) Q_b y_R(l) \tilde{m} \right] \in (0, 1).
\]

All else equal, the supply of risky claims is thus increasing in the capital requirement \( \bar{\lambda}_b \), but decreasing in the secondary market price \( Q_a \). The reason is that, by virtue of the fixed capital requirement, bankers aim to fill a fixed revenue target on secondary markets. As a result, supply curves are downward sloping. Most importantly, binding capital requirements put upward pressure on the secondary market price by reducing the supply of assets on secondary markets. As the next proposition shows, this price pressure may be sufficiently large that a fraction of bankers must start shirking.

**Proposition 11 (Shirking Due to Capital Requirements).** Assume that the financial system is highly constrained whether or not capital requirements are binding. Suppose that the competitive equilibrium without leverage constraints is full-monitoring with highly liquid secondary markets. Let \( \lambda^*_b \) denote the associated bank leverage. If \( \bar{\lambda}_b < \lambda^*_b \), then a strictly
positive fraction of bankers must shirk in the equilibrium with capital requirements.

Proof. See Appendix. □

The next corollary then follows immediately.

**Corollary 8** (Equilibrium with Binding Capital Requirements). If the financial system is highly constrained in the absence of capital requirements and the capital requirement is binding, the competitive equilibrium with capital requirements is a shirking equilibrium. The equilibrium secondary market price $Q^*_a$ satisfies

$$Q^*_a = \hat{y}_R - m \cdot \left[ \frac{\hat{L}_b(Q^*_a - y_R(l))}{\lambda_b(Q^*_a - m')} - (\lambda_b - 1) \right]$$

and is strictly decreasing in $\lambda_b$. The equilibrium portfolio of the high-type banker is given by $k^H_{R,b} = \bar{\lambda}_b w_b$, $a^H_b = \frac{w_b(\lambda_b(1 - y_R(l)\bar{m}))}{Q^*_a - y_R(l)}$ and $b^H_b = w_b(\lambda_b - 1)$. The equilibrium portfolio of the low-type banker is $k^L_{R,b} = k^H_{R,b}$, $a^L_b = k^L_{R,b}$ and $b^L_b = b^H_b$. The fraction of shirking bankers is $\Phi$ is determined by the secondary market clearing condition

$$\Phi k^H_{R,b} + (1 - \Phi)a^H_b = \frac{w_i}{Q^*_a - (1 - \phi)y_R(l)},$$

where $\phi = \frac{\Phi k^H_{R,b}}{\Phi k^H_{R,b} + (1 - \Phi)a^H_b}$ and $\Phi$ is decreasing in $\lambda_b$.

In Figure 9, I plot equilibrium outcomes as a function of the capital requirement $\lambda_b$ in an example economy in which secondary market liquidity is high in the absence of capital requirements. The top-left panel shows that secondary market sales by the high-type banker decrease as the capital requirement is relaxed. The reason is that bankers cannot lever beyond a fixed multiple of their net worth, and thus only issue sufficiently many risky claims to reach the target leverage. Accordingly, the next two panels show that both bond issuances and the level of investment increase as $\lambda_b$ increases. The bottom row plots the secondary market price $Q_a$, the fraction of shirking bankers $\Phi$, and tomorrow’s relative financier net worth after a good shock. As per the proposition, secondary market prices as well as the fraction of shirking bankers decrease in $\lambda_b$. The intuition is simple: tighter
leverage constraints push banks to withdraw assets from secondary markets, leading to excess demand for risky claims. If only the price were to adjust to clear the market, all bankers would have an incentive to shirk and sell. To satisfy the excess demand without inducing all bankers to shirk, the price increases slightly as the upper bound $\bar{Q}_a$ grows, and more bankers. The bottom-right panel plots the evolution of relative financier net worth $\tilde{w}$ conditional on a good aggregate shock. Relative to the unconstrained equilibrium depicted in blue, two effects jointly shape the degree of risk transferred to financiers. First, tighter capital requirements lead high-type bankers to withdraw assets from secondary markets and decreases the amount of risk transferred. Second, an increase in the fraction of shirking bankers leads to an increase in risk transfer because low-type banker sell more assets on secondary markets than high-type bankers. When capital requirements are not too tight,
the first effect dominates and relative financier net worth grows more slowly in the constrained equilibrium. When capital requirements are tight, the second effect dominates and relative financier net worth grows faster in the constrained equilibrium. The simulations reveal a static and a dynamic channel through which capital requirements adversely impact the flow of credit: statically, lending standards deteriorate as supply shortfalls push up prices; dynamically, increased risk transfer leads financiers to grow faster than bankers, inducing further falls in investment quality. It also stands to reason that the first channel is particularly strong when capital requirements are counter-cyclical – secondary market demand is particularly high at the peak of a boom – while the second channel is particularly strong when capital requirements are risk-weighted – if selling assets for cash relieves leverage constraints, then transferring risk on secondary markets is particularly attractive to bankers. For this reason, the model’s predictions are also consistent with the regulatory arbitrage view articulated in, e.g., Acharya, Schnabl, and Suarez (2013), that bankers used secondary markets to bypass capital requirements. It is also clear that capital requirements on financiers may be a useful policy tool to lean against some of the adverse effects of capital requirements on bankers. My results thus highlight why bank capital requirements may be harmful when set independently of financier regulation.

1.4.3 Post-crisis Interventions and Macro-prudential Regulation

I now summarize the model’s implications for post-crisis interventions and macro-prudential regulation. Begin by studying how to best kick-start lending in the aftermath of a financial crisis event. To this end, suppose that the financial system is highly constrained. Corollary 4 showed that increases in financier net worth lead to more lending than an equivalent increase in banker net worth when $y_S < \bar{y}_S$. Providing equity to financiers may therefore be a more cost-effective way to boost lending. On the downside, Corollary 7 shows that increased financier net worth may set the economy on the path towards a destabilizing
This suggests a role for macro-prudential policy in regulating the dynamics of secondary market booms more generally. Indeed, Corollary 6 shows that excessively large financier net worth may lead to Pareto-inferior outcomes within a period. A simple policy that eliminates this static inefficiency is to place a cap on the total amount of capital financiers can spend in secondary markets in a given period. To this end, let the regulator choose a $\tilde{w}_f$ such that financiers must invest at least $w_f - \tilde{w}_f$ in the safe technology. This cap on secondary market investment $\tilde{w}_f$ can be chosen such that $\Phi = 0$ whenever the competitive equilibrium in the absence of regulation is a shirking equilibrium in which reductions in financier net worth are Pareto-improving in accordance with Corollary 6. As a result, the policy eliminates within-period inefficiencies. Yet it may also have dynamic benefits. Indeed, it is easy to see that aggregate net worth $w_f + w_b$ is larger in any state of the world under this policy. The reason is that the policy eliminates shirking on the equilibrium path, while the conditions in Corollary 6 ensure that total investment is independent of $\Phi$. Aggregate net worth is generally not a sufficient statistic for welfare or total investment. Figure 10 presents an example in which the policy leads to strictly higher investment and, by extension, output in every period.

This suggests that constraints on the asset side of financier balance sheet are a useful macro-prudential policy tool. Three aspects of such a policy are of note. First, financier net worth is harmful only when it is large. Because financiers grow during expansions, the policy is pro-cyclical. Second, the policy is independent of financier capital structure. That is, there is a motive for regulation independent of whether financiers are levered or not. Third, the aggregate size of the financier sector, rather than the systemic relevance of individual financial institutions, is the relevant concern. The last two points contrast with a regulatory discussion at the Financial Stability Board, which focused on the designating individual asset managers as systemically important because they were fearful of sudden withdrawals from such institutions. In this sense, my results suggest a novel motive for financial regulation.
Notes: Equilibrium Outcomes when financiers must invest at least $w_f - \tilde{w}_f$ in the safe technology. $\tilde{w}_f$ chosen such that $\Phi = 0$ in every period in which reductions in financier net worth are Pareto-improving as in Corollary 6. Solid lines depict the equilibrium with the policy and dashed lines the equilibrium in the absence of the policy.

1.5 Conclusion

This paper offers a theory of the macroeconomic effects of secondary markets. Secondary market trading impacts the flow of credit through the distribution of aggregate risk exposure in the cross-section of financial intermediaries. Some risk transfer away from constrained lenders relaxes a borrowing constraint and allows for the expansion of credit volumes. Excessive risk transfer destroys monitoring incentives and leads to lax credit standards and excessive aggregate risk exposure. The level of risk transfer is determined by the distribution of net worth in the financial system. I distinguish between “bankers” – intermediaries that lend to firms and household directly, such as commercial banks or mortgage originators – and “financiers” – those who do trade in assets originated by other intermediaries, such as hedge funds or dealer banks. There is excessive risk transfer when financiers are too well-capitalized relative to bankers. Dynamically, the risk transfer that allows credit volumes to expand when financiers are not too large causes financier net worth to grow.
disproportionately after a sequence of good shocks. Endogenous secondary market credit
booms arise that gradually lead to declining investment efficiency and increasing financial
fragility.

Secondary market booms are triggered by periods of low interest rates. The model therefore
provides a novel link from expansionary monetary policy and “saving gluts” to future finan-
cial fragility. In this manner, it sheds new light on the origins of the U.S. credit boom that
eventually ended in the 2008 financial crisis. Regarding policy, I show that asymmetric cap-
itl requirements on bankers are harmful, and that there is a strong motive for pro-cyclical
restrictions on financier’s purchases of asset-backed securities.

There are two main avenues for future research. The first is to study the optimal design of
policy in the context of secondary market trading. The second is to undertake a quantitative
evaluation of the mechanisms proposed in this paper.
Chapter 2: Debt Crises: For Whom the Bell Tolls*

3.1 Introduction

Several features of sovereign debt markets are difficult to explain.

First, contagion. Sovereign debt crises tend to be highly correlated across countries and sovereign spreads (the sovereign’s cost of external funding), tend to co-move strongly. The most recent example is the 2010 debt crisis in Europe. Beirne and Fratzscher (2013), using information for 31 advanced and emerging economies during the crisis, find that there was a sharp and simultaneous increase in sovereign spreads in both European and non-European countries. Similar forces were at play in the debt crises initiated by Poland in 1981, Mexico in 1994, Thailand in 1997, Russia in 1998, and Argentina 2001.\(^2\)

Previous work has attempted to explain contagion by appealing to different types of linkages between countries. One branch of the literature focuses on real linkages. For example, trade in goods or financial assets between countries may transmit negative shocks from one country to the next and lead to co-movements in sovereign spreads (e.g., Alter and Beyer (2014) and Gross and Kok Sorensen (2013)). A second branch focuses on belief linkages through learning and herding. In this view (e.g., De Santis (2012)), contagion is

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*This chapter is co-authored with Harold L. Cole and Guillermo Ordoñez
\(^2\)For a survey of these cases see Reinhart and Rogoff (2009b).
driven by the correlation of beliefs about fundamentals in different countries, so that bad news about one country make investors pessimistic about other countries. Of course, a prerequisite for belief correlation to cause contagion is that observations about one country hold information about other countries. This requires correlation in fundamentals across countries, or the existence of a common unobservable variable linking all countries. Theories of contagion based on belief linkages therefore also require real linkages between countries.

Finally, a third set of explanations relies on the rationalization of crises as self-fulfilling rollover problems à la Cole and Kehoe (1996). To explain contagion, however, this literature requires a correlated structure of sunspots to induce simultaneous rollover crisis episodes in many countries at the same time.

Because many extant theories of contagion rely on the existence of structural links across countries, finding evidence for such linkages is imperative in providing support for them. Problematically, however, it is often difficult to empirically identify linkages that are plausibly powerful enough to induce the degree of contagion observed in many debt crisis episodes. Again taking the recent European experience as an example, Beirne and Fratzscher (2013) explore empirical models with economic fundamentals and find that “the market pricing of sovereign risk may not have been fully reflecting fundamentals prior to the crisis.”

Second, sovereign risk premia seem only loosely connected to the country’s fundamentals more generally: they frequently exhibit sudden changes without obvious changes in underlying fundamentals, and sometimes fluctuate without any observable changes in fundamentals at all. Indeed, sovereign risk premia seem to react differently to a given change in fundamentals at different points in time.

Third, there seems to be history dependence in the borrowing conditions faced by different countries: the same change in fundamentals may have different effects in different countries, and these differences are persistent over time. Indeed, a given country’s past behavior seems to matter for how sovereign spreads react to changes in fundamentals. Consider, for example, the diverging experiences of Argentina and the United States. The U.S. seems to be in a “stable” environment that allows it to accumulate high debt levels without triggering
increases in spreads, while Argentina, in contrast, seems to be in an “unstable” environment in which slight changes in fundamentals cause large and sudden changes in spreads.

To jointly accommodate all of these features within a single framework, we construct a model of sovereign bond markets with many countries and two key elements. First, there is a global pool of risk-averse investors who freely allocate funds across sovereign bond markets. Second, these investors can choose to produce information about a country’s fundamentals at a cost. This information is valuable because informed investors are able to exploit their superior knowledge of a country’s fundamentals to outbid uninformed investors in particularly attractive states of the world. In equilibrium, this benefit is exactly offset by the cost of becoming informed.

Our first result is that the free flow of capital across countries can generate contagion across countries, even in the absence of any real linkages, correlation of fundamentals, or belief updating about one country due to equilibrium outcomes in another country. Specifically, when investor preferences exhibit prudence (that is, \( u''(c) > 0 \), as is the case for CRRA utility functions), an increase in the probability of default in one country increases sovereign spreads for all sovereign bonds held by the investor. This is because an increase in the default risk of a given country increases the background risk inherent in the entire portfolio of sovereign bonds, and thereby reduces the investor’s appetite to invest in sovereign debt more generally. Hence, sovereign bond prices fall across all countries when one country becomes more likely to default. If this effect is sufficiently large and the increase in spreads is severe enough, it may no longer be feasible for countries to roll over their debt, causing a wave of debt crises.

Our contagion result relies only on investor prudence and the fact that there is a common pool of investors for all countries. Hence it does not rely on changes in investors’ wealth (as in Kyle and Xiong (2001) or Goldstein and Pauzner (2004)), borrowing constraints (as in Yuan (2005)) or short-selling constraints (as in Calvo and Mendoza (1999)). Indeed, contagion stems only from the portfolio rebalancing of prudent investors in response to an increase in the riskiness of a subset of assets at their disposal. For empirical evidence about
the importance of portfolio effects on contagion see Broner, Gelos, and Reinhart (2004).
For empirical evidence about the importance of risk aversion to explain sovereign spreads see Lizarazo (2013).

Our second result is that the option to produce information about countries’ fundamentals can generate multiple equilibria. In particular, an uninformed equilibrium, in which no investor acquires information about the country’s fundamentals, may co-exist with an informed equilibrium, in which some investors do acquire information about the country’s fundamentals. These information regimes have real effects: taking as given the stochastic process for fundamentals, the average level and the volatility of spreads differ across regimes. In the uninformed equilibrium, spreads are stable and low on average, because investors are relatively insensitive to variation in fundamentals. In the informed equilibrium, in contrast, spreads are volatile and high on average, because investors strongly react to variation in fundamentals and demand very high risk premia in bad states of the world. For this reason, sovereigns strictly prefer an uninformed equilibrium to an informed equilibrium. Because information acquisition is costly, and information rents come at the expense of other investors, the same is true for investors.

Why do all agents, investors and countries alike, lose in the informed equilibrium? In our setting information does not affect any real variable, so there are no benefits of information. Still information is costly and uses real resources that could be consumed otherwise, but are lost in equilibrium because of investors competing for a larger share of resources. We do not claim that information does not have benefits in terms of disciplining governments or allocating funds to productive investment opportunities, but we assume away those benefits to focus on the forces behind information acquisition. Any benefit of information will naturally go in the direction of making the uninformed equilibrium less desirable.

An important upshot from our analysis is that, because investors’ optimal portfolio choice and the information regime jointly determine the mapping from country fundamentals to sovereign bond spreads and the likelihood of debt crises, there need not exist a unique mapping from economic fundamentals to spreads in sovereign bond markets even in the absence
of roll-over crises driven by coordination failures. Indeed, since investors choose their portfolio by taking the fundamentals and information regimes in all countries into account, the mapping from fundamentals to prices in a single country depends on equilibrium outcomes in all other countries. To the extent that a given pool of investors prices sovereign bonds in multiple countries, understanding contagion and default risk therefore requires a “global” view of bond markets.

Finally, to the extent that informational regimes are persistent (in the sense that there is a change in regime only if the only if the old regime can no longer be sustained), only large changes in fundamentals can force a transition across regimes. This implies that a country starting out in an uninformed equilibrium begins to attract informed investors only if its fiscal situation worsens substantially, while a country starting out in an informed equilibrium requires a substantial improvement of their fiscal situation to discourage information acquisition. In the absence of such large shocks, two given countries may therefore be in different informational regimes, and thus have to pay different spreads, even when their current fundamentals are similar. A country’s past sins or virtues may therefore be important determinants of current borrowing conditions, and may remain with the country for a long time. We call this phenomenon hysteresis. This also implies that understanding contagion and default risk therefore also requires a “historical” view of bond markets.

In the next section we present a model with a single country in which we discuss multiplicity of equilibria in terms of information acquisition and the outcome in terms of sovereign spreads. In Section 3.3 we extend the results for two countries, discussing contagion of sovereign spreads in its purest form, without any fundamental linkage and no information acquisition and contagion of information regimes. In Section 3.4 we reinterpret the dynamics of sovereign spreads in the recent European debt crisis from the point of view of our model. In Section 3.5 we conclude.
3.2 A Single Country Model

3.2.1 Setting

Environment: This is a two period model with a mass 1 of investors and a government. Investors have wealth $W$ in the first period and only care about consumption $c$ in the second period. Their preferences over consumption are given by a strictly concave utility function $u(c)$ that satisfies the Inada conditions. Since investors only care about consumption in period 2, their problem is deciding how to invest their wealth in period 1, choosing between a safe asset that has gross return 1 (storage), and risky government debt. We describe the source of this risky debt next.

In period 1 the government has an amount of outstanding legacy debt $D$ coming due. This debt is new of the country’s period 1 income and is owed to previous, unspecified, investors. This implies that, in order to repay $D$ the government has to roll over the debt. We assume that the government rolls over this debt using pure discount bonds via an auction-type market. In this market, investors specify combinations (possibly menus) of prices $P$ and quantities $B$ they wish to purchase. The government sells debt to the highest bidder until it either exhausts the bids or sells enough to roll over its debt. If the government cannot roll over its debt then it must default on initial investors, a situation we call a debt crisis.

In period 2 the debt issued in period 1 comes due. The government then chooses whether to repay its debt using its income $Y$ generated in period 2, or to default. If the government defaults in either period the total output that remains is $(1 - \theta)Y$ where $\theta \in [0, 1]$ is the cost of default in terms of lost income, and it is known by the government. Both the government’s default cost factor $\theta$ and its income $Y$ are random. We assume the cost of default is independent of whether the government defaults in period 1 or period 2, and since the government is just seeking to roll over its debt during the first period, it will always do so if it can; reserving the decision to default for the second period.

While the realization of $Y$ is drawn in period 2 from a distribution $F(Y)$, the realization
of \( \theta \) is drawn in period 1 from a discrete distribution with \( S \) elements \( \Theta = \{ \theta_1, ..., \theta_S \} \), such that \( \theta_1 > .. > \theta_s > .. > \theta_S \). The realization of \( \theta \) is unknown to investors, they can choose to become informed about it in period 1 at a utility cost \( K \).

**Auctions:** Investors are ex-ante identical but end up being one of two types based upon their information choice: informed and uniformed. Denote by \( n \) the fraction of informed investors and by \( P \) the marginal price of government debt in period 1. If there are informed investors then this marginal price will depend upon the realized \( \theta \), and in this case we will denote it by \( P(\theta) \). Because informed traders know \( \theta \), they know the price that the marginal investor must pay for government debt and hence bid the price \( P(\theta) \) along with the (conditional) quantity that they wish to purchase at that price, \( B^I(\theta) \). The uninformed traders may (and will) find it advantageous to bid heterogeneous price-quantity pairs. Because they know the set of possible marginal prices, \( \{ P(\theta_1), ..., P(\theta_S) \} \) in an equilibrium with a fraction \( n \) of informed investors, they will choose the quantities to bid at each one of these prices. Let \( B^U(\theta) \) denote the amount that an uninformed trader bids if he chooses to bid at price \( P(\theta) \).

The auction arrangement leads to the following budget constraints for the government. In period 1, and for a given \( \theta \), if it can roll over its debt in period 1, then

\[
nB^I(\theta)P(\theta) + (1 - n) \sum_{\{\hat{\theta}: P(\hat{\theta}) \geq P(\theta)\}} B^U(\hat{\theta})P(\hat{\theta}) = D. \tag{5}
\]

Notice that the previous sum represents that, if the cost of default is \( \theta \), uninformed investors get to buy all their bids at prices larger than \( P(\theta) \).

If the government cannot roll over the debt in period 1, then

\[
nB^I(\theta)P(\theta) + (1 - n) \sum_{\{\hat{\theta}: P(\hat{\theta}) \geq P(\theta)\}} B^U(\hat{\theta})P(\hat{\theta}) < D,
\]

in which case it must default. We will refer to this second case as a *debt crisis.*
If the government hasn’t defaulted in period 1, its debt coming due in period 2 is

\[ R(\theta) = nB^I(\theta) + \sum_{\{\hat{\theta}: P(\hat{\theta}) \geq P(\theta)\}} (1 - n)B^U(\hat{\theta}) \]

In this case the government’s payoff if it doesn’t default in period 2 is \( Y - R(\theta) \), while it is \((1 - \theta)Y\) if it does default in period 2. This leads to a simple cut-off rule in which the government defaults in period 2 if and only if \( Y < \bar{Y}(\theta) \), where

\[ \bar{Y}(\theta) \equiv \frac{R(\theta)}{\theta}. \] (6)

Since we assume that the government’s income is \((1 - \theta)Y\) if it has already defaulted in period 1; irrespective of whether it defaults in period 2, the government is always weakly better off waiting to default in period 2 if possible (there are no gains from defaulting in the first period rather than rolling over with the possibility of repaying in the second period).

Since \( \bar{Y}(\theta) \) denotes the government’s cut-off rule for defaulting as a function of \( \theta \), the realized return to an investor is 1 if \( Y \geq \bar{Y}(\theta) \) and 0 otherwise. In other words, it is 1 with probability \( \Pr \{ Y \geq \bar{Y}(\theta) \} \) and 0 with probability \( 1 - \Pr \{ Y \geq \bar{Y}(\theta) \} \). Then, so long as the total amount coming due, \( R(\theta) \), is weakly decreasing in \( \theta \) (the higher the cost of default, the higher the price of debt and the less debt comes due in period 2), it follows that the default cut-off is strictly decreasing in \( \theta \) and the default probability is also weakly decreasing in \( \theta \). In words, the higher the cost of default \( \theta \) the less likely is that the country defaults, this decreases the repayment needs and reduces the probability of default, which is consistent with a lower repayment need.

**Short-sale Prohibition:** We will assume that our private investors cannot short the government’s bond. We make this assumption for two reasons. First, in our two-period context shorting the bond does not mean pledging to deliver a unit of the bond later. Rather it means committing to the same state-contingent payoff profile as the government.
But, in order to do this, the private investor would need access to exactly the sort of commitment technology as the government. Second, in an equilibrium in which uninformed investors were seeking to short the bond the ability to trade would reveal information about the realization of \( \theta \). This is because the other party to the trade will be an informed trader who is only willing to buy because the marginal price is weakly greater than the price asked by the uniformed investor. Similarly, an offer to sell the bond outside of the auction by an informed investor to an uninformed investor would also reveal information about the realization of \( \theta \).

**Investors’ Problem:** An informed agent knows \( \theta \) and takes as given the marginal price of debt \( P(\theta) \). Therefore, their maximization problem is given by

\[
U^I(\theta) = \max_{B^I(\theta) \geq 0} \left( u\left(W + [1 - P(\theta)]B^I(\theta)\right) \Pr \{ Y \geq \tilde{Y}(\theta) \} \right.
\]

\[
+ u\left(W - P(\theta)B^I(\theta)\right) [1 - \Pr \{ Y \geq \tilde{Y}(\theta) \}] - K,
\]

which implies that their first-order condition is,

\[
u'(W + [1 - P(\theta)]B^I(\theta)) [1 - P(\theta)] \Pr \{ Y \geq \tilde{Y}(\theta) \}
\]

\[
+ u'(W - P(\theta)B^I(\theta)) [-P(\theta)] [1 - \Pr \{ Y \geq \tilde{Y}(\theta) \}] \leq 0,
\]

and with strict equality if \( B^I(\theta) > 0 \).

An uninformed agent must choose how much to bid at each one of the possible marginal prices \( P(\theta) \). The maximization problem of an uninformed agent is then

\[
U^U = \max_{\{B^U(\tilde{\theta}_1), \ldots, B^U(\tilde{\theta}_S)\}} \sum_{\theta \in \Theta} \Pr(\theta) \left\{ u\left(W + \sum_{\tilde{\theta} : \tilde{\theta} \geq \theta} [1 - P(\tilde{\theta})]B^U(\tilde{\theta})\right) \Pr \{ Y \geq \tilde{Y}(\theta) \} + u\left(W - \sum_{\tilde{\theta} : \tilde{\theta} \geq \theta} P(\tilde{\theta})B^U(\tilde{\theta})\right) [1 - \Pr \{ Y \geq \tilde{Y}(\theta) \}] \right\},
\]

(9)
which implies that his first-order condition for $B^U(\hat{\theta})$ is,

$$
\sum_{\{\theta : \hat{\theta} \leq \theta \}} \Pr \{ \theta \} \left\{ u' \left( W + \sum_{\{\theta' : \theta \leq \theta' \}} [1 - P(\theta')] B^U(\theta') \right) [1 - P(\hat{\theta})] \Pr \{ Y \geq \bar{Y}(\theta) \} + u' \left( W - \sum_{\{\theta' : \theta \leq \theta' \}} P(\theta^{U}(\theta')) \right) [-P(\hat{\theta})] [1 - \Pr \{ Y \geq \bar{Y}(\theta) \}] \right\} \leq 0,
$$

(10)

where this condition holds as an equality if $B^U(\hat{\theta}) > 0$. As the decision of the quantities to bid at different prices are linked through first order conditions, the bids in equilibrium are the solution to the system of equations (10) for all $\theta$.

Finally, if an interior fraction of investors choose to become informed, $n \in (0, 1)$, then the investors must be indifferent between being informed or staying uninformed. If none of the investors become informed then this condition becomes an inequality with $U^U$ being weakly preferred. Alternatively, if $n = 1$ then the inequality is reversed with the payoff from being informed. Hence

$$
\sum_{\theta} \Pr \{ \theta \} U^I(\theta) - K \begin{cases} \leq & \text{if } n = 0, \\ = & \text{if } n \in (0, 1), \\ \geq & \text{if } n = 1.
\end{cases}
$$

(11)

**Equilibrium:** The previous discussion summarizes the main elements of the problem of a single country, which is completely indexed by $n$ from equation (11). Next we define the equilibrium.

**Definition 8.** An equilibrium will consist of a set of cut-offs $\bar{Y}(\theta)$, prices $P(\theta)$, quantities for the informed and uninformed ($B^I(\theta)$ and $B^U(\theta)$ respectively), a fraction of informed investors ($n$) such that the following conditions are satisfied.

1. The period 1 bond market from equation (5) clears in each country for each state $\theta$, or $P(\theta) = 0$ then $\bar{Y}(\theta) = \infty$ and there is a debt crisis in state $\theta$.

2. The set of cut-offs, $\bar{Y}(\theta)$, satisfy the threshold condition (6).

3. The choices of $B^I(\theta)$ and $B^U(\theta)$ are solutions to the informed and uniformed investors’ problems (first order conditions (8) and (10) respectively).
4. The fraction of informed investors \( n \) must satisfy the indifference condition (11). The country is an informed equilibrium when \( n > 0 \) and in an uninformed equilibrium when \( n = 0 \).

There are a variety of equilibria. This is in part because the price of government debt affects the likelihood of repayment, and this in turn can rationalize different prices of the debt. For example, no-lending with \( P(\theta) = 0 \) and \( \bar{Y}(\theta) = \infty \) for all \( \theta \) is always an equilibrium. At a zero price the government will not be able to rollover its debt and therefore must default, this in turn rationalizes the zero price. This multiplicity is well-known since the work of Calvo (1988) and Cole and Kehoe (1996). Next we present a simplified special case to characterize the other (potentially multiple because of information acquisition) equilibria in a tractable and intuitive way.

**Simplifications:** First, we assume just two possible costs of default (that is, \( S = 2 \)), such that \( 0 < \theta_L < \theta_H < 1 \), where \( \theta_H \) is realized in period 1 with probability \( a \) (situation that we denote as good state) and \( \theta_L \) is realized in period 1 with probability \( 1 - a \) (situation that we denote as bad state). Second, we assume just three possible income realizations in period 2, \( Y_L < Y_M < Y_H \), where \( Y_L \) happens with probability \( x \) and \( Y_M \) with probability \( z \). Finally, we assume \( \theta_s \) and \( Y_s \) are such that default cutoffs are exogenous. Formally,

**Assumption 3.**

\[
Y_L < \bar{Y}(\theta_H) < Y_M < \bar{Y}(\theta_L) < Y_H
\]

This assumption guarantees that when the cost of default is high (good state), the country only defaults when the income is low, which implies a default probability of \( \kappa_H \equiv x \). When the cost of default is low (bad state), the country only repays when the income is high, which implies a default probability of \( \kappa_L \equiv x + z \).

The previous assumption relies on endogenous variables (the prices of debt \( P(\theta_L) \) and \( P(\theta_H) \)). For example, for any \( D \) and \( \theta \), if \( P = 0 \), then \( \bar{Y} = \infty \), which implies that the country always defaults and \( P = 0 \) is indeed an equilibrium. There may be other equilibria under which the income level is equal to the cutoff and the government randomizes between
repaying or not in case such income is realized. We do not consider these equilibria as we are interested in the impact of changes in the probability of default of a country on prices and not on the impact of changes in prices on the probability of default. Notice that both effects are intertwined in the general setting in which the probability of default and prices are jointly determined. We relax this restriction later.

3.2.2 Characterization of Equilibria

First we study an equilibrium in which no investor is informed about the state of the country in terms of its cost of default. Then we study equilibria in which some investors may decide to become informed about the state of the country. Finally we describe the possibility of multiplicity, in which these equilibria coexist, and discuss its robustness to changes in parameters.

Uninformed Equilibrium

Define the expected probability of default as

\[ \hat{\kappa} \equiv ax + (1 - a)(x + z) \]

Since there is no information about the country’s state there is a single marginal price \( P \). Given this price, we can rewrite the first order condition (8) as

\[ \frac{u'(W + [1 - P]B)}{u'(W - PB)} = \frac{P\hat{\kappa}}{(1 - P)(1 - \hat{\kappa})} \]  

(12)

The next proposition displays properties of this first-order condition in terms of how bid quantities depend on parameters.

Proposition 12. The investors’ demand of sovereign bonds is decreasing on the price of the bond and on its default probability.
Proof. Rewriting the first order condition (12) as
\[
F(B|P, \hat{\kappa}) = \frac{u'(W + [1 - P]B)}{u'(W - PB)} - \frac{P\hat{\kappa}}{(1 - P)(1 - \kappa)} = 0
\]
define \( u'(+) \equiv u'(W + [1 - P]B) \) and \( u'(-) \equiv u'(W - PB) \). Differentiating with respect to \( \hat{\kappa} \), \( \frac{dB}{d\hat{\kappa}} \) is negative as
\[
\frac{\partial F}{\partial B} = \frac{(1 - P)u''(+))u'(-) + Pu''(-)u'(+)}{u'^2(-)} < 0
\]
and
\[
\frac{\partial F}{\partial \hat{\kappa}} = -\frac{P}{(1 - P)(1 - \hat{\kappa})^2} < 0
\]
Similarly, differentiating with respect to \( P \), \( \frac{dB}{dP} \) is negative if
\[
\frac{\partial F}{\partial P} = \frac{B}{u'^2(-)}[u''(-)u'(+) - u''(+))u'(-)] - \frac{\hat{\kappa}}{(1 - P)^2(1 - \hat{\kappa})} < 0
\]
A sufficient condition for this to be the case is that \( \frac{u''(-)}{u'(-)} \leq \frac{u''(+)}{u'(+) \rangle} \), which is always the case for CRRA and CARA preferences. \( \square \)

The first-order condition together with the resource constraint pins down the price in equilibrium. Substituting the resource constraint \( PB = D \) into the first-order condition,
\[
\frac{u'(W - D + \frac{D}{P})}{u'(W - D)} = \frac{P\hat{\kappa}}{(1 - P)(1 - \hat{\kappa})}
\]
(13)

**Proposition 13.** There is always an equilibrium with rollover failure and a debt crisis at \( P = 0 \). If there exist other equilibria with \( P > 0 \), the highest price equilibrium price decreases with the probability of default \( \hat{\kappa} \) and the country’s debt \( D \).

Proof. Define
\[
F(P|\hat{\kappa}) = \frac{u'(W - D + \frac{D}{P})}{u'(W - D)} - \frac{P\hat{\kappa}}{(1 - P)(1 - \hat{\kappa})}
\]
A price $P^*$ in equilibrium is given by $F(P^*|\hat{\kappa}) = 0$. At one extreme, the zeros of the function $F$ include $P = 0$. To see this note that under the Inada conditions (this is $\lim_{c \to \infty} u'(c) = 0$) the first term is zero and trivially the second term is 0 too. Hence, $F(P = 0|\hat{\kappa}) = 0$. However, assuming $Y$ has finite support, then a rollover failure occurs at $P^* = 0$, and hence this price can be an equilibrium. At the other extreme, for $P = 1 - \hat{\kappa}$, $F(P = 1 - \hat{\kappa}|\hat{\kappa}) < 0$ (the first term on $F(P|\hat{\kappa})$ is less than one and the second term is equal to one), then $P = 1 - \hat{\kappa}$ is never an equilibrium with risk aversion. Indeed, under risk-aversion, $P < 1 - \hat{\kappa}$ as the first term of $F(P|\hat{\kappa})$ is less than 1 and then the second term should also be less that 1.

If parameters are such that $F(P|\hat{\kappa}) < 0$ for all $P \in (0, 1 - \hat{\kappa}]$, then the only equilibrium is given by $P^* = 0$. If $F(P|\hat{\kappa}) > 0$ for some $P \in (0, 1 - \hat{\kappa}]$, then there are other equilibria besides $P^* = 0$. Among those, the maximum $P^*$ sustainable in equilibrium is such that $\frac{\partial F}{\partial P} < 0$ (recall $F(P^*|\hat{\kappa}) = 0$ and $F(P = 1 - \hat{\kappa}|\hat{\kappa}) < 0$).

The maximum sustainable price in equilibrium is decreasing in $\hat{\kappa}$ and $D/W$ as, on the one hand, $\frac{dP}{d\hat{\kappa}} = -\frac{\partial F}{\partial P}$ and $\frac{dP}{d\kappa} = -\frac{P}{(1-P)(1-\hat{\kappa})^2} < 0$ whereas on the other hand, $\frac{dP}{dD} = -\frac{\partial F}{\partial P}$ and $\frac{\partial F}{\partial D} = -\frac{1-P}{P}u''(+) + \frac{P(1+u''(-))}{u'(\hat{\kappa})} < 0$.

To provide intuition, the next figure plots the left-hand side of equation (13), in black and the right-hand side in different colors for three different levels of $\hat{\kappa}$. The equilibrium price is determined by the intersection of the two curves. The higher is the expected probability of default, the higher is the right-hand side and the smaller is the price $P$ in equilibrium. When $\hat{\kappa}$ is large enough, the only feasible equilibrium is $P^* = 0$ and there is a debt crisis.

The next figure shows the right hand side of equation (13) in black and the right hand side in different colors for three different levels of $D/W$. As before, the equilibrium price is determined by the intersection of the two curves. The higher is the relative indebtedness of the country, the higher is the left hand side and the smallest the price $P$ in equilibrium. When $D/W$ is large enough, the only feasible equilibrium is a $P^* = 0$ and there is a debt crisis.
When is an uninformed equilibrium sustainable? To answer this question, we have to determine the incentives for a single uninformed investor to deviate and acquire information, paying a utility cost $K$. Because a single investor’s bidding behavior does not impact equilibrium prices, the benefits of acquiring information come from the possibility of re-optimizing the quantities the investor bids at the marginal price $P$ in equilibrium, given that there is a single price.

If the investor learns the state is good, he would like to bid more than uninformed individuals. This is immediate from the first order condition (12) evaluated at $P$ and $\kappa_H$, as the bid is decreasing in the probability of default and $\kappa_H < \tilde{\kappa}$. Similarly, if the investor learns the state is bad, he would like to bid less than if he were uninformed.

Defining the expected benefits of acquiring information as

$$\chi^U \equiv a [U(B(\kappa_H, P)) - U(B(\tilde{\kappa}, P))] + (1 - a) [U(B(\kappa_L, P)) - U(B(\tilde{\kappa}, P))]$$

As $U(B(\kappa, P))$ is obtained by re-optimizing the quantities bid, it is clear that $\chi^U$ cannot be negative (as the investor can always replicate his uninformed bid). Then, the uninformed
Figure 12
Price Determination for Different Levels of D/W

The critical difference between the informed and uninformed equilibrium is that in the informed equilibrium there will be as many prices as states, as informed investors will bid different quantities in those different states. In a sense, the existence of informed investors

equilibrium is feasible as long as

\[ K > \chi^U \geq 0 \]

Notice that the difference between the optimal bid in each state and the bid without information (this is, \( B(\kappa_s, P) - B(\hat{\kappa}, P) \)) is increasing in the absolute difference \( \kappa_s - \hat{\kappa} \). Since \( \hat{\kappa} - \kappa_H = (1 - a) z \) and \( \kappa_L - \hat{\kappa} = az \), the gap increases with \( z \) and it is maximized at intermediate levels of \( a \). In the extremes, when \( a = 0 \), \( U(B(\kappa_L, P)) = U(B(\hat{\kappa}, P)) \) and \( \chi^U = 0 \). This is also the case for \( a = 1 \).

The incentives to acquire information is also increasing in \( D/W \) as more exposure to the risky asset increases the differences in utility from knowing the probability of default in each state.

Informed Equilibrium

The critical difference between the informed and uninformed equilibrium is that in the informed equilibrium there will be as many prices as states, as informed investors will bid different quantities in those different states. In a sense, the existence of informed investors
changes the structure of equilibrium as they will generate prices that are conditional on underlying fundamentals that are unknown unless information is produced, the cost of default $\theta$ in our setting.

Denoting the two prices $P_L \equiv P(\theta_L)$ and $P_H \equiv P(\theta_H)$ we can rewrite the first order condition (8) as

$$\frac{u'(W + [1 - P_s]B^L_s)}{u'(W - P_sB^L_s)} = \frac{P_s\kappa_s}{(1 - P_s)(1 - \kappa_s)}$$  \hspace{1cm} (14)

where $\kappa_s \in \{\kappa_L, \kappa_H\}$ are the expected probabilities of default in each state $s$ and $P_s \in \{P_L, P_H\}$ are the prices in each state $s$.

As in the uninformed equilibrium, the next proposition describes the features of these first order conditions, which are identical to those in Proposition 12, as is the proof.

**Proposition 14.** Informed investors’ demand of sovereign bonds is decreasing on the price of the bonds and on their default probability.

For uninformed investors bidding in the informed equilibrium, we can rewrite the first-order condition (10) for the bid at the marginal price in the low state, $B^L_U$, as

$$P_L\kappa_L u'(W - P_H B^U_H - P_L B^U_L) = (1 - P_L)(1 - \kappa_L)u'(W + (1 - P_H)B^U_H + (1 - P_L)B^U_L)$$  \hspace{1cm} (15)

and for the bid at the marginal price in the high state, $B^U_H$, as

$$a \left[ P_H \kappa_H u'(W - P_H B^U_H) \right] + (1 - a) \left[ P_H \kappa_L u'(W - P_H B^U_H - P_L B^U_L) \right] = a \left[ (1 - P_H)(1 - \kappa_H)u'(W(1 - P_H)B^U_H) \right]$$

$$+ (1 - a) \left[ (1 - P_H)(1 - \kappa_L)u'(W + (1 - P_H)B^U_H + (1 - P_L)B^U_L) \right]$$  \hspace{1cm} (16)

Critically, auctions with discriminatory pricing implies that, as $P_H > P_L$, the sovereign will sell $B^U_H$ to the uninformed at $P_H$ in the good state (as the price is $P_H$) but also in the bad state, in which the marginal price is $P_L$. This implies that uninformed understand that they will always buy whatever they decide to bid at $P_H$, but in a bad state they are buying at an overprice.
By comparing these first order conditions, the next proposition describes general properties of the total expenditures on sovereign debt by uninformed investors.

**Proposition 15.** Uninformed investors spend more than informed investors in the bad state and less than informed investors in the good state.

*Proof.* First, we prove that informed investors spend less than uninformed investors in the bad state, that is $P_L B_L^I < P_H B_H^U + P_L B_L^U$.

Suppose not, so that $P_L B_L^I \geq P_H B_H^U + P_L B_L^U$. Then

$$P_L \kappa_L u'(W - P_L B_L^I) \geq P_L \kappa_L u'(W - P_H B_H^U - P_L B_L^U)$$

From the first-order conditions for informed investors in the bad state (14) and the first-order condition for uninformed investors at the marginal price for the bad state (15), this implies

$$u'(W + (1 - P_L)B_L^I) \geq u'(W + (1 - P_H)B_H^U + (1 - P_L)B_L^U)$$

or

$$B_L^I - (B_H^U + B_L^U) \leq P_L B_L^I - (P_H B_H^U + P_L B_L^U) < B_L^I - \left(\frac{P_H}{P_L} B_H^U + B_L^U\right)$$

where the second strict inequality is the result of $P_L < 1$. This is a contradiction for all $P_H > P_L$.

Second, we prove that informed investors spend more than uninformed investors in the good state, this is, $P_H B_H^I > P_H B_H^U$. Notice the first-order condition for uninformed investors for bidding at the marginal price for the good state (16) can be rewritten as

$$(1 - a) \left[P_H \kappa_L u'(W - P_H B_H^U - P_L B_L^U)\right]$$

$$-(1 - a) \left[(1 - P_H)(1 - \kappa_H)u'(W + (1 - P_H)B_H^U + (1 - P_L)B_L^U)\right] = a \left[(1 - P_H)(1 - \kappa_H)u'(W(1 - P_H)B_H^U) - P_H \kappa_H u'(W - P_H B_H^U)\right]$$

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From equation (15) and $P_H > P_L$ the left hand side is positive. This implies

$$\frac{u'(W + [1 - P_H]B_H^U)}{u'(W - P_HB_H^U)} > \frac{P_H\kappa_H}{(1 - P_H)(1 - \kappa_H)}$$

Comparing with the first order conditions for informed investors in the good state (14), then $B_H^U < B_L^I$.

The intuition for this result is as follows. On the one hand, uninformed investors pay an overprice for a fraction $\frac{B_H^U}{B_L^U + B_H^U}$ of the debt that they purchase in the bad state. This implies that, if uninformed investors spend the same amount as informed investors in the bad state, they incur the same losses as the informed in case of default, but receive smaller gains in case of repayment as $B_L^U + B_H^U < B_L^I$. The marginal benefits of spending more in the bad state are thus larger than the marginal costs, which induces the uninformed to spend more than informed in the bad state. On the other hand, whatever uninformed spend in the good state, they also spend in the bad state. As they are overexposed to sovereign debt in the bad state they would rather reduce their exposure in the good state when compared to informed investors.

We refer to the set of parameters under which $B_H^U = 0$ (that is, parameters under which short selling constraints bind and uninformed investors bid nothing at $P_H$, not purchasing any bond in the high state), as the partial participation region (partial because only informed investors participate in the good state and purchase debt). For completeness, we refer to the set of parameters under which $B_H^U > 0$, so that uninformed investors also purchase some debt in the good state on the good state, as the full participation region.

Notice that, in the partial participation region, uninformed investors know the default probability conditional on being able to purchase debt in equilibrium, because they know they are only able to purchase debt in the bad state. Hence, the informed and the uninformed behave symmetrically in the bad state, bidding the same amount at the same price, $P_L$. This is straightforward from replacing $B_H^U = 0$ in the first order condition (15) and comparing it with the first-order condition (14). This implies that all information rents in the
partial participation region stem from informed investor’s ability to purchase bonds in both states of the world.

Now that we have characterized how informed and uninformed investors bid at different prices, we continue solving the informed equilibria as follows. Using the demand functions for bonds in each state along with market clearing in each state, we can characterize properties of the prices as a function of the fraction of investors that are informed, which we denote by $n$. Then we will endogenize the fraction of investors in equilibrium, $n^*$, by exploiting a free-entry condition under which investors are indifferent between being informed or uninformed.

**Proposition 16.** Consider the equilibrium with the highest sustainable prices. The good state price, $P_H$, increases with the fraction of informed investors, $n$.

**Proof.** If the economy is in a partial participation region, market clearing for the good state is just

$$nP_H B_H^I = D$$

Increasing $n$ is isomorphic to decreasing $D$, and as we showed in Proposition 13 this implies $\frac{dP_H}{dn} > 0$.

In contrast, if the economy is in a full participation region, market clearing for the good state is

$$nP_H B_H^I + (1 - n)P_H B_H^U = D,$$

which we can rewrite it in terms of excess demand as

$$ED(P_H) = B_H^U + n(B_H^I - B_H^U) - \frac{D}{P_H} = 0.$$ 

Then

$$\frac{dP_H}{dn} = - \frac{B_H^I - B_H^U}{nP_H^2 + (1 - n)P_H^2 - \left(-\frac{D}{P_H^2}\right)} > 0.$$ 

To see that this fraction is positive for the highest equilibrium price, note first that the
numerator is positive, as we have shown that \( B'_H > B'_U \). With respect to the denominator, however, as the slope of the demand (given by \( n \frac{\partial B'_I}{\partial P_H} + (1-n) \frac{\partial B'_U}{\partial P_H} \)) and of the supply (given by \( -\frac{D}{P_H^2} \)) are both negative, in principle the denominator could be positive or negative. For the highest price in equilibrium, however, the denominator is negative: when evaluated at \( P_H = 1 - \kappa \) there is an excess of supply, as \( B'_I = 0 \) and \( B'_U = 0 \) (then there is no demand), while the supply is given by \( \frac{D}{1-\kappa} \). The highest price in equilibrium is computed at the highest price at which demand and supply equalize, which implies that \( n \frac{\partial B'_I}{\partial P_H} + (1-n) \frac{\partial B'_U}{\partial P_H} < \left( -\frac{D}{P_H} \right) < 0. \)

In Figure 13 we illustrate how prices \( P_H \) and \( P_L \) depend on the fraction of informed investors \( n \) in the economy. As reference we also include in the figure the price for the uninformed equilibrium, which we denote by \( P_U \). The are two distinct regions in the graph. When \( n \) is low, the economy is in a full participation region and when \( n \) is high (in the figure to right of the arrows, for \( n \) above 0.55), the economy is in a partial participation region.

In the partial participation region, \( P_L \) does not change with \( n \) as \( B'_L = B'_U \) and the resource constraint in the bad state is just \( P_LB'_L = D \), which is independent of \( n \). Even though in the figure it looks as if \( P_L \) always declines with \( n \) in the full participation region, this is not necessarily the case, as \( P_H \) also enters in the market clearing for the bad state and the the evolution of \( P_L \) is jointly determined by an increase in \( n \) and by an increase in \( P_H \), which act as forces in opposite direction.

In contrast, \( P_H \) increases with the fraction of investors that are informed in the market, \( n \), in both regions. In the full participation region the sensitivity of \( P_H \) to \( n \) is moderated by the participation of the uninformed investors, but in the partial participation region the sensitivity is larger (the rate of increase of \( P_H \) with \( n \) is larger) as there is a pure cannibalization effect among informed investors, as the market in the good state is populated by a larger mass of informed investors, driving up demand and, thus, prices.

In Figure 14 we show how the utility of both informed and uninformed investors depend on the fraction of informed investors in the market. These utilities depend on the evolution of
prices, which we have shown depend on the fraction of informed investors. We also show the utility of investors in the uninformed equilibrium for reference. While the utility of uninformed investors decline with $n$ in the full participation region, it is independent of $n$ in the partial participation region as $P_L$ is independent on $n$ in this region, and this is the only price at which uninformed investors participate. For informed investors, however, utility always declines in the partial participation region (because of the cannibalization effect), while the utility in the full participation region may increase and then decline. Even though in the figure the utility of informed investors always decline with $n$, the reason is that in this specific numerical example $P_L$ always declines with $n$ as well.

The utility of informed investors in the informed equilibrium is always above the utility of investors in the uninformed equilibrium and the utility of uninformed investors in the informed equilibrium is always below their utility in the uninformed equilibrium. This does not imply, however, that informed investors are better-off in the informed equilibrium, as they have to spend utility costs to become informed in the first place. In Figure 15 we show that the informed equilibrium is characterized by the fraction of investors $n^*$ that make investors indifferent between being informed or uninformed, this is $U^I(n^*) - K = U^U(n^*)$, which implies that all investors are always worse-off in the informed equilibrium.
It is important to highlight at this point that the utility of investors in the informed equilibrium is lower as they end up spending resources to acquire information that is only useful to compete for whom gets the larger fraction of resources. There are no real benefits from information acquisition, and then information just implies a costly redistribution of resources across investors.

**Multiplicity**

Here we show that both the uninformed and informed equilibrium can coexist. Figure 15 shows a situation of multiple equilibria. The informed equilibrium, as discussed above, is the point at which the utility gap between informed and uninformed investors is equal to the utility cost of producing information $K$. In this specific case, a situation where all investors are uninformed is also an equilibrium since $\chi^U < K$.

The complementarity among the informed that generate this multiplicity is somewhat complicated. There is no complementarity among informed investors in the informed equilibrium (the utility of informed investors decrease as there are more informed investors, $n$), which is the reason there is an equilibrium $n^*$. However, there is an initial complementarity that
arises from moving from a regime with a single price in equilibrium (uninformed equilibrium) to multiple prices (informed equilibrium). A deviation of becoming informed when there is a single price is lower than a deviation of becoming uninformed when there are many prices in equilibrium.

In other words, multiple equilibria arises because of the discontinuous increase in the incentives to become informed at $n = 0$ when comparing the situation under which information allows to reoptimize quantities bid at a single price (uninformed equilibrium) and the situation under which information allows paying the right price in each state. The larger gains are intuitively higher as they imply reoptimizing bidding at prices that more closely aligned with correct default probabilities.

**Figure 15**

**Equilibrium Multiplicity**

Now we show how equilibria changes when changing fundamentals, in particular the average probability of default, $\tilde{κ}$. There are in principle different ways in which $\tilde{κ}$ can increase. For example, there can be an increase in the probability of a mediocre output $z$, an increase in the probability of a bad output $x$, and an increase in the probability of a bad state, $a$. As we discuss later all these changes will have different implications for equilibria, which implies that it is not sufficient to know how the average probability of default changes to predict changes in bond prices. Instead, one needs to know where the change comes from (a
reduction in the probability of a very good output, an increase in the probability of a very bad output, a change in the cost of default) to predict how information and bond prices change in our setting.

We start by analyzing how our equilibria change when there is an increase in $z$ (a reduction in the probability of a high income realization and an increase in the probability of a mediocre realization). This change induces an increase in the gap between $\kappa_L$ and $\kappa_H$. Figure 16 shows how the set of possible equilibria change in response to an increase in $z$. An increase in the probability of default, which is generated by an increase in the gap between the two states, induces more information acquisition.

**Figure 16**

**Effect of $z$ on Equilibrium Multiplicity**

The solid lines represent a low $z$ and the dotted lines a higher $z$. On the one hand, an increase in $z$ increases the individual incentives to deviate and become informed in the uninformed equilibrium (increasing $\chi^U$). In the case of the numerical simulation this effect is large enough for the uninformed equilibrium to become unsustainable. On the other hand, it increases the gap between informed and uninformed investors in the informed equilibrium, thus increasing $n^*$ in the informed equilibrium (the point at which the red solid line and the dotted black curve cross). A similar figure arises if we compare two levels of indebtedness, with a higher debt $D/W$ also increases the incentives to become informed.
in both equilibria.

Figure 17 shows the equilibrium fraction of informed investors, $n^*$, in the informed equilibrium, as we change the gap between the states in terms of default probabilities, $z$, and also as we increase $D/W$, the indebtedness of the country.

![Figure 17: Effect of $z$ and $D$ on Information in Equilibrium](image)

Now that we have characterized both the conditions for the uninformed equilibrium and the equilibrium fraction of informed investors in the informed equilibrium, we can compute the price $P_U$ in the uninformed equilibrium and the prices $P_H$ and $P_L$ in the informed equilibrium for different levels of $z$ (for the optimal $n^*$ at each fundamental $z$). We displayed these prices in Figure 18.

First, there are clearly three regions of equilibria as a function of $z$. For low levels of $z$ there are low incentives to acquire information and only the uninformed equilibrium is sustainable. In contrast, for high levels of $z$ there are high incentives to acquire information and only the informed equilibrium is sustainable. For intermediate region of $z$ both equilibria coexist. Interestingly, once we compute the weighted average of prices $E(P) = aP_H + (1 - a)[\omega P_H + (1 - \omega)P_L]$, where $\omega = \frac{(1-n)B_U^H}{(1-n)(B_H^H+B_L^H)+nB_L}$, the informed equilibrium is not only characterized by higher volatility of prices (which can fluctuate between $P_L$ and $P_H$), but also by a lower
average price, $E(P)$.

This result is important because not only investors are worse off in the informed equilibrium, as his cussed before, but also countries are worse off, both because debt can be roll over at lower prices and because they face higher volatility on those prices. This result on prices translate into the debt burden of countries: as the expected prices at which a country raises funds in the informed equilibrium are lower than in the uninformed equilibrium, the expected debt burden is higher in the informed equilibrium, as shown in Figure 19.

In other words, the informed equilibrium is inferior from both the country’s and the investors’ point of view. As we explained above, in this model information does not affect allocations, and then its costly acquisition motivated by obtaining a larger share of resources is only detrimental. even though the cost of information acquisition lies on investors, there is a pass through to the country in the form of lower sovereign bond prices.

This characterization of equilibria and potential multiplicity has implications for interpreting how shocks to fundamentals affect a country’s debt burden, as well as the volatility that countries experience in their sovereign spreads. Assume for example a simple and plausible equilibrium selection under which a country remains in a given equilibrium as long as sustainable. This “conservative” equilibrium selection introduces history dependence,
or *hysteresis*, such that small shocks to fundamentals may generate large changes in the behavior of sovereign prices.\textsuperscript{3} In different words, the past matters and two countries with identical fundamentals can have different average price of their debt, different debt burdens and different price volatility just because their past was different.

These results are relevant in interpreting the mapping from fundamentals to sovereign debt prices. Periods of calm sovereign experiences do not necessarily imply that fundamentals are calm, as it may be that the country raises funds in an uninformed equilibrium, in which prices are simply not sensitive to movements in fundamentals. In contrast, periods of turbulent sovereign experiences do not necessarily imply that fundamentals have become much more turbulent than normal, as it may be that the country transitioned to an informed equilibrium in which prices are more sensitive to movements in fundamentals.

### 3.3 Two-Country Model

So far we have studied the different informational equilibria under which a single country may raise funds. Now we study a setting in which the same mass 1 of investors bid in two

\textsuperscript{3}A history-dependent selection criterion is formally proposed and solved by Cooper (1994).
different countries, with the same characterization of income \(Y\) and default costs \(\theta\), but possibly different parameters. First, we focus on a situation in which information about \(\theta\) cannot be produced and discuss contagion on sovereign debt prices and debt crises in its purest form, without any fundamental linkage across countries other than this common pool of investors. We show in this case that the condition for contagion just relies on the utility functions displaying prudence, that is \(u'''(c) > 0\).

Second, we introduce again the possibility of information acquisition and we show that there are complementarities across countries in the incentives to acquire information. This leads to a second form of contagion based on information regimes: A country transitioning to an informed equilibrium increases the likelihood the other country moves to an informed equilibrium as well.

To extend our analysis to a two-country environment and maintain tractability we make the following assumptions. We assume that the investor household is composed of two members who each attend one of the two simultaneous auctions in the two countries. Before each auction takes place the household splits its wealth up between its two members. Each household member can become informed about the country whose auction they are attending but cannot communicate this information to the other member at the other country’s auction. They then place their bids without knowing the bids of the other household member. These assumptions allow us to restrict the number of equilibrium prices, and the conditional bids that a household might undertake. Thus, reducing the dimensionality of the problem to draw crisp conclusions.

Without these assumptions the number of prices can become quite large as the number of countries increases to 2. If there were \(J\) values of \(\theta\) in each country the number of prices in each country would be \(J^2\) if some investors were becoming informed in each country. This in turn would imply that a household that was not informed about a particular country would be choosing \(J^2\) possible marginal bid levels in each country for a potential total of \(2J^2\) bids across the two countries. Our assumption reduces this number to a maximum of \(2J\) prices in equilibrium.
3.3.1 Pure Contagion on Sovereign Debt Prices

We start by analyzing the simpler case in which both countries are in the uninformed equilibrium, and hence no investor is informed about the state in either country. This case turns out to be a fairly straightforward extension of the one-country uniformed case. Since there are now three possible assets (a safe asset, or no investment, country 1’s bonds and country 2’s bonds) the maximization problem can be written simply as

$$\max_{B_1, B_2} U = \hat{\kappa}_1 u(W - P_1 B_1 - P_2 B_2) + (1 - \hat{\kappa}_2) u(W - P_1 B_1 + (1 - P_2) B_2)$$

$$+ (1 - \hat{\kappa}_1) [\hat{\kappa}_2 u(W + (1 - P_1) B_1 - P_2 B_2) + (1 - \hat{\kappa}_2) u(W + (1 - P_1) B_1 + (1 - P_2) B_2)]$$

The first-order condition for the quantities bid in country $j$ is

$$\frac{E_j(u'(+))}{E_j(u'(-))} = \frac{P_j \hat{\kappa}_j}{(1 - P_j)(1 - \hat{\kappa}_j)}$$

where

$$E_j(u'(-)) = \hat{\kappa}_{-j} u'(W - P_j B_j - P_{-j} B_{-j}) + (1 - \hat{\kappa}_{-j}) u'(W - P_j B_j + (1 - P_{-j}) B_{-j})$$

and

$$E_j(u'(+)) = \hat{\kappa}_{-j} u'(W + (1 - P_j) B_j - P_{-j} B_{-j}) + (1 - \hat{\kappa}_{-j}) u'(W + (1 - P_j) B_j + (1 - P_{-j}) B_{-j})$$

The next proposition shows that, when utilities follow CRRA utility functions and display prudence (that is $u'''(c) > 0$), an increase in the expected default probability in one country reduces the sovereign price in the other country. Notice we have constructed a simple portfolio problem where the returns on the two risky assets are i.i.d. and there is no feedback other than the one imposed by investors rebalancing their portfolio. Furthermore, there is no feedback from information acquisition, which we explore in the next subsection.
Proposition 17. There is contagion (i.e. \( \frac{\partial P}{\partial \kappa_{-j}} < 0 \)) when preferences are CRRA.

Proof. Impose resource constraints \( P_1 B_1 = D_1 \) and \( P_2 B_2 = D_2 \) for each country in the first order conditions. Denoting \( R = P_1 B_1 + P_2 B_2 = D_1 + D_2 \), write first-order conditions as

\[
\frac{\hat{\kappa}_{-j} u'(W - R + \frac{D_j}{P_j^j}) + (1 - \hat{\kappa}_{-j}) u'(W - R + \frac{D_j}{P_j^j} + \frac{D_{-j}}{P_{-j}^j})}{\hat{\kappa}_{-j} u'(W - R) + (1 - \hat{\kappa}_{-j}) u'(W - R + \frac{D_{-j}}{P_{-j}^j})} - \frac{P_j \hat{\kappa}_j}{(1 - P_j)(1 - \hat{\kappa}_j)} = 0
\]

For simplicity

\[
\frac{\hat{\kappa}_{-j} u'(+ -) + (1 - \hat{\kappa}_{-j}) u'(++) - p_j \hat{\kappa}_j}{\hat{\kappa}_{-j} u'(- -) + (1 - \hat{\kappa}_{-j}) u'(- +) - (1 - p_j)(1 - \hat{\kappa}_j)} = 0
\]

where the first argument of \( u' \) corresponds to the repayment or not of country \( j \) and the second argument to the repayment or not of country \( -j \).

\[
\frac{dP_j}{d\hat{\kappa}_{-j}} = - \frac{u'(+ -) - u'(++) - (1 - \hat{\kappa}_{-j}) \frac{D_j}{P_j^j} \frac{\partial P^2_{-j}}{\partial \kappa_{-j}} u'(++)}{E_j(u') - \frac{D_j E_j(u^0(+))}{P_j^2 E_j(u^-(-))} - \frac{\hat{\kappa}_j}{(1 - P_j)^2(1 - \hat{\kappa}_j)}}
\]

\[
+ \frac{E_j(u^0(+))}{E_j(u^-(-))} \left[ \frac{u'(- -) - u'(- +) - (1 - \hat{\kappa}_{-j}) \frac{D_{-j}}{P_{-j}^j} \frac{\partial P^2_{-j}}{\partial \kappa_{-j}} u''(- +)}{- \frac{D_{-j} E_j(u^0(+))}{P_{-j}^2 E_j(u^-(-))} - \frac{\hat{\kappa}_{-j}}{(1 - P_j)^2(1 - \hat{\kappa}_{-j})}} \right]
\]

There is contagion, by which we mean \( \frac{dP_j}{d\kappa_{-j}} < 0 \), when the denominator is negative which is the case (as was discussed in the one country case) for the highest \( P_j^* \) in equilibrium, and the numerator is also negative. The numerator is negative when,

\[
\frac{u'(+ -) - u'(++) - (1 - \hat{\kappa}_{-j}) \frac{D_j}{P_j^j} \frac{\partial P^2_{-j}}{\partial \kappa_{-j}} u''(++)}{E_j(u'(+))} < \frac{u'(- -) - u'(- +) - (1 - \hat{\kappa}_{-j}) \frac{D_{-j}}{P_{-j}^j} \frac{\partial P^2_{-j}}{\partial \kappa_{-j}} u''(- +)}{E_j(u'(-))}
\]

In words, the relative change in the gains from bidding in country \( j \) are smaller than the relative change in the losses. This implies a reduction in bidding in country \( j \), a decline in the demand and then a decline in sovereign prices.

\( \square \)
Figure 20 is similar to Figure 12, but for different levels of risk aversion (which, for CRRA utility functions, also implies different levels of prudence) and with the left hand side computed by the ratio of marginal utilities in expectation (which depends on the probabilities of default in the country that suffers a shock). We can draw several conclusions from the figure. First, as we already discussed, the larger the level of risk aversion the smaller the sovereign price in equilibrium.

Second, we show in blue a situation in which the other country has a low expected probability of default and in red when the expected probability of default in the other country is higher. As is clear from the figure, given a shock in the probability of default in the other country, contagion is stronger the larger the risk aversion (and then the larger the prudence). This result arises for two reasons. On the one hand, the higher level of prudence the larger is the reaction of investors, moving investment away from risky sovereign bonds. On the other hand, the higher the level of risk aversion the lower the price in equilibrium and more sensitive it is to movements in the left hand side (this is, the left and right hand sides coincide in flatter regions).
3.3.2 Contagion on Information Regime

With informed investors in at least one of our countries, the model becomes more complicated. To handle that and impose the restrictions implied by our assumptions about time and lack of information sharing within investor households, we define the state vector as 
\[ s = (\theta_1, \theta_2, Y_1, Y_2) \] where \( \theta_i \) is the realized default cost and \( Y_i \) is the realized output level in country \( i \) and we denote by \( B_{ij}(\theta_i) \) the investor’s investment in country \( i \) at marginal price \( j, P_{ij} \). Given this notation the payoff to the investor’s portfolio is given by 
\[ W + \sum_{i=1}^{2} \sum_{j:\theta_j \geq s_{\theta_i}} [\mathbb{I}(Y_i > Y(\theta_i)) - P_{ij}] B_{ij}(\theta_i), \]

where \( s_{\theta_i} \) is the realized value of \( \theta_i \). For the uninformed investor in country \( i \), there is an additional restriction which takes the form of a simple measurability condition, or
\[ B_{ij}(\theta_j) = B_{ij'}(\theta_{j'}) \text{ for all } j \text{ and } j'. \quad (17) \]

The portfolio payoff to the investor is given by 
\[ \sum_s U \left( W + \sum_{i=1}^{2} \sum_{j:\theta_j \geq s_{\theta_i}} [\mathbb{I}(Y_i > Y(\theta_i)) - P_{ij}] B_{ij}(\theta_i) \right) \Pr\{s\}, \quad (18) \]

where \( \Pr\{s\} \) denotes the probability of state \( s \). The maximization problem of an uninformed investor household is to choose \( \{B_{ij}(\theta_i)\} \) for \( i = 1, 2 \) and \( j = 1, 2 \) subject to our measurability condition (17) for both \( i = 1, 2 \). The problem of an investor who is informed in country 1 is to choose \( \{B_{ij}(\theta_i)\} \) subject to our measurability condition (17) for both \( i = 1, 2 \). Note that the payoff is (18) minus the cost of information, \( K \). The problem of an investor who is informed in both countries is to choose \( \{B_{ij}(\theta_i)\} \) to maximize (18) where we need to subtract \( 2K \) to get the final payoff.

Figure 21 shows a situation in which both countries are symmetric with respect to the fundamentals and plots the incentives to acquire information vs. the cost in three different
equilibrium configurations with respect to information acquisition. Two of the configurations are symmetric - both countries in the uniformed equilibrium and both countries in the informed equilibrium. In these two cases we focus on symmetric equilibria. This means that the price in each country will be the same in the uniformed equilibria. It also means that prices $P_H$ and $P_L$ are the same in both countries in the informed equilibrium.

The third case we consider in figure 21 is an equilibrium in which the home country is informed and the other country is uniformed. In this case, the incentives $\chi^I$ to acquire information in a country are computed imposing the no information equilibrium in the other country (the solid black curve). In this case there is a single price in the other country and the the information incentives depend on the marginal prices in the country where information is a possibility.

**Figure 21**

**COMPLEMENTARITY ON INFORMATION INCENTIVES**

The green functions in the figure show the incentives to acquire information under a symmetric informed equilibrium in which both countries have the same fraction of informed investors. While $\chi^I_1$ shows the incentives to acquire information in one country (solid green
function), \( \chi^I_2 \) shows the incentives to acquire information in a second country (this is, the additional gains from acquiring information on a second country, the dashed green function). As we focus on a symmetric equilibrium, when \( n < 0.5 \) there is a mass \( 2n \) of investors who are informed in one of the countries, and \( 1 - 2n \) uninformed investors. When \( n > 0.5 \), then all investors are informed, with mass \( 2(n - 0.5) \) informed in both countries and mass \( 2(1 - n) \) informed in only one of the countries.

The Figure shows a situation in which, conditional on no one being informed in the other country, only the uninformed equilibrium is sustainable (this is, \( \chi^U < K \) and \( \chi^I < K \) for all \( n \)). In contrast, conditional on a symmetric information equilibrium, there are two equilibria that are sustainable, an uninformed equilibrium where no investor is informed about any country (as \( \chi^U < K \)) and an informed equilibrium where all investors are informed about at least one country (as \( \chi^I_1 > K \) and \( \chi^I_2 = K \) for \( N^* > 0.5 \)). This shows the strength of complementarity across countries in the incentives to acquire information.

This result has important implications for the contagion of information regimes, with their implications on expected prices, volatility of prices and debt burden. As long as a country remains in the uninformed equilibrium it is less likely that investors decide to acquire information about other countries. As soon as a country changes to an informed equilibrium, then there are more incentives to acquire information in other countries.

The intuition for this result can be explained as follows: If one country is in an uninformed equilibrium while the other is in the informed equilibrium, investors that are uninformed in both countries do not have that much of an incentive to become informed as they can always participate more in the country with a single price. In contrast, when both countries have informed investors, investors that are uninformed in both countries cannot avoid paying excessive prices in some states of the world, and this increases their incentives to acquire information.

This intuition can be corroborated in Figure 22, which shows the bidding in country 1 of an investor who is uninformed about country 1. The bids are plotted as function of \( z_1 = z_2 \).
shows how these bids react to a symmetric increase in both z’s. $B^U_1$ shows the bidding in country 1 when both countries are in the uniformed equilibrium. In contrast, $B_{1,H}^I$ and $B_{1,L}^I$ shows the bidding in country 1 when both counties are in the informed equilibrium and the investor is informed in country 2 (but not about country 1). In the informed equilibrium case there are two marginal prices in each country and the graph shows his bids for each of these prices. $H$ and $L$ respectively. This shows the segmentation that information generates. Informed investors tend to invest more in the country in which they are informed, and at some point exclusively in such a country.

**Figure 22**

SEGMENTATION

3.4 An illustration Based on the European Debt Crisis

Sovereign bond spread in Europe have displayed an interesting pattern since the Euro was introduced in 1999. After a long period in which government bond yields were relatively
stable and quite similar across countries, they showed the first signs of divergence on September 2008 (right after the banking crisis in Ireland that followed the collapse of Lehman). This divergence then become magnified during 2010 and 2011 (during the so-called “Greek sovereign crisis”). As can be seen in Figure 23, after 2009 government bond yields increase significantly in comparison to the mean during the five years preceding the crisis for some countries (notably Greece, Ireland and Portugal), while for some other countries declined (notably Germany, France and Netherlands). The “fanning out” of spreads across european countries stopped right after Mario Draghi’s influential statement during a panel discussion in July 2012, where he claimed that the ECB ”...is ready to do whatever it takes to preserve the Euro. And believe me, it will be enough.” Since then, the spreads of most countries started a process of convergence.

**Figure 23**
**European 10 years bond yields (in %)**

Source: Eurostat, EMU Convergence Criterion Database. Notes: As in Wright (2014), data are derived from secondary market information on prices of government bonds issued in local currency with a residual maturity of around 10 years.

One explanation of this pattern is that government yields closely reflect fundamentals and that these fundamentals diverged considerably following the 2008 global crisis, substantially
Table 1
Regression Results

<table>
<thead>
<tr>
<th></th>
<th>Coeff.</th>
<th>s.d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_1$</td>
<td>-0.204***</td>
<td>(0.023)</td>
</tr>
<tr>
<td>$\beta_2$</td>
<td>-0.174***</td>
<td>(0.050)</td>
</tr>
<tr>
<td>$\beta_3$</td>
<td>-0.023***</td>
<td>(0.008)</td>
</tr>
<tr>
<td>$\beta_4$</td>
<td>0.027***</td>
<td>(0.005)</td>
</tr>
</tbody>
</table>

$R^2$ 0.64

$N$ 1493

$FE$ Yes

deteriorating in countries like Greece and Ireland and improving in countries like Germany and France. Another explanation is that, even though fundamentals did not change dramatically, the sensitivity of yields to fundamentals increased during the crisis.

To capture these explanations we run the following simple OLS regression

$$Yields_{it} = (\beta_1 + \beta_2 I_c) \Delta GDP_{it} + (\beta_3 + \beta_4 I_c) \left( \frac{Debt_{i}}{GDP_{it}} \right) + \eta_i + \eta_t + \epsilon_{it}$$

with yearly data from Eurostat for 28 European countries since 2000.\(^4\) $Yields_{it}$ correspond to 10 year government bond yields for country $i$ in year $t$. The observed fundamentals we include are the yearly change of real GDP per capita, $\Delta GDP_{it}$ and the outstanding level of public debt over GDP, $\left( \frac{Debt_{i}}{GDP_{it}} \right)$. We allow for country and year fixed effects and also for the possibility that the sensitivity of yields to fundamentals changes during crises, captured by the indicator $I_c$, which is equal to 1 for the crisis years, 2009-2013.

This regression controls for the first explanation, as GDP growth and debt over GDP seem to be significant variables explaining the evolution of yields, and shows that the second explanation is partly correct, as the sensitivity of yields to GDP growth and debt over GDP increases significantly during the crisis. Still these explanations are not enough to explain the evolution of sovereign yields during the recent European debt crisis, as shown in the

\(^4\)Countries are Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and United Kingdom.
evolution of the regression errors, $\epsilon_{it}$ for 2009-2013. Figure 24 shows that the regression errors increased significantly between 2009 and 2013, which is the time frame in which yields diverged significantly.\(^{5}\)

Consistent with these results, Bocola and Dovis (2015) find that standard empirical models that tend to capture the evolution of yields in normal times, are not able to accommodate their dynamics during the recent European sovereign crisis. This implies the divergence cannot be explained by the observed behavior of the usual fundamentals, such as GDP growth or the level of indebtedness of the country. More specifically, the standard deviation of the regression errors increased by a factor of three during the crisis when compared to normal times.

**Figure 24**
**Regression Errors**

Our paper provides an alternative interpretation of this residual, which cannot be accommodated by the more standard explanations. The divergence of the errors and the higher

\(^{5}\)For more involved empirical analyses, but similar results, see Borgy, Laubach, Mesonnier, and Renne (2012), von Hagen, Schuknecht, and Wolswijk (2011) and Baldacci and Kumar (2010).
sensitivity to publicly observable fundamentals during crises may be the reflection of a different information regimen. This explanation can account not only account for variables that are publicly observable but also for variables that are not public and costly to obtain by investors. In the recent European debt crisis these variables may include the political cost of default, the health of the domestic financial institutions, the exposure of domestic banks to certain assets, etc.

Indeed both the larger sensitivity to observed fundamentals and the larger errors from a regression based on those fundamentals can be explained by our model when one country suffers a shock that pushes it into an informed equilibrium. To see this, imagine a situation with seven countries with different $z$ levels, which can be interpreted as the inverse of the GDP growth (the larger the GDP growth, the lower the expected probability of default for the country). Imagine also that during normal times these countries are all in an uninformed equilibrium. In Figure 25 this is captured by the seven green dots having a sovereign price according to $p^U$. As can be seen, prices are not very sensitive to fundamentals and can be perfectly explained by the observed fundamental $z$ (in this extreme there would be no errors if running a regression as the one above).

**Figure 25**

**Simulation During Normal Times**

![Figure 25 Simulation During Normal Times](image)

- Low sensitivity to fundamentals
- Small errors when U equilibrium

\[ P^U \]
\[ p_U \]
\[ p_H \]
\[ p_L \]
\[ E(p) \]
Imagine now that the country with the largest $z$ (or the smaller GDP growth) has a negative, relatively small, shock that reduces its GDP growth even more. For such a country the uninformed equilibrium would become unsustainable, then attracting information about its economy. As now there is information in some other country there are more incentives to acquire information about the countries that have not been hit by the GDP growth shock, and some of them would also move to an informed equilibrium. After this reinforcing effect on information acquisition across countries, the Figure 25 may change to Figure 26.

**Figure 26**

**Simulation During Crises**

In Figure 26, the five countries with the lowest GDP growth (highest $z$) have moved to an information equilibrium. Sovereign bond prices reflect now information not only about $z$ but also about $\theta$, which is not publicly observable and is not included in the regression. This effect has two implications. First, for some countries information about $\theta$ is “positive” ($\theta_H$ or high cost of default) and their price will be $p_H$, which is above what $p^U$ would imply. For some countries information about $\theta$ is “negative” ($\theta_L$ or low cost of default) and their price will be $p_L$, which is below what $p^U$ would imply. This immediately implies that during a crisis any regression model that uses standard publicly observable data to explain yields will have more errors that in normal times, as there are variables not observed by
the econometrician that enter into the pricing of debt. Second, since in the informed equilibrium the average price is lower than in the uninformed equilibrium, having more countries in the informed equilibrium makes the sensitivity of prices to fundamentals $z$ larger (higher slope in the regression, which is now an average between the blue $p^U$ that uninformed countries follow and the purple $E(p)$ that country sin the informed equilibrium follow in expectation).

### 3.5 Conclusions

We constructed a simple model of portfolio choice with information acquisition, where the portfolio is composed by sovereign debt of different countries and information about some determinants of default are not easily observable and costly to acquire.

For a single country we have shown that the participation of informed investors (informed equilibrium) is more likely when the country is highly indebted and when there is more certainty about its fundamentals. An equilibrium in which a country raises funds from informed investors is inferior, as investors obtain less utility and the country faces higher and more volatile prices, then higher debt burden.

Given that an informed and a uninformed equilibrium may coexist, small changes in fundamentals can generate large changes in the sovereign debt experience. If the selection of equilibrium is hysteresis (the country remains in a given equilibrium as long as it is sustainable) then the sovereign price of two countries with the same fundamentals but different past can have very different experiences.

Once we allow for many countries, there are two important sources of contagion. On the one hand, contagion of sovereign debt prices does not require fundamental linkages or common factors, just a common pool of investors that react to changes in fundamentals of each country and rebalance the portfolio. On the other hand, the information regime is also contagious, as one country moving to an informed equilibrium increases the incentives to
acquire information about other countries, even in the absence of economies of scale to acquire information.

Our results show why it is not straightforward to interpret changes in sovereign debt prices as informative about the country’s fundamentals, as they depend not only on publicly observable fundamentals but sometimes also on fundamentals that are not easily observable, as they depend not only on the country’s own fundamentals but also on other countries’ fundamentals, as they depend not only on the country’s informational regime (and thus, potentially on past fundamentals) but also on other countries’ informational regime.

We have highlighted the main forces behind information acquisition and then behind the mapping between observable and non-observable fundamentals to sovereign debt spreads. There are many reasons why we may expect these forces to be also quantitatively relevant. Just to mention a few magnifying forces. First, the probability of default is endogenous and depends on sovereign prices. There is a feedback effect across countries: an exogenous increase in default probability in one country induces a reduction of prices in several other countries, increasing the probabilities of default in all those countries, further reduction of prices, and so on. Second, fundamental linkages across countries naturally magnify contagion. Third, if there is time varying prudence, for example because of time varying risk-aversion or time varying wealth. Fourth, market segmentation can concentrate contagion in certain regions, buffering others. Finally, how a shock in a country changes the informational equilibrium in other countries depend on the structure of the costs to acquire information: if a country attracts informed investors and then makes easier for them to acquire information about other similar countries, then it is more likely that those other countries also attract informed investors.
Chapter 3 : Does Universal Banking Affect the Risk and Productivity of Firms?*

3.1 Introduction

In this paper, we exploit the stepwise repeal of the Glass-Steagall Act in the U.S. to empirically evaluate the effects of bank-scope deregulation on the performance of bank-dependent firms. In doing so, we take a step towards measuring the value added of large universal banks as suppliers of financing to the real economy.

The Glass-Steagall Act of 1933 imposed a strict separation between commercial banking, such as borrowing and lending, and investment banking, such as securities underwriting. Its repeal allowed for the formation of universal banks able to offer both loans and non-loan products. We argue that this deepening of bank-firm relationships led to reduced informational asymmetries and broader financial contracting opportunities, generating economies of scope in financial intermediation and relaxing constraints in the provision of external finance.

We map this channel to the data by asking whether the deregulation of universal banks led to an increase in the supply of credit for firms making risky investments. Our argument is

*This chapter is co-authored with Farzad Saidi
that constraints on external finance stemming from asymmetric information are typically particularly tight for volatile projects (see, e.g., Stiglitz and Weiss (1981) and Greenwood, Sanchez, and Wang (2010)). As a result, volatile ventures are the marginal projects that stand to benefit the most from reduced informational asymmetries under universal banking. We answer this question in the affirmative: the deregulation of universal banking led to increases in firm-level sales-growth volatility of at least 14%. We find effects of similar magnitude for firms’ stock-return and idiosyncratic volatilities. We also show that these risk increases were accompanied by higher total factor productivity, capital expenditure, and market capitalization of universal-bank-financed firms.

To identify the effect of bank scope on firm-level outcomes, we focus on a deregulatory event in 1996 that removed some of the firewalls in extant universal banks. Prior to 1996, these firewalls limited universal banks’ ability to offer loans and concurrent non-loan products in a coordinated manner. Their removal allowed universal banks to share more resources and information across their commercial-bank and securities divisions, and to potentially use this information to enter richer intermediation relationships. Our empirical strategy, thus, is to use the 1996 deregulation as a shock to universal banks’ propensity to engage in deeper relationships with their borrowers. We then compare changes in the volatility of universal-bank-financed firms before and after 1996 to the volatility of firms that received loans from banks whose scope of banking was unaffected by the deregulation. In this manner, we provide evidence that the increased scope of universal banking boosted lending to riskier firms.

Figures 28 and 29 illustrate our findings. We plot the loan-weighted average six-year sales-growth volatility of public firms in the U.S. that received loans from commercial and universal banks. In Figure 28, we focus on loans granted by universal banks. Among universal-bank loans, we differentiate between cross-sold and non-cross-sold ones, where we label loans as cross-sold when the respective debtor firms also received an underwriting product from the same universal bank. Until 1996, cross-sold and non-cross-sold universal-bank loans are associated with similar levels of firm risk, but after 1996 the firm-level risk associated
with cross-sold universal-bank loans exceeds that of non-cross-sold loans. In Figure 29, we contrast cross-sold universal-bank loans and commercial-bank loans. The two series exhibit similar levels of firm risk prior to 1996, but cross-sold universal-bank loans are associated with substantially higher firm-level volatility after 1996. This suggests that informational economies of scope from cross-selling are a key driver of firm-level volatility.

Our empirical results hold up to the inclusion of firm fixed effects, so that we identify the treatment effect off firms with multiple bank relationships. This implies that the treatment effect does not operate solely at the extensive margin, but also at the intensive margin. That is, the deregulation of universal banks relaxed financial constraints for risky firms that otherwise would not have received any financing, and also allowed firms to realize riskier projects than the ones for which they were already able to secure financing from universal banks before the deregulation.

As our identification strategy is based on time variation at the bank level, we need to ensure that our treatment effect is not contaminated by other shocks to credit supply around the 1996 deregulation. A key concern in this period is the state-level deregulation of bank branching. We control for this by including state-year fixed effects, after which our results remain robust.

We then turn to the question as to whether the 1996 deregulation of universal banks led to the financing of excessively risky firms that may be more likely to default, or whether the risk-increasing developments were accompanied by higher productivity of universal-bank-financed firms. First, we provide evidence that the increases in firm-level risk were not associated with higher default risk. Second, we show that the deregulation of universal banks led to long-lasting within-firm increases in total factor productivity of approximately 3%. Further results indicate that these productivity increases stem from increases in capital expenditure, which are furthermore associated with positive market valuations. Our findings attest to a potentially efficiency-increasing effect of deregulating bank scope: when universal banks receive the enhanced ability to cross-sell loans and non-loan products, this leads to an increase in the supply of credit for firms making risky, productivity-increasing
investments.

Next, we provide evidence that the firm-level real effects of universal banking are due to informational economies of scope across divisions, rather than higher bank revenues from cross-selling. To do so, we exploit bank mergers among commercial and investment banks as a source of variation in the resulting universal banks’ information about borrower firms. Specifically, we consider firms who received both a loan from a commercial bank and an underwriting product from an investment bank, and contrast two groups: those whose lender and underwriter merged with each other, and those whose lender and underwriter both merged with another bank to form a universal bank, but not with each other.

While both groups’ banks are now universal banks and, thus, have access to the same contracting opportunities going forward, only the former group’s banks are able to access both extant loan and non-loan private information about the same firms. As a result, our approach varies universal banks’ information about borrower firms, but holds constant potential revenues from the intermediation relationship. We find that firms dealing with better informed lenders, once again, exhibit increases in total factor productivity of up to 3%, which lends support to the idea that our treatment effects are due to informational economies of scope.

Last, we complement our analysis based on loans issued by mature, public firms with evidence on firms early in their life cycle. Namely, we examine whether universal banks extended their risk-taking behavior to their role as underwriters by serving as bookrunners for IPOs of younger and, thus, potentially riskier firms. To this end, we compare the age of firms in IPOs run by universal banks compared to investment banks, whose scope of banking activities was unaffected by the deregulation, before and after 1996. We find that as a response to the deregulation, universal banks took firms public that were at least 6 years younger than those serviced by investment banks. Our evidence on IPO age supports the idea that the deregulation of universal banks facilitated the entry of younger and riskier firms into the U.S. stock market.
In summary, our paper documents the real effects of bank-scope deregulation. We establish that by allowing universal banks to proactively cross-sell loans and non-loan products, they reap informational economies of scope that enable them to finance riskier projects with higher productivity. Thus, increasing bank scope from pure commercial banking (i.e., lending) to combined lending and corporate-securities underwriting has not just changed the landscape of U.S. banks, but also left its mark on publicly listed firms that obtained external financing through universal banks.

Related Literature

Our paper is related to two main strands of literature. The first is on the impact of banking deregulation on firm-level real outcomes, most notably in the context of bank branching deregulation. The second is on the effects of expanding bank scope and relationship banking.

Regarding bank branching deregulation, Morgan, Rime, and Strahan (2004) and Correa and Suarez (2009), respectively, find stabilizing effects on state-level growth and firm-level volatility among large, publicly listed firms in the U.S. Most closely related to our paper is Krishnan, Nandy, and Puri (2015), who show that interstate branching increased the supply of credit for financially constrained firms, allowing them to use these funds to invest in productive projects. By focusing on bank scope rather than branching deregulation, we provide evidence of increasing volatility and productivity. We also employ a different identification strategy than is typical in the branching literature. Rather than exploiting the staggered timing of branching deregulation across states, and then distinguishing between bank-dependent and non-bank-dependent firms in treated states, we use data on firms’ lending relationships with universal banks to directly identify the impact of financial deregulation on firm-level outcomes. Butler and Cornaggia (2011) share our focus on the

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2See Amore, Schneider, and Zaldokas (2013); and Benfratello, Schiantarelli, and Sembenelli (2008) using Italian data.

3While this idea is similar in spirit to that pursued by Herrera and Minetti (2007) using data from Italy, the authors do not make use of any regulatory quasi-experiment to identify the impact of informed lending on firm outcomes.
effects of finance on productivity, but exploit variations in demand interacted with access to external finance rather than variations in bank structure.

Drucker and Puri (2007) survey the literature on expanding bank scope and its effects on relationship banking. One part of this literature looks at the bank-level effects of the repeal of the Glass-Steagall Act as in Saunders, Strock, and Travlos (1990) and Cornett, Ors, and Tehranian (2002). Ang and Richardson (1994), Kroszner and Rajan (1994), and Puri (1994) argue that there is little evidence of a conflict of interest in universal banking in the pre-Glass-Steagall era by examining the long-run performance of bank-underwritten securities.\(^4\) In line with a certification role for universal banks, Puri (1996) finds that investors were willing to pay higher prices for securities underwritten by universal rather than investment banks, while Gande, Puri, Saunders, and Walter (1997) show that price differentials between universal-bank and investment-bank underwritings are higher when information costs are large. In line with these papers, we also highlight economies of scope from concurrent lending and underwriting, but track their impact on firm-level real outcomes.\(^5\) We also present direct evidence suggestive of informational economies of scope.\(^6\)

The importance of cross-selling has been pointed out in Yasuda (2005), Bharath, Dahiya, Saunders, and Srinivasan (2007), and Santikian (2014), among others. With the notable exception of Ljungqvist, Marston, and Wilhelm (2006) and Puri and Rocholl (2008), most studies document pricing effects of cross-selling. Drucker and Puri (2005) and Calomiris and Pornrojnangkool (2009) present evidence that universal banks are more likely to offer discounted yield spreads on concurrent loans, which is also confirmed by Calomiris and Pornrojnangkool (2009). We advance this research by providing evidence of universal banks’ ability to bring economies of scope to bear on firm-level real outcomes. Another example is Schenone (2004), who finds significantly less IPO underpricing for firms that have pre-IPO

\(^4\)More recently, Duarte-Silva (2010) shows that an issue’s certification is enhanced by private information acquired through pre-existing lending relationships.

\(^5\)Note that our paper does not focus on universal banks’ holding equity stakes in companies and their representation on the latter’s boards (see Ferreira and Matos (2012)), as is the case under the classical model of universal banking in Germany.

\(^6\)Kanatas and Qi (1998) and Kanatas and Qi (2003) theoretically study the impact of informational economies of scope on underwriting, but not on firm-level real outcomes.
lending relationships with prospective underwriters (i.e., universal banks). Unlike Schenone (2004), we use firm-level risk and productivity of universal-bank-financed firms to infer informational economies of scope in universal banking.

3.2 Empirical Strategy and Data

We start our analysis by first describing the institutional background of the stepwise repeal of the Glass-Steagall Act. We then develop our key hypothesis, and present our identification strategy. Finally, we describe the empirical implementation and the data.

3.2.1 Institutional Background

The Glass-Steagall Act of 1933 separated commercial and investment banking, and until its stepwise repeal starting in 1987, shaped the financial architecture of the U.S. Under Section 20 of the Glass-Steagall Act, commercial banks were prohibited from engaging in any kind of underwriting or securities business. These activities were subsequently entirely in the hands of investment banks and other investment houses. The repeal allowed for the formation of universal banks combining both commercial and investment banking services.

Starting April 30, 1987, commercial banks were allowed to open so-called Section 20 subsidiaries and generate up to 5% of gross revenues from underwriting and dealing in certain securities, namely municipal revenue bonds, mortgage-related securities, consumer-receivable-related securities, and commercial paper. Two years later – on January 18, 1989 – banks were allowed to engage in veritable investment-banking activities, most notably corporate debt and equity underwriting, and on September 13, 1989, the revenue limit was raised to 10%. This gave rise to another possibility for commercial banks to become universal banks, other than through Section 20 subsidiaries, namely by purchasing or merging with investment banks. These measures constitute the first stage of the repeal of the Glass-Steagall Act, followed by seven years of regulatory inactivity.
While at that point universal banks were able to engage in both lending and corporate-securities underwriting, there were still firewalls in place that separated the two activities. An important consequence of this was that universal banks could not actively cross-sell loans and non-loan products to their clients. Indeed, such cross-selling was prohibited, or at least severely restricted, under the Federal Reserve Act (Sections 23A and B). This affected banks’ lending decisions insofar as loans are granted upon approval by a credit committee, often on the basis of high expected depth of cross-selling.\textsuperscript{7}

In a major expansion of cross-selling opportunities, the Federal Reserve Board proposed the elimination of some of the informational and financial firewalls on August 1, 1996, and simultaneously raised the revenue limit on underwriting securities from 10 to 25\%.\textsuperscript{8} This also enabled more commercial banks to expand into universal banking by directly merging with an investment bank.

In particular, the removal of informational firewalls interacts with cross-selling in a meaningful way, as it allows for the possibility of sharing non-public customer information across commercial-bank and securities divisions. Thus, the 1996 deregulation deepened bank-firm relationships and enhanced banks’ monitoring capabilities, generating economies of scope across financial products.

### 3.2.2 Hypothesis Development

Our basic hypothesis is that the advent of universal banking led to increases in firm-level risk. Specifically, we argue that the 1996 deregulatory shock boosted cross-selling by universal banks, while cross-selling in turn represents a positive shock to the quality of banks’ information about borrower firms (Kanatas and Qi (1998) and Kanatas and Qi (2003)).

\textsuperscript{7}This phenomenon has also been discussed in the academic literature: Bharath, Dahiya, Saunders, and Srinivasan (2007) provide ample evidence of cross-selling of loans and non-loan products (fee-generating services), such as debt and equity underwriting. Furthermore, Drucker and Puri (2005) and Yasuda (2005) examine the relationship between past lending relationships and seasoned equity offerings and debt underwriting, respectively. Santikian (2014) shows the importance of cross-selling in small business lending.

\textsuperscript{8}This specific regulatory event period culminated in the Federal Reserve Board’s announcement of replacing further firewalls on August 22, 1997.
A robust conclusion from theoretical corporate finance is that lender informedness is particularly effective at reducing barriers to external finance for risky firms. For example, Greenwood, Sanchez, and Wang (2010) show that in a canonical costly-state-verification framework, cash-flow volatility reduces the firm’s pledgeable income and borrowing capacity, but that these frictions can be overcome more easily by an informed lender. Information frictions thus disproportionately reduce risky firms’ access to external finance, and informational economies of scope in universal banking improve the funding ability of risky enterprises.

For a given set of investment opportunities, relaxed information frictions allow firms to invest in relatively risky but productive ventures for which they could not previously obtain external financing. Accordingly, our key empirical hypothesis is that universal-bank-financed firms exhibit higher risk after an increase in the scope of the respective universal banks’ activities, and that these increases in risk are accompanied by increased firm-level productivity and profitability. We will show that this holds across various risk measures, not just limited to corporate lending, but also in terms of risk associated with younger firms taken public by universal banks. We furthermore show that universal-bank-financed firms exhibit higher total factor productivity, capital expenditure, and market capitalization.

3.2.3 Identification Strategy

Our identification strategy exploits the 1996 deregulation as a shock to universal banks’ propensity to cross-sell loans and non-loan products to their clients, allowing them to derive informational economies of scope. In order to empirically evaluate the impact of such increases in bank scope on real outcomes of borrower firms, we employ a difference-in-differences framework. Our treatment group consists of borrower firms that received universal-bank loans. The control group consists of firms that received loans from other types of banks, typically commercial banks, whose scope of banking was unaffected by the
To test the impact of the 1996 deregulation on the characteristics of universal-bank-financed firms, we estimate the following difference-in-differences specification at the level of years in which a firm $i$ received at least one loan from one or multiple banks $j$:

$$y_{ijt} = \beta_1 Universal-bank\ loan_{jt} \times After(1996)_t + \beta_2 Universal-bank\ loan_{jt}$$

$$+ \beta_3 X_{ijt} + \delta_t + \eta_j + \epsilon_{ijt},$$

(19)

where $y_{ijt}$ is a firm-level outcome in year $t$, e.g., change in firm-level volatility, $Universal-bank\ loan_{jt}$ is an indicator variable for whether at the time of any loan transaction in year $t$ any one of the lead arrangers $j$ was a universal bank, $After(1996)_t$ is an indicator for whether the firm’s loan year in question was in 1997 or later, $X_{ijt}$ denotes other control variables measured in year $t$, and $\delta_t$ and $\eta_j$ denote year and bank fixed effects, respectively, where bank fixed effects are included for all lead arrangers of all loans in a given year.

This bank-level specification effectively estimates the average risk associated with loans granted by universal banks compared to pure commercial or investment banks before and after 1996. In particular, we do not rely on the establishment dates of universal banks – i.e., the conversion of commercial into universal banks – as our main variation in bank scope, as commercial banks endogenously chose to become universal banks.\(^9\) Conversely, it is unlikely that banks and firms were anticipating the deregulatory policy before 1996. This is affirmed by the fact that the banking industry had already proposed the elimination of firewalls in 1991, which was rejected by the United States House Committee on Financial Services.

In the presence of bank fixed effects $\eta_j$, the difference-in-differences estimate $\beta_1$ is identified off the lending behavior of commercial banks that became universal banks prior to the deregulation and, thus, experienced a shift in the scope of their activities in 1996. That is,\(^9\) As noted by Bhargava and Fraser (1998) among others, the initiation of universal-banking deregulation from 1987 to 1989 was based on the Federal Reserve’s responses to specific requests from large banks (Bankers Trust, Citicorp, and J.P. Morgan).
to estimate $\beta_1$ and $\beta_2$, a given bank $j$ needs to be observed as a lender in at least three instances: when it is still a commercial bank, after it has opted to become a universal bank but before the 1996 deregulation, and as a universal bank after the 1996 deregulation.

A potential concern is that post-1996 risk taking by universal banks may be due to the sorting of new firms with different risk profiles seeking financing from universal banks after the deregulation was implemented. This would render it problematic to compare universal-bank loans before and after 1996. To address this issue, we also include firm fixed effects in our regressions. We thus identify the treatment effect off firms that received multiple loans over time. More specifically, after the inclusion of firm fixed effects, the difference-in-differences estimate $\beta_1$ is identified off multiple loans to firm $i$ granted by at least two different banks. Each bank $j$, in turn, needs to be observed to contract with firm $i$ at least twice, as a commercial and as a universal bank.

Note that as the difference-in-differences estimate is at the bank-year level $jt$, we cannot include bank-year fixed effects. In order to interpret $\beta_1$ as a shift in bank-level supply for risky firms, we need to ensure that $\beta_1$ is not contaminated by other shocks to credit supply around the 1996 deregulation. The key concern in this period is the relaxation of bank branching restrictions (see, among others, Jayaratne and Strahan (1996)), which constituted a positive credit-supply shock at the state level while allowing commercial banks to expand the range of their products through mergers with already existing universal banks within and across states. To control for this possibility, we also include state-year fixed effects, as defined by the state of the borrower firm’s headquarter.

We then take one more step to provide supporting evidence of our conjecture that observed increases in risk and productivity are due to informational economies of scope. To do so, we must take into account that cross-selling does not only vary lenders’ information about borrower firms, but also enables universal banks to derive greater profits from their relationships with firms. The two channels may even be intertwined, in that informational economies of scope support the cross-marketing efforts of universal banks, leading to increased revenues, and the very process of cross-selling generates further information about
the client through closer intermediation relationships.

To identify the effect of information on firm-level outcomes, we exploit that in addition to removing firewalls, the 1996 deregulation also lifted the revenue limit on underwriting securities from 10 to 25%. This spurred a wave of bank-scope-expanding mergers between commercial, or already existing universal, banks and investment banks. We use such bank mergers as a shock to bank-level information acquisition about borrower firms, because merged universal banks can make use of the information embodied in both its extant commercial-bank and investment-bank division.

We operationalize this strategy by comparing firms that in the past received both a loan from a commercial (or already existing universal) bank as well as an underwriting product from an investment bank. In the treatment group, the two institutions merge with each other, thereby pooling their information about borrower firms. In the control group, both banks merged with financial institutions of complementary scope – i.e., the commercial/universal bank merges with an investment bank and vice versa – but not with each other. In this manner, we hold constant the potential for future revenues through cross-selling to treatment and control firms, as both treated and control firms remain in relationships with universal banks after the mergers. Yet, firms in the treatment group interact with a better informed universal bank, while those in the control group do not.

We show that all results based on our difference-in-differences estimations hold for this alternative universal-bank-mergers identification strategy. This serves as evidence that universal banks’ ability to finance riskier firms is indeed due to informational economies of scope rather than differences in revenues from bank-firm relationships.

### 3.2.4 Empirical Implementation

To test our claim that universal banks financed riskier firms, we use transaction-level data on syndicated loans issued by publicly listed firms in the DealScan database. We focus on lead arrangers when characterizing the types of banks that granted the loan. For our
analysis, we collapse our loans sample to the firm-loan-year level, i.e., we summarize all
loans of a firm in a given year.

In order to determine whether a bank was a universal bank at the time of a given loan
transaction, we compare the completion date of a bank-scope-expanding (from commercial
to investment banking) acquisition or the opening date of the respective bank’s first Section
20 subsidiary to the transaction date.

As an example, consider the historical anatomy of J.P. Morgan. Before acquiring Bank One
on July 1, 2004, J.P. Morgan had already become a universal bank by opening a Section
20 subsidiary on April 30, 1987, followed by a merger with Chase Manhattan, which had
a Section 20 subsidiary since December 30, 1988 (and later merged with Chemical Bank).
Similarly, Bank One, J.P. Morgan’s acquisition target in 2004, maintained a Section 20
subsidiary which it had opened on February 2, 1989. Thus, despite a series of mergers, J.P.
Morgan became a universal bank through opening a Section 20 subsidiary in 1987, and any
loan granted by J.P. Morgan after April 30, 1987 is labeled as a loan granted by a universal
bank. In Table 2, we provide an overview of all universal banks in our loan data.

In our baseline regression, we run the difference-in-differences specification (19) on the
sample of firm-loan years to estimate the treatment effect of the 1996 deregulation on the
riskiness of borrowers contracting with universal banks. As dependent variable, we use
the difference between a logged six-year volatility measure from \( t \) to \( t + 5 \) and that from
\( t - 6 \) to \( t - 1 \), where \( t \) is the firm-loan year in question. That is, the outcome variable
measures the percent change in risk around year \( t \) in which a firm received at least one loan.
Standard errors are clustered at the bank level, using a vector of all banks \( j \) that acted as
lead arrangers to firm \( i \) in a given year \( t \)

\(^{10}\) Note that we also have U.S. banks of international origin in our sample. These banks are special cases
in that before the International Banking Act of 1978, they were not subject to the Glass-Steagall Act. As a
consequence, international banks that were active in the U.S. before 1978 and established as universal banks
outside the U.S. were allowed to continue their business model in the U.S. (as long as they would not expand
their activities further). None of the banks in our sample were subject to the International Banking Act.
For instance, Deutsche Bank became a universal bank only after acquiring Morgan Grenfall, a London-based
investment bank, in 1990. Similarly, Crédit Suisse acquired a controlling stake in the American investment
bank First Boston Corporation in December 1988.
As the sample is limited to years in which firm \( i \) received at least one loan, the omitted category consists of firm-loan years with only commercial or investment banks as lead arrangers, none of which experienced a change in their scope of banking activities following the 1996 deregulation.

When we move to analyzing firm-level outcomes such as firms’ total factor productivity (TFP) that do not require multiple years of data for their calculation, we also include all firm years (from Compustat) without any loan transactions. As changes in productivity might not materialize immediately after a loan issue, we define firm-loan years based on whether a firm received a loan anytime in the past five years.\(^{11}\) This implies that our estimated effects of universal-bank vs. non-universal-bank-loans on, among other outcomes, TFP last, or show only in, up to five years. Given that we also include firm-year observations for which all loans-related variables are zero, firms with no loan in a given year become the omitted category. Furthermore, this enables us to include firm fixed effects and estimate within-firm effects of universal-bank loans by estimating the following regression specification:

\[
y_{it} = \beta_1 \text{Universal-bank loan}_jt \times \text{After}(1996)_t + \beta_2 \text{Universal-bank loan}_jt \\
+ \beta_3 X_{ijt} + \delta_t + \mu_i + \eta_j + \epsilon_{it},
\]  

\[(20)\]

where \( y_{it} \) is the natural log of firm \( i \)'s outcome variable in year \( t \), \( \text{Universal-bank loan}_jt \) is an indicator variable for whether, given any loans received by firm \( i \) from year \( t - 4 \) to \( t \), at the time of any loan transaction any one of the lead arrangers \( j \) was a universal bank, \( \text{After}(1996)_t \) is an indicator for whether the year in question was in 1997 or later, \( X_{ijt} \) denotes other control variables measured in year \( t \), and \( \delta_t, \mu_i, \eta_j \) denote year, firm, and bank fixed effects, respectively, where bank fixed effects are included for all lead arrangers of all loans granted to firm \( i \) from year \( t - 4 \) to \( t \). Standard errors are clustered at the firm-year level.

Finally, in order to disentangle the revenue channel from informational economies of scope

\(^{11}\)Note that for all loans after 1996, this definition is censored at the year 1997. Our results are robust to variations of the five-year horizon, and are available upon request.
using bank mergers, we estimate the following specification similar in spirit to (20):

\[
y_{it} = \beta_1 \text{Loan from CB, underwriting from IB, both merged}_{jt} \\
+ \beta_2 \text{Loan from CB that merged}_{jt} \times \text{Underwriting from IB that merged}_{jt} \\
+ \beta_3 \text{Loan from CB that merged}_{jt} \\
+ \beta_4 \text{Underwriting from IB that merged}_{jt} \\
+ \beta_5 \text{Any loan}_{it} \times \text{Any underwriting}_{it} \\
+ \beta_6 \text{Any loan}_{it} + \beta_7 \text{Any underwriting}_{it} + \beta_8 X_{ijt} + \delta_t + \mu_i + \epsilon_{it},
\]

(21)

where \(y_{it}\) is the natural log of firm \(i\)'s outcome variable in year \(t\), \textit{Loan from CB, underwriting from IB, both merged}_{jt} indicates whether anytime from \(t - 10\) to \(t - 1\), firm \(i\) received a loan from a commercial or universal bank, an underwriting product from an investment bank, and both banks merged with each other until year \(t\), \textit{Loan from CB that merged}_{jt} is an indicator variable for whether anytime from \(t - 10\) to \(t - 1\), firm \(i\) received a loan from a commercial or universal bank that merged with an investment bank thereafter, and \textit{Underwriting from IB that merged}_{jt} is an indicator variable for whether anytime from \(t - 10\) to \(t - 1\), firm \(i\) received an underwriting product from an investment bank that merged with a commercial or universal bank thereafter. \textit{Any loan}_{it} and \textit{Any underwriting}_{it} are indicator variables for whether firm \(i\) received any loan or any underwriting product, respectively, from any commercial, universal, or investment bank anytime from \(t - 10\) to \(t - 1\), \(X_{ijt}\) denotes other control variables measured in year \(t\), and \(\delta_t\) and \(\mu_i\) denote year and firm fixed effects, respectively. Standard errors are clustered at the firm-year level.

The relevant time window comprises eleven years so as to realistically accommodate the triplet of events (loan transaction, underwriting, and any mergers). Note that our ten-year window for the two transactions (loan and underwriting) ends in \(t - 1\), rather than \(t\) (the last possible year that we consider for a potential merger). In this manner, we safeguard that both loan and underwriting transactions took place before any potential merger of the two banks, rather than their being a result of the merger. We show that our results are
robust to a shorter window in the Online Appendix.

The treatment effect is captured by $\beta_1$, which estimates the effect on a firm that received a loan from a commercial or universal bank and an underwriting product from a separate investment bank after these two banks have merged. We interpret this as an intention-to-treat effect under the premise that the respective firm is likely to continue contracting with the newly formed universal bank that now has more information about its borrowers after pooling information from previous loan and underwriting transactions.

This assumption is verified, for example, in the literature on lock-in in underwriting relationships (see, for example, James (1992) and Ljungqvist, Marston, and Wilhelm (2006)). We find similar evidence in our regression sample. Among firms in the treatment group, 50.9% (68.3%) returned to the merged universal bank for another loan (underwriting product) within five years after the merger, and in the control group, 52.1% (59.8%) returned to any one of the two universal banks involved in mergers for another loan (underwriting product). These ex-post probabilities are high, and remarkably similar despite the comparison between returning to one vs. two universal banks involved in mergers.

### 3.2.5 Data Description

The focus of our analysis will be on estimating the impact of universal banking on different firm-level outcomes, most notably risk and productivity. To this end, we use as our main data sources Compustat accounting data, CRSP stock prices, DealScan loan data, and SDC debt- and equity-underwriting data. As is customary, we drop public-service, energy, and financial-services firms from our analysis. On the transaction level, we focus on loans granted to public firms in the U.S. in the DealScan database since 1987, as well as on U.S. IPOs listed in the SDC database since 1976. For IPOs we consider the bookrunners, and we focus on the lead arrangers of syndicated loans in the DealScan database.

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$^{12}$The treatment effect equals the difference between treatment and control group, for both of which it holds that $\text{Loan from CB that merged}_{jt} \times \text{Underwriting from IB that merged}_{jt} = 1$.

$^{13}$We match DealScan with Compustat data using the link provided by Chava and Roberts (2008).
In addition, we use string matching to generate unique bank identifiers for commercial, universal, and investment banks across these datasets. To identify mergers between any two banks in DealScan loan data and SDC underwriting data, we use the SDC M&A database, in conjunction with hand-collected mergers obtained through a LexisNexis news search.

**Outcome Variables**

Among the most important outcome variables considered in this paper are firm-level risk measures. We focus primarily on the six-year volatility of sales-growth rates $\gamma_{it}$ of firm $i$ in year $t$.\textsuperscript{14} For sales-growth volatility, we follow Davis, Haltiwanger, Jarmin, and Miranda (2007) in constructing annual growth rates that accommodate entry and exit:

$$\gamma_{it} = \frac{x_{it} - x_{i,t-1}}{\frac{1}{2}(x_{it} + x_{i,t-1})},$$

(22)

where $x_{it}$ denotes sales from Compustat.

Using these growth rates, we obtain the six-year standard deviation of firm $i$’s sales growth over six years, $\sigma(\hat{\text{sales}}_i)^{6y}$. As alternative measures of firm-level risk associated with loans, we also consider six-year stock-return volatilities $\sigma(\text{return}_i)^{6y}$, which are calculated using monthly CRSP stock-return data, and idiosyncratic volatilities $\sigma_{\text{idiosyncratic},i}^{6y}$, estimated from the Fama and French (1993) three-factor model. As a robustness check (in the Online Appendix), we use three-month implied volatilities calculated using the volatility surface from option prices, which are obtained from Option Metrics and available starting in 1996.

Given that public firms in DealScan are typically mature, we use another outcome measure to capture firm risk earlier in the firm’s life cycle: the firm’s age at the time of its IPO. To calculate the latter, we use the founding dates of firms with IPOs recorded in SDC until

\textsuperscript{14}We use six-year volatilities to limit the number of firms dropping out of our sample due to survival reasons.
Besides the above-mentioned risk measures, we also analyze effects on firm-level TFP, for which we use data from Imrohoroglu and Tuzel (2014), who employ the semiparametric estimation procedure by Olley and Pakes (1996) for the panel of Compustat firms. As alternative outcome variables, we will also use capital expenditure (from Compustat) as well as market capitalization (i.e., market value of equity) from CRSP.

Summary Statistics

In Table 24, we present summary statistics of firm-specific and transaction-level variables for all major regression samples used in the paper. We start with our loans sample from DealScan, on the basis of which we generate the firm-loan-years sample comprising only years in which a given firm received at least one loan. Next, we construct the Compustat sample by using Compustat to add observations on years in which firms did not receive any loans. Finally, we use SDC IPO data to generate our IPO sample.

Our loans sample is based on DealScan data from 1987 to 2010. The respective regression sample comprises 19,053 loans of public firms in general, 64% of which were granted by universal banks. Another 11% were granted by investment banks, and the remainder by commercial banks (i.e., banks that remained pure commercial banks throughout the sample period, or universal banks during their former commercial-bank period). Only universal and investment banks can offer both loans and non-loan products. Among such loans granted by universal and investment banks, 12,061 were associated with concurrent underwriting of corporate securities of the same borrower firm within a five-year circle around the loan issue, of which 79% were cross-sold by universal or investment banks. Within this sample, 11,863 loans were associated with concurrent debt underwriting, and 4,008 with concurrent equity underwriting. Loans were much more likely to be cross-sold with debt-underwriting

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15 We thank the authors for sharing their data with us.
16 Note that these numbers add up to more than 12,061 because we separately account for debt and equity underwriting.
mandates: 85% of loans associated with concurrent debt underwriting were cross-sold by the same universal or investment bank, while only 19% of loans associated with concurrent equity underwriting were cross-sold.

We also give an overview of the number of banks in DealScan. In particular, 6 out of 8 universal banks that came into existence through mergers and acquisitions were established prior to August 1, 1996, and 28 out of 37 commercial banks turned into universal banks through opening Section 20 subsidiaries before the deregulation.

In the second panel, we move to the firm-loan-years sample, which summarizes all loans that a given firm received in a year. For firm-loan year $t$, $\Delta_t \ln(\sigma(sales_i)^{6y})$ is the difference between the logged six-year standard deviation of firm $i$'s sales growth from $t$ to $t+5$ and that from $t-6$ to $t-1$. $\Delta_t \ln(\sigma(return_i)^{6y})$ is the difference between the logged six-year standard deviation of firm $i$'s stock returns from $t$ to $t+5$ and that from $t-6$ to $t-1$. $\Delta_t \ln(\sigma_{idiosyncratic,i}^{6y})$ is the difference between the logged six-year idiosyncratic volatility of firm $i$'s stock returns from $t$ to $t+5$ and that from $t-6$ to $t-1$, estimated from the Fama and French (1993) three-factor model and expressed in annualized terms. In the case of multiple loans per firm in consecutive years, $t-1$ is replaced by the last year without any loans for the respective firm prior to the sequence of years with loans, and $t$ is replaced by the last year in the sequence. Remarkably, the average effect of a loan on a borrower firm's riskiness is close to zero across all three variables, which correspond to the dependent variables in Tables 4 to 6.

For the third panel, we merge our DealScan data with Compustat data starting in 1987, including firms that never received loans recorded in DealScan. The variables in the first four rows correspond to the dependent variables in Tables 8, 14, 15, and 21. The smaller sample size for the TFP measure is due to data availability in our TFP-data source (Imrohoroglu and Tuzel (2014)), which covers the period from 1987 to 2009. Similarly, option-implied volatility $\sigma_{implied}^{it}$ is available from 1996 only. We also provide summary statistics for the definition of treatment and control observations based on our alternative universal-bank-mergers identification strategy.
Our SDC IPO sample in the last panel is limited to IPOs with no more than one bookrunner, leaving us with a regression sample of 3,835 initial public offerings. This sample is conditional on the availability of IPO age (based on Loughran and Ritter (2004)). Unlike in the loan data, investment banks dominate the IPO market: 460 investment banks were responsible for 83% of the IPOs, whereas the remainder of the firms were taken public by universal banks. 31% of the firms were taken public by investment banks that eventually merged with, or were eventually acquired by, universal banks. In the SDC IPO data, 5 out of 5 universal banks established through M&A existed before August 1, 1996. Among Section 20 subsidiaries, 12 out of 15 were opened before the deregulation.

### 3.3 Results

We now turn to the estimation results using the loan data, and investigate whether universal banks financed riskier firms. We exploit the 1996 deregulation as a shock to the scope of universal banks’ activities, especially their mode of cross-selling loans and non-loan products. We then investigate whether these risk-increasing developments were accompanied by within-firm increases in total factor productivity and investment. To isolate informational economies of scope as the driving force underlying our results, we use universal-bank mergers as a source of variation in bank-level information acquisition. Finally, we also consider risk taking by universal banks in the market for initial public offerings, and analyze whether universal banks took public younger firms than investment banks following the 1996 deregulation.

#### 3.3.1 Impact of Universal Banking on Firm Risk

In Table 4, we estimate (19), and use as dependent variable borrower firms’ percent change in six-year sales-growth volatility, $\Delta_t \ln(\sigma(\hat{\text{sales}}_i)^{6y})$. After including industry fixed effects alongside transaction-specific and firm-level control variables in the second column, we find
that sales-growth volatility increased by 13.8% for universal-bank-financed firms following the 1996 deregulation. As we always include bank fixed effects, the difference-in-differences estimate is identified off the lending behavior of commercial banks that converted to become universal banks before the deregulation. As we saw in the first panel of Table 24, this applies to three-quarters of all universal banks.

This already substantial impact on borrower firms’ sales-growth volatility increases to 17.9% in the third column after including state-year fixed effects. We introduce these fixed effects to control for the possibility that our difference-in-differences estimate, which varies at the bank-year level, may capture any effects of bank branching deregulation. For instance, bank branching could interact with universal banking by expanding the geographical access to universal banking for firms.

In the fourth column, we add firm fixed effects, which further increases the difference-in-differences estimate to 23.6%. This indicates that the increase in firm risk also operates at the intensive margin. That is, the increase in firm risk is not driven exclusively by firms that would not have received any loan in the absence of the 1996 deregulation. Instead, firms that previously obtained financing from universal banks also engage in riskier ventures after the 1996 deregulation.

The inclusion of firm fixed effects forces our identification to come from firms with multiple loans granted by at least two different banks. Out of 3,362 firm-loan years, a majority of 1,972 are associated with firms that had at least two bank relationships. As we include bank fixed effects, we furthermore require each bank-firm pair to be observed at least twice, i.e., before and after a commercial bank became a universal bank, or if the bank was already a universal bank at the time of the first loan, before and after 1996. This is the case for 1,731 observations. We achieve full identification within firms that contracted with multiple banks, one of which granted loans to the same firm at all three stages (when it was a commercial bank, a universal bank before 1996, and a universal bank after 1996). This is the case for 434 observations.
Thus far, the omitted category consists of all banks whose scope of banking activities was unaffected by the 1996 deregulation, i.e., commercial and investment banks. The latter are the least active category of banks in the syndicated-loans market, as seen in the first panel of Table 24. As these two types of banks differ along other dimensions as well, it is worthwhile to separately estimate the effect of the 1996 deregulation on their lending behavior. To this end, we re-run the same specification as in the fourth column, but explicitly include a difference-in-differences term for investment banks, leaving commercial banks as the omitted category.\(^{17}\) The estimated coefficient of 0.004 in the last column suggests that investment banks did not finance differentially risky firms compared to commercial banks. The estimate is, however, significantly lower than the difference-in-differences estimate for universal banks.

As a final robustness check, we test whether there were any notable pre-trends in universal banks' lending behavior. In particular, we replace After(1996)\(_t\) by a placebo year, 1993. The difference-in-differences estimates in Table 11 are insignificant throughout.

Our key hypothesis was that the differential risk-taking effect is due to universal banks' economies of scope from cross-selling after the 1996 deregulation. To provide further evidence for this channel, we compare the incidence of cross-selling before and after the deregulation for universal and investment banks, the two types of banks that theoretically have the capacity to offer both loans and non-loan products. In Table 12, we limit the sample of loans to those that were associated with concurrent underwriting of corporate securities by the same borrower firm within a five-year circle (from year \(t - 2\) to \(t + 2\), where \(t\) corresponds to the year of the loan issue in question), and use as dependent variable an indicator for whether the loan and the underwriting mandate were accompanied by the same bank.

In the first three columns of Table 12, we employ the same fixed-effects structure as in the second to fourth columns of Tables 4 to 6, and find that following the 1996 deregulation,

\(^{17}\)Note that this may lead to a change in the estimated coefficient on Universal-bank loan\(_{jt}\) × After(1996)\(_t\), as some firms may have received loans from both universal and investment banks in a given year.
universal banks were six percentage points more likely to cross-sell than investment banks.\textsuperscript{18} Focusing only on universal banks and their mode of establishment in the last three columns, it appears that universal banks that were established through Section 20 subsidiaries, rather than through M&A, were seven percentage points more likely to cross-sell after 1996, which could be due to their early specialization in corporate-securities underwriting, rather than any other investment-banking operations.

All results from Table 4 carry over to using firms’ stock-return volatility, $\Delta_t \ln(\sigma(return_{it})^{6y})$, and the corresponding idiosyncratic volatility, $\Delta_t \ln(\sigma_{idiosyncratic_{i}}^{6y})$. The results are in Tables 5 and 6, respectively. The risk-increasing effect for stock-return volatility is similar to that estimated for sales-growth volatility across the first three columns, but is lower after including firm fixed effects. Conversely, the estimates for idiosyncratic volatility are similar to those for stock-return volatility after including firm fixed effects, but tend to be somewhat lower without them.

To better characterize the source of this increase in firm-level volatility, we next assess whether universal-bank loans were associated with higher credit risk. That is, we examine whether universal banks relaxed financial constraints for risky projects, or whether they financed excessively risky firms that were on the verge of defaulting. Our hypothesis is that they did the former.

In Table 7, we return to our firm-loan-years sample, and use as dependent variable an indicator for whether the borrowing company went bankrupt\textsuperscript{19} in the ten years following the loan-issue year.\textsuperscript{20} As can be seen in Table 7, universal-bank loans were not associated with greater default risk among borrower firms after the 1996 deregulation, i.e., the

\textsuperscript{18}However, we do not find that universal banks, on average, extended loans at more favorable terms after the 1996 deregulation, as measured by the so-called all-in-drawn spread, which is the sum of the spread over LIBOR and any annual fees paid to the lender syndicate (cf. Table 13).

\textsuperscript{19}We use the following CRSP delisting codes to identify bankruptcy: any type of liquidation (400-490); price fell below acceptable level; insufficient capital, surplus, and/or equity; insufficient (or non-compliance with rules of) float or assets; company request, liquidation; bankruptcy, declared insolvent; delinquent in filing; non-payment of fees; does not meet exchange’s financial guidelines for continued listing; protection of investors and the public interest; corporate governance violation; and delist required by Securities Exchange Commission (SEC).

\textsuperscript{20}Our results are robust to variations in the horizon.
difference-in-differences estimate is not significantly different from zero. However, after the inclusion of firm fixed effects in the fourth column, universal-bank loans were associated with significantly less default risk after 1996. Furthermore, in the last column, we find that following the 1996 deregulation, investment banks – unlike commercial and universal banks – financed firms that were 10 percentage points more likely to be delisted for bankruptcy-related reasons within ten years after the loan issue. The effect is significant at the 1% level.

These results also address another concern. Namely, recall that our benchmark measures of firm risk were based on the within-firm change in risk after vs. before loan issues. A potential downside to this forward-looking definition of the outcome variables is that we may be systematically omitting (or prematurely dropping) firms that did not survive $6 + 6 = 12$ years, which was necessary for constructing our outcome variables, because they were excessively risky. Our results in Table 7 indicate that this was not the case.\footnote{Note also that the sample we use for these default-risk tests is \textit{not} conditional on the availability of six-year-volatility data before and after the firm-loan year.}

### 3.3.2 Impact of Universal Banking on Productivity and Investment

Thus far, we have considered only measures related to firm-level risk as outcomes. We now turn to the question as to whether the additional risk of universal-bank-financed firms was rewarded by higher productivity, as suggested by a risk-return trade-off. Our analysis proceeds much like that in the previous section. The only difference is that we estimate long-run within-firm effects on annual observations rather than six-year volatilities. For this purpose, we modify our loans-related variables to be based on any loan transactions within the past five years.\footnote{Bank fixed effects are defined accordingly.} We also include all firm years without any loan transactions.

The resulting sample comprises all publicly listed firms for which all our non-banking-related variables are available. This corresponds to what we label as our \textit{Compustat sample} in the
third panel of Table 24. We then run regression specification (20) on this sample, including all firm-year observations from 1987, and cluster the standard errors at the firm-year level. Note that we now also include firm-year observations for which all loans-related variables are zero, so that firms with no loan in a given year become the omitted category.

In Table 8, we use the natural logarithm of firm-level total factor productivity (TFP) in year $t + 1$ as dependent variable. We use TFP in $t + 1$ because our TFP measure is the result of an estimation, conducted by Imrohoroglu and Tuzel (2014), that uses as input variables capital and labor in $t$, which are potentially correlated with our right-hand-side variables. After including transaction-specific and firm-level controls in the second column, we find a significantly positive difference-in-differences estimate of 2.9% for universal-bank loans after 1996. This estimate holds up to including state-year fixed effects in the third column. Conversely, in the last column, we find a negative and insignificant difference-in-differences estimate for investment-bank loans after 1996. These results paint an analogous picture to the risk estimates. What is more, our estimated treatment effects are relatively long-lived, up to six years, due to the definition of the five-year window and an additional lag due to measurement of TFP in year $t + 1$.

To show that these increases in productivity also translate into increases in actual investment and higher market capitalization, we re-run the regressions from Table 8, and use as dependent variable the natural logarithm of the firm’s capital expenditure in year $t$ as well as the natural logarithm of the firm’s market value of equity in year $t$.\textsuperscript{23} The results are in Tables 14 and 15, respectively, and demonstrate that our previous findings for TFP are also valid for these measures. Capital expenditure increase by at least 2%, although not all results are robustly significant, and firms’ market capitalization by at least 9%.\textsuperscript{24}

To conclude, we find that universal-bank loans were associated with significantly higher

\textsuperscript{23}As we used as outcome variables TFP in year $t + 1$ for the above-mentioned reasons, but capital expenditure and market capitalization in year $t$, in untabulated tests, we verified that our results for the latter two dependent variables are robust to using their realizations in year $t + 1$.

\textsuperscript{24}Note that these treatment effects are unlikely to be due to equity-raising activities, as universal banks cross-sold loans and debt-underwriting services much more frequently than loans and equity-underwriting services (cf. first panel of Table 24).
TFP, capital expenditure, and market capitalization after the 1996 deregulation, as compared to loans granted by commercial and investment banks. These results complement our findings for firm-level risk, and guide the economic interpretation. Our evidence is consistent with universal-bank relationships resulting in firms making risky, productivity-increasing investments along a risk-return frontier. This implies that there is a real component to the increase in risk that we document in this paper. Still, this leaves open the question as to whether the increases in productivity are large enough to compensate for increased risk. A revealed-preference argument would suggest that it does. At the very least, our evidence does not contradict the possibility of firm-level efficiency gains from universal banking.

3.3.3 Bank-level Information Acquisition through Universal-bank Mergers

In this section, we provide evidence that the treatment effects are due to increased information on the part of universal banks rather than due to higher revenues from cross-selling. Specifically, we use universal-bank mergers as a variation in bank-level information acquisition. To do so, we follow the identification strategy associated with regression specification (21). We compare firms that contracted with a loan-granting commercial bank and also received an underwriting product from an investment bank, both of which have merged – either with each other (treatment group) or with other banks of complementary scope (control group). In Figure 31, we provide evidence of parallel pre-trends in terms of TFP, capital expenditure, and market capitalization among our treatment and control groups in the period leading up to the bank mergers.

In Table 9, we estimate (21), and use as dependent variable firm-level TFP as in Table 8. The treatment effect is given by $\beta_1$ in the first row, and indicates that TFP increases by 2 to 3%, which is similar to the effects in Table 8. This result is robust to including state-year fixed-effects in the third column and, in addition, industry-year fixed effects in the last column, which capture time-varying factors underlying banks’ considerations to merge with
each other, such as the nature of client portfolios.

We also report positive treatment effects on capital expenditure and market capitalization in Tables 16 and 17, respectively. The magnitude is somewhat higher for capital expenditure than in Table 14, and significant at the 1% level throughout. However, the magnitude is weaker for market capitalization in comparison to Table 15, and loses statistical significance after including state-year fixed effects in the third column of Table 17.

These estimates are robust to changing the time window for the triplet of events (loan transaction, underwriting, and a potential merger) from eleven years to nine years (see Tables 18 to 20). In summary, the results based on our alternative universal-bank-mergers identification strategy point to informational economies of scope as the driving force underlying the firm-level real effects of universal banking we document in this paper.

To show that this insight holds also for the risk-increasing effect of bank-scope deregulation, we consider an alternative risk measure, namely option-implied volatility $\sigma_{it}^{implied}$, which has the advantage of allowing the construction of an annual measure, thereby fitting our empirical setup in (21).²⁵

The results are in 21, and suggest a significantly positive treatment effect on this risk measure, ranging from 5.5% in the first column to 2.3% after including state-year and industry-year fixed effects in the last column. While somewhat weaker in magnitude than our difference-in-differences estimates in Tables 4 to 6, our results should be comparable in their interpretation given the forward-looking nature of option-implied volatility: as argued by Christensen and Prabhala (1998), it does not just subsume information from past-realized volatility, but is also forward looking in the sense that it helps forecast future volatility.

²⁵Note that the respective data are available only starting in 1996.
3.3.4 Impact of Universal Banking on IPO Age

The evidence from the loan data suggests that universal-bank-financed firms were more volatile, but the analysis is confined to publicly listed and, thus, mature firms. We now complement our loans-based analysis with evidence on firms earlier in their life cycle, and scrutinize the impact of universal banking on the age of firms when they go public.

For this IPO-level analysis, we implement a difference-in-differences strategy, and compare the average age of IPOs with universal banks as bookrunners to the average age of IPOs with investment-bank bookrunners before and after 1996. We use the age of firms at the time of their IPOs as a risk measure following the logic that younger firms are typically riskier (Petersen and Rajan (1994), Pastor and Veronesi (2003), and Schenone (2010)). Looking at the effect of universal banking on IPO age may also be a fruitful exercise in the sense that previous research by Brown and Kapadia (2007) and Fink, Fink, Grullon, and Weston (2010) has found that higher idiosyncratic risk in the U.S. stock market was associated with younger firms that went public.

In Figure 30, we plot the market-value-weighted average age of firms at the time of their IPOs and the proportion of IPOs accompanied by universal banks. We observe a negative correlation that is stronger after 1996. Note that the IPO market share of universal banks soars around 1996 as well.

In a difference-in-differences setup akin to that employed before, we test whether following the 1996 deregulation, universal banks took younger firms public than investment banks whose scope of banking activities was unaffected by the deregulation. Given that commercial banks that are not yet universal banks cannot be bookrunners, the control group consists of investment banks, a subset of which was eventually acquired by commercial or already existing universal banks. For a universal bank to be treated under the 1996 deregulation, it needs to be established before the deregulation. We run the following regression

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specification:

\[
IPO \text{ age}_{ijt} = \beta_1 UB_j \times Est.(1996)_j \times After(1996)_t + \beta_2 UB_j \times Est.(1996)_j
\]
\[
+ \beta_3 UB_j + \beta_4 Eventually UB through M\&A_j
\]
\[
+ \beta_5 After(1996)_t + \beta_6 X_{ijt} + \beta_7 industry_i + \mu_t + \epsilon_{ijt},
\]

(23)

where \( IPO \text{ age}_{ijt} \) is firm \( i \)'s age in years at the time \( t \) of its IPO with bank \( j \) as bookrunner, \( UB_j \) (M&\&A or Section 20) is an indicator variable for whether the bookrunner was a universal bank (formed through a merger or through opening a Section 20 subsidiary), \( Est.(1996)_j \) indicates whether a universal bank (through M&\&A or Section 20) was established prior to August 1, 1996, \( After(1996)_t \) is an indicator for whether the IPO date was on or after August 1, 1996, \( Eventually UB through M\&A_j \) is an indicator variable for whether the bookrunner, which was still an investment bank, eventually becomes a universal bank through M&A, \( IPO \text{ count}_{jt} \) denotes the number of IPOs accompanied by universal or investment bank \( j \), up to and including the current IPO, \( X_{ijt} \) denotes firm and IPO characteristics, and \( industry_i \) and \( \mu_t \) are industry and year fixed effects, respectively. Standard errors are clustered at the bookrunner level.

In the first column of Table 10, we estimate (23) without any firm or IPO-specific controls. The difference-in-differences estimate for universal banks established before the deregulation compared to the control group of pure investment banks, which is captured by the coefficient on \( UB_j \times Est.(1996)_j \times After(1996)_t \), is significantly negative (at the 1% level), reflecting 8.7 years younger and, thus, riskier IPOs. Note that in the absence of bank fixed effects, the coefficient on \( UB_j \) captures universal banks established after the deregulation.

The 1996 deregulation carries particular significance for the underwriting activities of universal banks. Besides the increased scope for cross-selling, transactions between commercial-bank and securities divisions could be used to cross-finance riskier investment-banking operations.\(^{26}\) An alternative explanation may be that commercial banks inherited the risk-taking

\(^{26}\) The Federal Reserve Act limits such loans to any single securities affiliate to 10% of a bank’s capital.
properties of the smaller investment banks that they acquired or merged with. To test this, we include an indicator for whether the bookrunner was an investment bank that eventually merged with a commercial or an already existing universal bank, Eventually UB through M&A, on the right-hand side. However, the respective coefficient is significantly larger (at the 5% level, implying that these investment banks took older firms public) than the sum of all three coefficients for universal banks established before 1996.\textsuperscript{27} Therefore, this alternative explanation seems unlikely.

In the second column of Table 10, we include bank fixed effects for all universal and investment banks, as in our previous analyses. This refined difference-in-differences estimate suggests that universal banks served as bookrunners for IPOs of firms that were 6.1 years younger after the deregulation. This estimate holds up to the inclusion of state-year fixed effects (leading to a drop in the sample size due to data availability) in the third column, which capture any confounding effects of, for instance, bank branching deregulation. The average reduction in the age of firms that were taken public by universal banks is economically significant, and corresponds to one-third of a standard deviation of IPO age.

In the fourth column, we delineate the treatment effect by the universal banks’ mode of establishment, namely whether the universal bank in question was established through M&A or through opening a Section 20 subsidiary. The difference-in-differences estimates are both negative, but only significantly so for universal banks established through M&A.

In order to evaluate whether these results may be driven by any other characteristics that differ between universal banks established through M&A and Section 20 subsidiaries, we collected key summary statistics for the bank-holding companies in our sample a year before to a year after becoming universal banks. As Table 22 shows, universal banks established through M&A are typically larger than Section 20 subsidiaries. Such mergers constitute one-time increases in total assets, net income, cash flow (approximated by EBIT), and the number of employees. Section 20 subsidiaries grow more gradually.\textsuperscript{28} Nevertheless,\textsuperscript{27} The coefficient on Eventually UB through M&A is also larger, and significantly so at the 1% level, than that on UB, which captures the average age of IPOs run by universal banks established after 1996.\textsuperscript{28} Note that we could not include universal banks for which the data do not cover all three time periods.
both types of universal banks are strikingly similar in their equity-to-assets and cash-to-assets ratios. As a result, higher risk taking by universal banks established through M&A cannot be readily explained by a different leverage position or excess cash. Loan-to-assets ratios are somewhat higher for universal banks formed through Section 20 subsidiaries, as investment-banking operations are a smaller portion of their business model.

Finally, we consider another, market-structure-based explanation for the younger age of firms that were taken public by universal banks. Commercial banks entering the underwriting business as newly formed universal banks naturally lack a track record for IPOs. This may force them to take younger firms public in an effort to build a track record.

To test this, we include interactions with $IPO \text{ count}_{j,t}$, which is the number of IPOs accompanied by the respective universal and investment banks, up to and including the IPO in question (of firm $i$ with bookrunner $j$ at time $t$). If lack of a track record was responsible for our findings, then one would expect the respective interaction effects to be positive, indicating that universal banks with an established track record of IPOs took older firms public. However, we fail to find any differential effect of $IPO \text{ count}_{j,t}$ for either type of universal bank. This suggests that the explanatory power of this alternative mechanism for the effects of increased bank scope on IPO age is limited.

### 3.4 Conclusion

In this paper, we focus on a narrowly defined set of deregulatory events that expanded the scope of banking in the U.S. to evaluate bank scope as a determinant of firm-level real outcomes. Our empirical strategy exploits a deregulatory shock to the scope of banking activities in 1996. We provide evidence that the advent of universal banking improved the access to finance for risky but productive enterprises through informational economies of scope across loans and non-loan products.

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i.e., we had to drop universal banks that were established right when the data became available (1987) or that were eventually acquired by other banks.
Our findings are in accordance with previous research on the evolution of firm-level volatility in the U.S. Based on Campbell, Lettau, Malkiel, and Xu (2001), Comin and Philippon (2006) document that idiosyncratic firm risk has been rising over the past thirty years. Our results suggest that bank-scope deregulation may have contributed to this phenomenon. Indeed, the explanation we propose in this paper can accommodate the dichotomy found in Davis, Haltiwanger, Jarmin, and Miranda (2007) that volatility has been increasing for publicly listed but not for private firms, because the cross-selling of underwriting products affects primarily public firms. An interesting direction for future research could be to quantify the explanatory power of increased bank scope for the observed run-up in firm-level fluctuations.

In light of recent proposals to limit the scope of banking and re-establish the Glass-Steagall Act, our evidence suggests that there may be firm-level efficiency gains from concurrent lending and underwriting of corporate securities that should be balanced against the risks associated with banks becoming too big to fail and other concerns of macroeconomic fragility.
Chapter 4 : Does Bank Scope Improve Monitoring Incentives in Syndicated Lending?*

4.1 Introduction

Loan syndication refers to the joint provision of loans to a firm by a group, or *syndicate*, of financial institutions. Typically, the syndicate consists of lead arrangers and participants, with lead arrangers expected to actively monitor the borrower, and participants serving to diversify loan risk without actively monitoring. To ensure that lead arrangers have an incentive to diligently monitor the borrower, they tend to hold relatively large fractions of syndicated loans on their balance sheet, so as to create bank exposure to firm outcomes.

In the U.S., syndicated-loan markets have grown dramatically. In 1990, the total syndicated-loan-issuance volume was $20 billion; in 2008 it was $790 billion (Ivashina and Scharfstein (2010b)). Over the same time frame, loan shares retained by lead arrangers fell sharply, from a peak of around 70% in 1990, to around 30% in the years leading up to the 2008 financial crisis. To some observers, these developments serve as evidence that syndicated lending is a valuable financial innovation that helps to diversify loan risks and lowers the

*This chapter is co-authored with Farzad Saidi
cost of borrowing for firms. Yet, they have also led to concerns that because lenders do not have incentives to diligently monitor borrowers when lead shares are small, the growth of syndicated-loan markets may have contributed to a loss of efficiency in financial intermediation and precipitated the crisis (see, for example, Gorton and Metrick (2012) and Ivashina and Scharfstein (2010b)).

In this time period, the repeal of the Glass-Steagall Act drastically changed the architecture of the financial system in the U.S., and led to the rise of universal banks able to offer a broad array of financial instruments, ranging from lending to corporate-securities underwriting. This has had important consequences for the nature of bank-firm relationships: the simultaneous provision of multiple financial products by a universal bank to a given firm has become a key feature of many intermediation relationships (for evidence, see Drucker and Puri (2005) and Neuhann and Saidi (2014)). In this paper, we propose that this broadening of bank-firm interactions also substantially altered the structure of loan syndicates and the distribution of loan shares within syndicates.

In particular, we argue that in the presence of broad interactions across financial products, loan shares alone are no longer a sufficient statistic for a lead arranger’s monitoring incentives, since a bank’s total exposure to firm outcomes may be much greater than its loan share alone would suggest. If a bank cares about firm performance for reasons other than its loan share, it may no longer need to retain large loan shares to have incentives to monitor. In this view, then, falling loan shares are merely a benign side effect of broader bank-firm relationships rather than a symptom of worsening of monitoring efficiency. We attempt to understand these developments in the context of financial deregulation leading to changes in the nature of bank-firm interactions and, thus, in banks’ total exposure to the firms they are servicing.

In Figure 27, we plot the average loan share retained by lead arrangers from 1987 to 2009 for three samples: all syndicated loans, syndicated loans in which at least one lead arranger was a universal bank, and syndicated loans in which no lead arranger was a universal bank. The average lead share fell across all samples. We find large cross-sectional differences:
Figure 27

Source: own analysis based on DealScan loan data.

syndicates in which at least one lead arranger was a universal bank exhibit substantially lower lead shares than syndicates without any universal-bank lead arrangers throughout the time series. What is more, these differences are particularly pronounced in the years leading up to the financial crisis. These facts are suggestive of our hypothesis that the advent of universal banking and the resulting richness of bank-firm interactions are a key determinant of the evolution of lead shares from the mid 1990s onwards.

We formalize our argument in a model of syndicated lending with banks of heterogenous scope. In the model, firms contract with a syndicate of banks to obtain loans. We assume that banks can increase firm value by monitoring, subject to moral hazard, but dislike large balance-sheet exposures to a single borrower because managing the resulting risk is costly. We analyze the model in two steps. First, we take the value of monitoring as given, and characterize the optimal syndicate structure as a function of bank characteristics, such as scope and prior or future exposure to the firm. Second, we link the value of monitoring to firm characteristics, such as volatility and productivity, and characterize the
comparative statics of syndicate structure as we jointly vary the fundamentals of bank and firm. In doing so, we explore the mechanisms through which bank monitoring impacts firm performance.

In the first step, we find that banks monitor the firm only if they are assigned a sufficiently large share of the loan. Since holding large exposures to a single loan is costly for banks, the firm provides monitoring incentives through large loan shares to a subset of banks only, and spreads the remaining loan shares across the rest of the syndicate. We refer to banks that monitor as *lead arrangers*, and to banks that do not as *participants*. To minimize borrowing costs, the firm chooses banks for whom relatively small loan shares suffice for incentive provision as lead arrangers. We refer to the smallest loan share consistent with monitoring incentives as the *required* loan share, and find that it varies with bank characteristics. In particular, the required loan share is smaller if (i) the bank has underwritten corporate securities for the firm in the past, or expects to do in the future, and (ii) is exposed to the firm’s performance through non-loan products. This is likely to be the case for banks of wide scope, because these banks have ample opportunities to provide non-loan products to the firm. Thus, a key prediction of our model is that banks of wide scope, such as universal banks, are more likely to be chosen as lead arrangers, but receive lower loan shares *conditional* on being lead arrangers. Crucially, lower loan shares for banks of wide scope do *not* imply a loss in monitoring efficiency; loan shares are smaller because it is easier to provide monitoring incentives to banks of wide scope. In addition, because reduced loan shares allow for better risk diversification, increased bank scope reduces borrowing costs.

In the second step, we extend our model to explicitly analyze the process by which bank monitoring increases production efficiency at the firm level. We use the extended model to derive two key quantities of interest as a function of firm fundamentals and the optimal intermediation contract: the *value of information*, as measured by the increase in production efficiency when the lender monitors, and the *monitoring incentives* provided by the optimal intermediation contract, as measured by the additional payoff the lender obtains when
monitoring, given the contract.

Since the optimal intermediation contract is specific to firm characteristics, so are monitoring incentives. We find that both the value of information and monitoring incentives are increasing in the volatility of the firm’s production technology. Hence, monitoring is particularly valuable for volatile firms, i.e., even banks of narrow scope are willing to monitor highly volatile firms. The monitoring benefits of wider bank scope are more pronounced for low-risk firms that would otherwise not be monitored by banks of narrower scope. Linking these results to our earlier finding that banks of wide scope are more likely to become lead arrangers, and receive smaller lead shares, we find that the loan-share-decreasing effect is less pronounced for riskier firms.

We find empirical support for all of these predictions by exploiting the variation in bank scope generated by the stepwise repeal of the Glass-Steagall Act. As in Neuhann and Saidi (2014), we focus on a shock to bank scope through a deregulatory event in 1996 that removed informational and financial firewalls between securities and lending divisions in existing universal banks. In particular, we argue that the 1996 deregulation led to a boost in cross-selling of loans and non-loan products by universal banks, thereby enabling them to realize economies of scope. This maps to an increase in the extent of bank-firm interactions in our model.

To distill the impact of bank scope on syndicate structure, we separately analyze the choice of lead arrangers within syndicates, and the resulting lead share at the more aggregate loan level. For this purpose, we employ a difference-in-differences specification around the 1996 deregulation for universal banks established before that date vs. commercial banks whose scope of banking was not affected by said deregulation. In this manner, we find that within loan syndicates, universal banks were at least ten percentage points more likely to be chosen as lead arrangers following the 1996 deregulation. Similarly, we show that syndicates with universal banks assigned up to five percentage points smaller shares to their lead arrangers after the 1996 deregulation than did syndicates without any universal-bank participation. We also use this setup to generate empirical evidence in favor of the comparative statics of
our model with respect to borrower-firm-level volatility.

In sum, our findings provide new theoretical and empirical insights into the provision of monitoring incentives in financial markets. In particular, we find that banks’ non-loan exposures to firms are a key determinant of monitoring incentives, and may substitute for loan shares. Furthermore, our results suggest that falling lead shares may not have had adverse effects on monitoring incentives. In this sense, we argue for a holistic view of bank-firm interactions, especially in the aftermath of the repeal of the Glass-Steagall Act and the subsequent functional heterogeneity of banks in the syndicated-loans market.

4.1.1 Related Literature

Our paper relates to the empirical and theoretical literature on lending under asymmetric information.

On the empirical side, our paper is related to the literature that investigates the determinants of lead shares in syndicated lending. Sufi (2007) argues that unrated firms are harder to monitor than rated firms, and finds that lead arrangers retain a larger share of loans to unrated firms as a result. Our paper differs in that we investigate the bank-level, rather than the firm-level, determinants of syndicate structure. In addition, we also interact firm-level and bank-level characteristics, thereby refining the results in Sufi (2007). Ivashina (2009) estimates the costs of asymmetric information between lead arrangers and syndicate members by explicitly accounting for bank-level risk exposure. We complement her findings by characterizing the role of bank scope in driving the structure of loan syndicates through non-loan interactions. Ivashina and Scharfstein (2010a) as well as Ivashina and Scharfstein (2010b) focus on the cyclical properties of the lead arranger shares. Our paper complements this line of work by focusing on secular trends in the lead share as a response to financial deregulation and broader trends in the architecture of the financial system.

In particular, we conjecture that a bank’s total exposure to a borrower firm, rather than the loan exposure alone, needs to be taken into account to determine a bank’s monitoring
incentives. Our empirical approach relies on bank-firm-level variation in said exposure, and for this purpose, we use the variation in bank scope generated by the stepwise repeal of the Glass-Steagall Act. Existing work considers other kinds of variations affecting bank-firm interactions, stemming primarily from the borrower firm, such as the impact of corporate ownership structure (Lin, Ma, Malatesta, and Xuan (2012)) and shareholder rights (Bharath, Dahiya, and Hallak (2013)) on the structure of lending syndicates. The crucial difference between our paper and this line of research is that our variation in bank scope affects syndicate members differentially, allowing us to dissect heterogenous effects within lending syndicates. By focusing on borrower-level variation, existing work does not make use of any within-syndicate heterogeneity.

On the theoretical side, our model relates to the literature through four channels. First, we argue that the extent of asymmetric information between borrower and lender is an important determinant of firm-level outcomes. Second, we provide a model in which asymmetric information determines the extent to which the lender can provide incentives to overcome the firm’s moral hazard, generating adverse selection on incentive contracts. Third, we allow for monitoring by banks to alleviate this adverse selection. Fourth, we argue that the scope of banking is an important determinant of lenders’ incentives to acquire information. In the following, we link each of these features to the existing theoretical literature, and establish how our model innovates on extant approaches.

In the sense that we vary the degree of information asymmetry between borrower and lender, our model is related to a large literature on bank monitoring, such as Holmstrom and Tirole (1997), and relationship banking, such as Sharpe (1990), Rajan (1992), and von Thadden (2004). In these papers, lending relationships serve to reduce information asymmetries within a relationship, with two key effects. First, there may be informational rents captured by the lender, which expose the borrower to hold-up. Second, the lender may be able to make flexible financial decisions that enhance the value of the firm.

Bolton, Freixas, Gambacorta, and Mistrullie (2013) develop a model of relationship banking over the business cycle based on Bolton and Freixas (2006), and provide evidence for
information acquisition in lending relationships. Our paper takes a similar approach in that we are interested in the effects of reductions in informational frictions as determinants of firm-level outcomes gains. However, our model differs in that we analyze the role of scope rather than repeated interactions as the key driver of our results. As shown empirically by Degryse and van Cayseele (2000), the dimension of a bank-firm relationship, as determined by the bank’s scope, dominates the length of the relationship in characterizing the benefits and efficiency gains. Furthermore, we link firm primitives, most notably risk and productivity, to efficiency gains from contracting with an informed lender that is well placed to overcome the firm’s moral hazard. Conversely, Bolton, Freixas, Gambacorta, and Mistrullie (2013) center their attention on relationship lending over the business cycle, without linking the state of the world (the business cycle) to any firm-level frictions (such as moral hazard in our model).

Our paper is also related to the literature on performance monitoring by markets or investors in the tradition of Holmström and Tirole (1993), who discuss the role of outside investors’ information about managerial effort. In our model, we discuss the importance of asymmetric information about the optimal course of action in mediating the ability of investors to overcome asymmetric information about managerial effort. Our paper therefore discusses a different type of information asymmetry than Holmström and Tirole (1993), and leads to predictions about the type of projects chosen by firms in response to this asymmetry.

In that we focus on the firm-level effects of changes in lender informedness, our paper is also similar in spirit to Greenwood, Sanchez, and Wang (2010), who develop a model of financial intermediation based on Townsend (1979) to analyze the characteristics of firms financed in equilibrium. While Greenwood, Sanchez, and Wang (2010) scrutinize general-equilibrium effects, we argue that changes at the level of the bank-firm relationship are crucial in determining the ability of firms to obtain financing.

In addition, we endogenize the lender’s information-acquisition decision, and study its interaction with borrower characteristics. In this regard, our model relates to previous work that studies endogenous information acquisition in finance, such as van Nieuwerburgh and
Veldkamp (2010) and, in particular, Yang and Zeng (2015), who scrutinize optimal security design by a borrower that tries to provide incentives for a lender to produce information that is valuable to the borrower.

Lastly, by providing an application to bank scope, our paper is related to a sizeable literature on universal banking that focuses on the ability of universal banks to simultaneously offer loans and underwriting services. For example, Kanatas and Qi (1998) and Kanatas and Qi (2003) argue that universal banks can save on information costs by monitoring a firm once and for all, while stand-alone banks have to exert monitoring effort for each service separately. As such, firms may become locked in to a universal bank due to reduced information costs. This lock-in has adverse affects on a universal bank’s incentives: if the bank expects to be able to sell a loan to a firm when underwriting fails, it may exert less effort in underwriting. A trade-off thus arises between bank effort and reduced information costs. Our model differs from these in that we consider the implications of bank scope on syndicates, and relate it to firm-level outcomes and characteristics.

4.2 A Model of Monitoring in Syndicates

We now propose a model of lending by a syndicate of heterogenous financial intermediaries to a firm in the spirit of Holmstrom and Tirole (1997). In this section, we focus on the first step of our analysis, which is to characterize the optimal syndicate structure based on bank characteristics, taking the value of monitoring as given. In the next section, we then enrich the borrower side of the model to characterize the comparative statics of syndicate structure with respect to firm characteristics.

There is a single period. There is one penniless borrower (manager, entrepreneur) and \( N \) deep-pocketed banks, indexed by \( n \), all of which are risk neutral. The manager has access to an investment project that requires \( k \) units of capital and yields an expected return \( R > k \).

\[ \text{In this regard, our paper is also related to recent work on the regulation of the financial sector (see Opp, Opp, and Harris (2013), Hoffmann, Inderst, and Opp (2014), and Harris, Opp, and Opp (2014)).} \]
at the end of the period. The borrower is limited in his ability to borrow because of an implicit moral-hazard problem: the borrower’s pledgeable income is strictly below $R$. Bank monitoring is valuable because it increases pledgeable income by alleviating the underlying moral-hazard problem. If a bank monitors the borrower, pledgeable income is $\bar{v}$; if no bank monitors the borrower, then pledgeable income is $v$. We assume that bank monitoring is essential for credit provision: $\bar{v} > k > v$. In Section 4.3, we explicitly characterize $\bar{v}$ and $v$ as a function of the borrower’s production technology and the optimal intermediation contract. For now, we focus on the optimal choice of lead arrangers and the associated allocation of monitoring incentives within the syndicate, taking the benefits of monitoring as given.

Each bank’s monitoring effort is observable but not verifiable, and banks occur a private cost $B$ when monitoring. Hence, there is moral hazard in monitoring. Monitoring is also valuable: $\bar{v} > v + B$. The financial contract between the borrower and the syndicate works as follows. The borrower assigns loan share $s_n$ to bank $n$, with $\sum_{n=1}^{N} s_n \leq 1$. Given the loan share, bank $n$ provides $s_n k$ units of capital, and receives $s_n \cdot \bar{v}$ if monitoring occurs, and $s_n \cdot v$ if no monitoring occurs. We refer to the $N \times 1$ vector of loan shares as a sharing rule, and denote it by $s$. Holding a loan on the balance sheet is costly to banks. In particular, each bank occurs a holding cost $c(s_n k)$, with $c(\cdot)$ strictly convex and increasing. The convexity of $c(\cdot)$ introduces a motive for risk diversification across syndicate members. For a given sharing rule $s$, the total borrowing costs are given by

$$C(s, k) = k + \sum_{n=1}^{N} c(s_n k).$$

Borrowing costs are thus minimized by setting $s_n = 1/N$ for all $n$, but doing so may not provide sufficient monitoring incentives to banks.

Banks are heterogeneous along two dimensions: whether the bank has underwritten a corporate security (such as equity or debt) for the borrower firm in the past, and whether it expects to underwrite securities for the firm in the future. We assume that there are
economies of scope in monitoring across corporate-securities underwriting and loan products: if bank $n$ has previously underwritten a corporate security for the firm, the cost of monitoring is reduced by $b^*_n \cdot B$; if the bank expects to underwrite the equity in the future, the value of monitoring to the bank increases by $v^*_n \cdot B$. We model both the benefits and reduced costs as proportional to the unconditional cost of monitoring because we view economies of scope as coming from the ability to save on the (partial) duplication of costly monitoring efforts. Hence, we refer to $B_n \equiv v^*_n + b^*_n$ as bank $n$’s scope. We assume that $B_n \leq 1$ for all $n$, and let $n^* = \arg \max_n B_n$.

Given its loan share $s_n$, bank $n$ monitors the borrower only if no other bank monitors, and

$$s_n \overline{v} + v^*_n \cdot B \geq s_n \underline{v} + B - b^*_n \cdot B.$$  

The latter condition can be rearranged to give

$$s_n \geq \underline{s}_n \equiv \frac{B \cdot (1 - B_n)}{\overline{v} - \underline{v}}. \quad (M)$$

To make the problem interesting, we assume that $\underline{s}_{n^*} > \frac{1}{N}$, so that providing equal loan shares to all lenders is inconsistent with monitoring.

The incentive compatibility constraint for monitoring (M) allows us to characterize the borrower’s choice of syndicate structure. In particular, given that holding costs are convex, the borrower assigns monitoring tasks to those that require the smallest loan share to do so. We refer to banks that monitor the borrower as lead arrangers, and to borrowers that do not monitor but hold a fraction of the loan as participants. Proposition 18 reveals that the borrower chooses the bank with the highest bank scope as the unique lead arranger, and provides this lead arranger with the smallest share consistent with monitoring incentives.

We omit the corresponding proof here and, instead, include it in Appendix C.2.

**Proposition 18 (Syndicate Structure).** $n^*$ is the unique lead arranger. The lead share is $\underline{s}_{n^*}$; the total participant share is $1 - \underline{s}_{n^*}$, and each participant receives a share $\frac{1 - \underline{s}_{n^*}}{N - 1}$. 

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Given our explicit characterization of the lead share in (M), the comparative statics in Corollary 9 follow directly.

**Corollary 9 (Comparative Statics).**

1. The lead share is decreasing in the lead arranger’s bank scope \( B_{n^*} \).
2. The lead share is increasing in the monitoring cost \( B \).
3. \( \frac{\partial^2 s_{n^*}}{\partial B_{n^*} \partial (\bar{v} - \underline{v})} > 0 \), i.e., an increase in \( B_{n^*} \) reduces the lead share by more the smaller the monitoring incentives, \( \bar{v} - \underline{v} \).

First, we find that a bank of wide scope requires a smaller loan share to monitor than a bank of narrower scope. This is the case either because monitoring is more valuable to the bank, or because it has monitored the borrower in the past. Second, borrowers that are hard to monitor, such as unrated borrowers, must provide a larger loan share to the lead arranger, as in Sufi (2007). Third, increases in bank scope lead to greater reductions in lead shares when monitoring incentives are weak.

Most of these predictions can be readily tested, as we will show in Section 4.4. For the comparative static with respect to monitoring incentives, we require a richer model that allows us to link the latter to observable firm-level characteristics, to which we turn next.

### 4.3 Extended Model: Linking Monitoring to Firm Characteristics

We extend our model to characterize the value of bank monitoring as a function of borrower characteristics. We show how in our setting, bank monitoring increases pledgeable income and the value of the firm by reducing asymmetric information between bank and firm.

A key result of the basic model in Section 4.2 is that the borrower optimally chooses a syndicate with a single lead arranger. In this section, we take this result as given, and consider a financial-contracting problem between a single risk-neutral borrower, a single
lead arranger, and a fixed number of syndicate participants. We then focus on deriving \( \overline{v} \), the pledgeable income when the borrower is being monitored, and \( v \), the pledgeable income when it is not, as a function of borrower characteristics. These quantities are important because (i) they determine the ability of the borrower to obtain financing with and without monitoring, and (ii) their difference determines the lead share required to induce monitoring.

We study a contracting problem subject to moral hazard on the part of the borrower, and asymmetric information between bank and borrower. The type of moral hazard faced by the borrower is stochastic: in one state of the world, the borrower can misappropriate capital for private consumption, while it can engage in risk shifting in the other state. In addition, the borrower’s expected returns differ across states of the world. There is asymmetric information because the borrower knows the state of the world, while the bank does not. The bank can, however, learn the state of the world by monitoring. When the bank does not monitor, it must overcome moral-hazard frictions without knowing which moral-hazard problem the borrower faces, leading to adverse selection.\(^3\) When the bank monitors, it knows which moral-hazard problem the borrower faces, and can efficiently provide incentives to overcome the moral hazard problem at hand. Bank monitoring is, thus, valuable because it allows for more efficient financial contracting.

To characterize pledgeable income with and without monitoring, we proceed as follows: we begin by taking as given that the bank monitors the borrower, and derive the contract that maximizes pledgeable income under symmetric information. We refer to this contract as the optimal symmetric-information contract, and to the resulting pledgeable income as \( \overline{v} \). Since the borrower’s moral-hazard problem is state contingent, the optimal symmetric-information contract consists of two state-contingent incentive schedules. We then ask whether the optimal symmetric-information contract does indeed provide monitoring incentives to the lead arranger for a given loan share \( s \). In particular, we ask what payoff the lead arranger can

\(^3\)For expositional ease, we focus on a simple setting with two states of the world and three potential profit realizations at the borrower level. This setting allows us cleanly characterize the key forces at play in our model. Nevertheless, none of our key results depend on this structure.
obtain by assigning one of the state-contingent incentive schedules of the optimal symmetric-information contract to the borrower \textit{without knowing the state of the world}. We refer to this quantity as $v$, and to $\overline{v} - v$ as the \textit{monitoring incentives} provided by the borrower. As highlighted in the previous section, this quantity is of crucial importance in determining the loan share that must be assigned to the lead arranger to ensure monitoring.$^4$

Next, we ask what the borrower’s pledgeable income is if no monitoring occurs. To this end, we characterize the optimal contract under asymmetric information, and call the resulting pledgeable income $\hat{v}$. Accordingly, we refer to $\overline{v} - \hat{v}$ as the \textit{value of information}. This quantity is crucial in determining whether an active monitor is important for firms to be able to access credit.

Since our model fully specifies the firm’s production technology, we can use it to link monitoring incentives and the value of information to firm characteristics. Our key result is that both are increasing in the \textit{volatility} of the firm’s production technology, as measured by the range of the firm’s expected returns across states of the world, and \textit{productivity}, as measured by the average expected return across states. We then use this result to generate testable predictions for syndicate structure in general, and for the lead share as a function of observable firm characteristics in particular.

\section*{4.3.1 Basic Environment}

We consider the problem of a penniless firm seeking funds for an investment project with uncertain prospects that requires a fixed amount of start-up funding $k_0$. Time is discrete, and runs for three dates, $t = \{0, 1, 2\}$. At date 0, the borrower commits to an intermediation agreement with the syndicate. At date 1, a random variable $z \in Z$ is realized. We refer

$^4$An important consideration that we neglect in our discussion is whether the firm would like to distort the borrowing contract in order to induce information acquisition by the syndicate, in line with the arguments in DeMarzo and Duffie (1999) and Yang and Zeng (2015). While doing so may serve to increase the lead arranger’s monitoring incentives, it is clear that any distortion of the optimal symmetric-information contract will reduce pledgeable income relative to the symmetric-information baseline and will, thus, preserve the key comparative statics that we test in our empirical application. In the interest of parsimony, we therefore abstract from analyzing the firm’s security-design problem in more detail.
to z as the state of the world, and say that it is either high (h) or low (l), i.e., \( Z = \{h, l\} \). The state of the world is high with probability \( \gamma \), and low with complementary probability \( 1 - \gamma \). When talking about a generic state of the world \( z \), the probability of that state occurring is \( \Pr(z) \). At date 2, the project outcome \( X_j \in X \equiv \{X_1, X_2, X_3\} \) is realized, with \( X_3 > X_2 > X_1 \).

### 4.3.2 Production Technology

Fix the set of project outcomes \( X \). The borrower’s technology is then given by the probability distribution over \( X \). At date 0, the firm is born with a basic production technology \( p = \{p_1, p_2, p_3\} \). At date 1, a new technology \( q^z = \{q_1^z, q_2^z, q_3^z\} \) arrives in addition to the basic technology \( p \). We denote the expected output of the firm given the basic and new technology by \( \Pi = pX \) and \( \Pi^z = q^zX \), respectively. At date 1, the firm’s technology portfolio is thus given by \( \{p, q^z\} \). The firm must then decide which technology to employ for production. In deciding which technology to implement, two key properties of the new technology are its incremental *value*, relative to the basic technology, and its *riskiness*.

**Definition 9 (Value and Riskiness of the New Technology).** The value of the new technology in state \( z \) is \( \pi^z \equiv \Pi^z - \Pi \). The riskiness of the new technology is \( \zeta \equiv \Pi^h - \Pi^l \).

To generate testable predictions, we will be interested in the comparative statics of our model as we vary the riskiness of the new technology. To this end, we define a mean-preserving risk increase of the new technology as follows.

**Definition 10 (Mean-preserving Risk Increase).** A mean-preserving risk increase of the new technology is an increase in \( \zeta \equiv \Pi^h - \Pi^l \) such that (i) \( \Pi^h \) increases, (ii) \( \Pi^l \) decreases, and (iii) \( \gamma \Pi^h + (1 - \gamma) \Pi^l \) remains unchanged.

Throughout the paper, we simplify language by referring to the riskiness of the new technology as firm risk, and to a mean-preserving risk increase as a risk increase. The following remark is important for many of our results.

**Remark 1.** The value of the new technology \( \pi^h \) (\( \pi^l \)) is increasing (decreasing) in a mean-
preserving spread.

If \( z = l \), implementing the new technology is costless. If \( z = h \), implementing requires an additional capital investment of size \( k_1 \). The value of the new technology \( q^z \) depends on the state of the world: the new technology is more productive than the basic technology when \( z = h \), but less productive when \( z = l \). Formally, we have that

\[
\Pi^h - k_1 > \Pi > \Pi^l,
\]

which implies that \( \pi^h - k_1 > 0 \) and \( \pi^l < 0 \). Because \( q^h \) increases expected output, we refer to this technology as a growth option.

In addition to the differences in expected returns, the production technologies also differ in their volatility. In particular, \( q^l \) places more probability mass on both the lowest and highest outcomes than does \( p \). Formally,

\[
q^l_3 > p_3 \quad \text{and} \quad q^l_1 > p_1,
\]

with \( q^l_3 - p_3 < q^l_1 - p_1 \). The new technology thus introduces a risk-shifting problem in state \( l \): the borrower can use \( q^l \) to gamble on the best outcome, at the cost of an increased likelihood of the worst outcome. This will be an important concern whenever an intermediation contract offers the borrower large payments after good outcomes, but low payments after poor outcomes. For this reason, we refer to \( q^l \) as a risky gamble.

To simplify notation, we let \( \tilde{q} = \gamma q^h + (1 - \gamma)q^l \) denote the expected distribution over outcomes when the new technology is chosen in every state of the world, and denote by \( \tilde{q} = \gamma q^h + (1 - \gamma)p \) the expected distribution over outcomes when the efficient technology is chosen in every state of the world.
4.3.3 Information Structure and Sources of Moral Hazard

There are two potential frictions between the borrower and the bank. First, the state of the world \( z \) is the borrower’s private information. As such, the bank’s only source of information about \( z \) is a report \( \hat{z} \in \{h, l\} \) by the borrower, which need not be truthful but is fully contractible. We call this friction *asymmetric information*. Second, the borrower’s technology choice is unobservable to the bank and, thus, not contractible. In particular, we assume that the borrower can misappropriate any capital intended for use in the implementation of the growth option for private consumption. We denote the borrower’s unobserved decision to implement \((i)\) or discard \((d)\) the new technology in state of the world \( z \) by \( a(z) \in \{i, d\} \).

Since the fact that \( a \) is unobservable leads to an agency problem, we call this friction *moral hazard*.

4.3.4 Contracts and Strategies

Contracting takes place at date 0 under full commitment. An intermediation contract is a tuple \( C = \{ \kappa_0, \tau(\hat{z}), \kappa_1(\hat{z}) \} \in \{h, l\} \), where \( \kappa_0 \) denotes the initial date-0 capital transfer from bank to borrower, \( \tau(\hat{z}) = [\tau_1(\hat{z}), \tau_2(\hat{z}), \tau_3(\hat{z})] \) denotes the repayment schedule from borrower to bank conditional on \( \hat{z} \) and the project outcome, and \( \kappa_1(\hat{z}) \) denotes an additional date-1 capital transfer from bank to borrower conditional on \( \hat{z} \). The borrower’s *wages* or, equivalently, the borrower’s residual profits after repayment are given by \( w(\hat{z}) = X - \tau(\hat{z}) \).

Contracts are subject to the borrower’s *limited liability*, i.e., \( \tau(\hat{z}) \leq X \) for all \( \hat{z} \). We refer to \( \bar{C} = \{ \tau(\hat{z}), \kappa_1(\hat{z}) \} \in \{h, l\} \) as the *continuation contract* detailing only the repayment schedules and additional fund transfers for technology adoption. Whenever there is no risk of confusion, we use the terms *contract* and *continuation contract* interchangeably.

A strategy for the bank is a contract offer \( C \), while a strategy for the borrower is a pair of functions \( \hat{z} : Z \rightarrow Z \) and \( a : Z^2 \rightarrow \{i, d\} \), consisting of an adoption decision \( a(z, \hat{z}) \) and a reporting decision \( \hat{z}(z) \). We denote the optimal reporting strategy given a contract offer by \( \hat{z}^*(z) \), and the optimal adoption decision given \( \hat{z}^* \) by \( a^*(z, \hat{z}) \). Since the borrower has full
discretion about the choice of technology for every \( z \), the technology used in production is an equilibrium outcome. We denote this technology by:

\[
Q(a, \tilde{z}, z) = \begin{cases} 
q^h & \text{if } (a, z) = (i, h) \text{ and } \kappa_1(\tilde{z}) \geq k_1 \\
q^l & \text{if } (a, z) = (i, l) \\
p & \text{otherwise.}
\end{cases}
\]

Since the borrower is free to misappropriate any capital intended for implementation, choosing the growth option forces him to incur a private cost in terms of foregone private consumption \( c \). This cost is given by:

\[
c(a, z) = \begin{cases} 
k_1 & \text{if } (a, z) = (i, h) \\
0 & \text{otherwise.}
\end{cases}
\]

Under the optimal strategy \( \{a^*(z, \tilde{z}^*(z)), \tilde{z}^*(z)\} \), the optimal technology choice in state \( z \) is a function of \( z \) only, and is given by:

\[
Q^*(z) \equiv Q(a^*(z, \tilde{z}^*(z)), \tilde{z}^*(z), z).
\]

Similarly, we let \( \kappa_1^*(z), c^*(z), \text{ and } w^*(z) \) denote, respectively, the additional capital transfer, the private cost of the adoption decision, and the borrower’s wages under the optimal strategy. Given the borrower’s optimal strategy, the borrower’s total expected wages are:

\[
W = \sum_z \Pr(z) \begin{bmatrix}
Q^*(z)w(\tilde{z}^*(z)) \\
\text{residual profits}
\end{bmatrix} + \begin{bmatrix}
\kappa_1^*(z) - c^*(z) \\
\text{misappropriated capital}
\end{bmatrix}.
\]

Accordingly, the optimal contract under asymmetric information is the solution to the
following program:

\[
v = \max_{\{w(\cdot), \kappa_1(\cdot)\}} \sum_z \Pr(z) \left[ Q^*(z) (X - w(\tilde{z}^*(z))) - \kappa_1(\tilde{z}^*(z)) \right]
\]

s.t

(i) for every \((z, \tilde{z})\)

\[
a^*(z, \tilde{z}) = \arg\max_a Q(a, z, \tilde{z})w(\tilde{z}) + \kappa_1(\tilde{z}) - c(a, z)
\] (IC)

(ii) for every \(z\)

\[
\tilde{z}^*(z) = \arg\max_{z'} Q(a^*(z, z'), z, z')w(z') + \kappa_1(z') - c(a^*(z, z'), z)
\] (REV)

(iii) \(w(z) \geq 0\) for every \(z\), (LL)

and \(v\) is the borrower’s pledgeable income. The incentive-compatibility constraint (IC) and the information-revelation constraint (REV) require that the borrower choose its technology and its reporting strategy so as to maximize its private benefit, while (LL) imposes limited liability on the part of the borrower.

### 4.3.5 Maintained Assumptions

To make the contracting problem under asymmetric information interesting, we maintain the following assumptions:

**Assumption 4** (Conflicting Incentive Problems). *There does not exist a \(j \in \{1, 2, 3\}\) such that \(q^h_j > p_j > q^l_j\).*

This assumption implies that no outcome \(j\) exists such that payments to the borrower after \(j\) simultaneously provide incentives to (i) choose the growth option over the basic technology, and (ii) choose the basic technology over the risky technology.

**Assumption 5** (Monotone Likelihood Ratio for the Growth Option). *The likelihood ratio of \(q^h\) with respect to both \(p\) and \(q\) is monotone in outcomes. That is, both*

\[
LR_{q^h, p}(X) \equiv \frac{Pr(X|q^h)\mu}{Pr(X|q^h)\mu + Pr(X|p)(1 - \mu)}
\]
and

\[ LR_{q^h,q^l}(X) \equiv \frac{Pr(X|q^h)\mu}{Pr(X|q^h)\mu + Pr(X|q^l)(1 - \mu)} \]

are monotonically increasing in \( X \) for any prior \( \mu \in (0, 1) \).

This assumption implies that better outcomes represent “better news” about the borrower’s choice of the growth option over any other technology, in the sense of Milgrom (1981).

In the absence of asymmetric information, Assumption 5 implies that to provide efficient incentives for choosing the growth option, the lender pays the borrower only after the best outcome, as in a standard debt contract. If there is asymmetric information, however, Assumption 4 implies that a standard debt contract also provides incentives to choose the inefficient risky gamble over the basic technology. The optimal contract under asymmetric information must therefore balance these two forces.

Finally, we assume that the agency problem in state \( h \) is not severe enough to deter adoption of the growth option under symmetric information about \( z \). As we will show in the next section, this is guaranteed by Assumption 6.

**Assumption 6 (Weak Moral Hazard under Symmetric Information).** The growth option satisfies

\[ \Pi^h - \gamma k_1 > \gamma q_3^h \frac{k_1}{q_3^h - p_3} \]

### 4.3.6 Optimal Contract under Symmetric Information

We begin by analyzing the optimal contract under symmetric information. In particular, we take as given that the lead arranger monitors, so that \( z \) is common knowledge, and allow the syndicate to design state-contingent incentive schedules \( \{w(h), w(l)\} \) and transfers \( \{\kappa_1(h), \kappa_1(l)\} \).

Take as given that the bank wants to implement \( q^h \) when \( z = h \), and \( p \) when \( z = l \). Then
we can specialize (IC) to two state-contingent incentive-compatibility constraints:

\[ pw(l) \geq q'w(l) \quad \text{(DET)} \]
\[ q^h w(h) \geq pw(h) + \kappa_1(h). \quad \text{(IMP)} \]

The agency problem in state \( l \) is particularly simple: \( w = 0 \) satisfies (DET), and transfers all project returns to the bank.

The incentive problem in state \( h \) is harder to overcome: since the borrower can misappropriate \( \kappa_1(h) \), providing incentives to implement the growth option will generically require the bank to cede moral-hazard rents to the borrower. What is the most efficient way for the bank to deal with this friction? First, note that the tightness of (IMP) is strictly increasing in \( \kappa_1(h) \). As such, the bank will never place more than the required \( k_1 \) units of additional capital at risk of misappropriation. Second, standard results from agency theory indicate that the bank should pay the borrower only after those project outcomes that represent the “best news,” namely that the borrower did indeed choose \( q^h \) over \( p \). Assumption 5 then implies that the bank minimizes the borrower’s moral-hazard rents stemming from (IMP) by paying wages after outcome 3 only.

**Lemma 6** (Optimal Contract under Symmetric Information). The optimal contract under symmetric information is given by

\[ \pi_1(l) = 0, \quad \pi_1(h) = k_1, \quad w(l) = 0, \quad w(h) = \left[ 0, 0, \frac{k_1}{q^h_3 - p_3} \right]. \]

The borrower receives expected wages \( \bar{W} = \gamma q^h_3 \frac{k_1}{q^h_3 - p_3}, \) and pledgeable income is \( \bar{v} = \bar{q}X - \gamma k_1 - \bar{W}. \)

It is now clear that Assumption 6 guarantees that the bank does indeed want to provide incentives to implement the growth option in state \( h \): the required wages are smaller than the gain in expected output.

Given that the symmetric-information contract can be implemented only if the lender ac-
quires information, we now ask whether the lender’s payoffs in the optimal symmetric-information contract are such that the lender does indeed have incentives to monitor.

4.3.7 Monitoring Incentives in the Optimal Symmetric-information Contract

We characterize the incentives to monitor that arise in the optimal symmetric-information contract. In particular, we ask: what is the payoff to the lead arranger when he assigns either \(\{\pi_1(l), \omega(l)\}\) or \(\{\pi_1(h), \omega(h)\}\) to the borrower, without knowing what the actual state of the world is? There are two important observations. First, if \(z = h\), but the bank assigns the contract \(\{\pi_1(l), \omega(l)\}\), then the borrower does not implement the growth option. Second, if \(z = l\), and the bank assigns the contract \(\{\pi_1(h), \omega(h)\}\), then the borrower implements the risky gamble, because the risk-shifting properties of \(q^l\) allow the borrower to gamble on receiving wages after the best outcome. By assigning \(\{\pi_1(l), \omega(l)\}\), the bank thus receives an expected payoff of \(pX\), while by assigning \(\{\pi_1(h), \omega(h)\}\), the bank receives an expected payoff of \(qX - \gamma k_1 - \tilde{W}\), where \(\tilde{W} \equiv (1 - \gamma)k_1 + q_h^h \frac{k_1}{q_h^h - p_3}\) is the expected cost of \(\{\pi_1(h), \omega(h)\}\) under asymmetric information. \(\tilde{W}\) differs from \(W\) because the borrower no longer chooses the efficient technology in every state of the world, and receives the additional transfer \(k_1\) even when the growth option is not available. Hence, when not monitoring, the bank obtains the payoff

\[
\varphi = \max \left\{ pX, qX - \gamma k_1 - \tilde{W} \right\}.
\]

Accordingly, the monitoring incentives under the optimal symmetric-information contract are

\[
\bar{\varphi} - \varphi = \min \left\{ \gamma \left( \pi^h - k_1 \right) - \tilde{W}, -(1 - \gamma)\pi^l + (W - \tilde{W}) \right\}.
\]

We now show that higher firm risk, in line with Definition 10, increases monitoring incentives in the optimal symmetric-information contract. To do so, we characterize the comparative
statics of monitoring incentives with respect to the riskiness of the new technology $\zeta$.\footnote{There is a slight subtlety in the implementation of the mean-preserving spread in terms of model parameters, since firm riskiness is defined in terms of expected outcomes. In particular, a change in expected outcomes does not uniquely identify a change in the underlying parameters. To most cleanly delineate the effects of increases in risk, we implement mean-preserving spreads such that expected wages $\bar{W}$ and $\tilde{W}$ do not change. In Appendix ??, we show that wages are independent of $X$, and that wages are never paid in every state of the world. Hence, we always have enough degrees of freedom to implement mean-preserving spreads in the desired manner.}

**Proposition 19** (Monitoring Incentives and Risk). Monitoring incentives $\overline{v} - \underline{v}$ are strictly increasing in a mean-preserving spread of firm risk.

The proof follows directly from Remark 1, which shows that $\pi^h$ is strictly increasing in firm risk, while $\pi^l$ is strictly decreasing. In Section 4.4, we use this result to derive testable predictions from our model.

### 4.3.8 Optimal Contract under Asymmetric Information

We now consider the situation in which $z$ is the borrower’s private information and the implementation decision continues to be unobservable. Thus, the bank simultaneously faces both moral hazard and asymmetric information. To highlight the key difference relative to the setting in which there is only moral hazard, we refer to this setting simply as *asymmetric information* (AI), and take it to be understood that moral hazard is present *in addition* to asymmetric information.

When the bank is uninformed about $z$, it must, in essence, provide incentives to overcome the borrower’s moral-hazard problem at the technology-adoption stage without knowing whether the borrower must decide between $q^h$ and $p$, or between $p$ and $q^l$. Formally, we require that the contract not be explicitly conditioned on $z$, but rather on the borrower’s report $\hat{z}$ only. The bank’s uncertainty about the nature of the borrower’s moral-hazard problem leads to tension between the optimal incentive provision in each state: the bank may have to forego providing incentives in one state of the world in order to efficiently provide them in the other state, or the bank must cede steep moral-hazard rents in order to be able to provide incentives in both states of the world. The optimal contract under
asymmetric information will therefore fall into one of three classes: full-incentive contracts (FI), in which the borrower chooses the efficient technology in every state of the world, implementation contracts (I), in which the borrower chooses the new technology in every state of the world, and deterrence contracts (D), in which the borrower keeps the basic technology in every state of the world. We index a generic contract class by \( j \), and refer to the contract that maximizes pledgeable income in each class as the optimal contract within that class. The optimal contract under asymmetric information then is the optimal class-\( j \) contract that delivers the highest pledgeable income across all contract classes.

We relegate a full analysis of the contracting problem to Appendix ??, and only present our key findings. In particular, Proposition 20 summarizes the properties of the optimal contract that allow us to derive empirical predictions for syndicate structure as a function of borrower characteristics.

**Proposition 20** (Optimal Contract under Asymmetric Information). Let \( W^j \) denote the expected wage payments in the optimal class-\( j \) contract. Then we have:

1. The optimal deterrence contract consists of offering \( \{ \bar{\kappa}(l), \bar{\omega}(l) \} \) in every state of the world. Hence, \( W^D = 0 \) and pledgeable income is \( pX \).

2. The optimal implementation contract consists of offering \( \{ \bar{\kappa}(h), \bar{\omega}(h) \} \) in every state of the world. Hence, \( W^I = \bar{W} \) and pledgeable income is \( \tilde{q}X - \gamma k_1 - \tilde{\bar{W}} \).

3. Expected wages under the optimal full-incentive contract are higher than under the optimal implementation contract and the optimal symmetric-information contract:
   \[ W^{FI} > W^I \text{ and } W^{FI} > \bar{W}. \]
   Pledgeable income is \( \tilde{q}X - \gamma k_1 - W^{FI} \).

4. Pledgeable income in the optimal contract under asymmetric information is
   \[ \tilde{v} = \max \left\{ \tilde{q}X - \gamma k_1 - W^{FI}, \tilde{q}X - \gamma k_1 - \bar{W}, pX \right\}. \]

5. There exist thresholds \( \Pi^l \) and \( \Pi^h \) such that the optimal contract under asymmetric information is a full-incentive contract if and only if \( \Pi^l \geq \Pi^l \) and \( \Pi^h \geq \Pi^h \).
Taking the difference between $v$ and $\hat{v}$ reveals the value of information:

**Corollary 10 (Value of Information).** The value of information is

$$v - \hat{v} = \min \left\{ W^{FI} - W, \gamma \left( \pi^h - k_1 \right) - W, -(1 - \gamma)\pi^l + (W - \hat{W}) \right\}.$$

The following proposition shows that the value of information is weakly increasing in firm risk.

**Proposition 21 (Value of Information and Risk).** The value of information is weakly increasing in firm risk. In particular, the value of information is strictly increasing in firm risk if $\Pi^l < \Pi^t$ or $\Pi^h < \Pi^h$, and it is independent of firm risk if $\Pi^l \geq \Pi^t$, $\Pi^h \geq \Pi^h$, with at least one inequality being strict.

The proof is simple. If the optimal contract is not a full-incentive contract, the proof follows directly from the proof of Proposition 19. In particular, as long as the optimal contract under asymmetric information induces an inefficient action in one state of the world, the costs of asymmetric information increase when the costs of choosing the wrong technology, defined by the payoff differences $\pi^h$ and $\pi^l$, increase. As highlighted in Remark 1, these costs increase precisely when riskiness increases. If the optimal contract is a full-incentive contract, the borrower chooses the efficient technology in every state of the world under both symmetric and asymmetric information. Hence, increased riskiness does not impact the value of information. Putting these pieces together, the value of information is weakly increasing in firm risk.

### 4.4 Empirical Analysis

In this section, we take our model’s predictions regarding the impact of bank scope on syndicate structure and loan shares retained by universal-bank lead arrangers to the data. We show that by enabling the realization of economies of scope across loans and non-loan products, the deregulation of bank scope leads to universal banks (i) being more likely to
become lead arrangers (ii) while, conditional on being chosen as lead arrangers, retaining smaller loan shares. We begin by summarizing the empirical predictions of our model, and then turn to describing our identification strategy and empirical implementation. Section 4.4.3 compiles our results.

4.4.1 Empirical Predictions

In this section, we derive testable predictions from our theoretical model. In doing so, we rely on three main findings. First, recall that the bank with the widest scope is chosen as the unique lead arranger, and its lead share is

$$s_{n^*} = \frac{B \cdot (1 - B_n^*)}{\bar{v} - \underline{v}}.$$ 

Hence, the lead share is decreasing in bank scope $B_n$, and decreasing in monitoring incentives $\bar{v} - \underline{v}$. Second, $\bar{v} - \underline{v}$ is strictly increasing in firm risk. Third, as stated in Corollary 21, the value of information is weakly increasing in risk as well.

Our first empirical prediction considers the choice of lead arranger. Since banks of wide scope require small loan shares to monitor, they are more likely to be chosen as lead arrangers.

**Empirical Prediction 1** (Lead-arranger Probability). Banks of wide scope are more likely to be chosen as lead arrangers.

Second, we consider the model’s predictions for loan shares. We have shown that the lead share decreases when a bank of wide scope is the lead arranger.

**Empirical Prediction 2** (Lead Shares). Banks of wide scope receive smaller loan shares, conditional on becoming lead arrangers. Thus, when the syndicate includes a bank of wide scope, the lead share decreases.

Finally, we consider the comparative statics of lead shares with respect to borrower characteristics. Namely, we have that the decreases in the lead share are less pronounced for
risky borrowers, because the value of information is higher for them.

**Empirical Prediction 3** (Lead Shares: Comparative Statics). *The negative effect of wider bank scope on lead shares is weaker for risky borrowers.*

### 4.4.2 Empirical Setup

We next discuss our identification strategy based on the bank-scope deregulation following the stepwise repeal of the Glass-Steagall Act, as already used in Neuhann and Saidi (2014). Then, we will describe the data on syndicated loans and our sample selection.

**Identification Strategy**

An important prerequisite for estimating the impact of bank scope on syndicate structure is an empirical design that provides variation in bank scope. In Neuhann and Saidi (2014), we argue that the stepwise repeal of the Glass-Steagall Act constitutes such a setting. The Glass-Steagall Act of 1933 imposed a separation of commercial banking (deposit taking and lending) and investment banking (especially underwriting of corporate securities). The first major step of the repeal took place in January and September 1989, which is when commercial banks were allowed to generate a certain proportion (10% in 1989, which increased to 25% in 1996) of their revenues through underwriting activities, including underwriting of corporate debt and equity. Commercial banks became universal banks typically by opening so-called Section 20 subsidiaries for these purposes. Another possibility was to acquire an investment bank.

While this first step towards universal banking led to an increase in bank size by allowing banks to engage in both commercial and investment banking, they did so with firewalls in place separating the two activities. These prudential limits, or firewalls, within bank-holding companies were, however, abolished by the Federal Reserve Board in a second step on August 1, 1996. Most importantly, the elimination of firewalls between securities and commercial-bank divisions enabled universal banks to cross-sell loans and non-loan
products, which used to be severely restricted, not to say forbidden, under the Federal Reserve Act (Sections 23A and B).

We wish to test whether banks of wide scope are more likely to be chosen as lead arrangers and whether, conditional on becoming lead arrangers, they retain smaller shares of loans. In our model, the underlying mechanism is based on universal banks’ ability to realize economies of scope across financial products. Empirically, this is operationalized through cross-selling of loans and non-loan products. Thus, we hypothesize that universal, rather than commercial, banks are more likely to become lead arrangers and retain smaller shares of loans granted to firms that could enter into cross-selling relationships with those universal banks.

In an attempt to match this interpretation of our model, we make use of the 1996 deregulation to capture varying propensities to cross-sell loans and non-loan products. Namely, we employ a difference-in-differences strategy around August 1, 1996 for treated universal banks vs. commercial banks that were unaffected in their scope of banking activities. Only universal banks gained the ability to actively cross-sell after the deregulation, and we will be able to differentiate between universal banks that existed already before the deregulation and commercial banks that became universal banks thereafter.

The validity of our identification argument rests on two key assumptions. First, the timing of the 1996 deregulation must have been unexpected. This assumption is affirmed by the fact that the banking industry had already proposed the elimination of firewalls in 1991, but had been rejected by the United States House Committee on Financial Services. Hence, it is unlikely that banks and firms were anticipating the deregulatory policy before 1996. Second, we assume that universal-bank and commercial-bank loan shares followed parallel trends prior to the deregulation, for which we have presented some evidence in Figure 27.

We next turn to the empirical implementation. Each syndicated loan is a package that consists of one or multiple facilities which, in turn, consist of loan shares provided by one or multiple syndicate lenders. As we are interested in effects on each individual bank’s share
within a loan syndicate, our outcome variables are defined at the package-bank level. That is, for each syndicated loan, we include multiple observations per package, and dissect all facilities within each package into one observation per (participating or lead) bank. This allows us to include package-level fixed effects as well. We estimate the following regression specification:

\[
\text{outcome}_{ijkt} = \beta_1 UB_{ijkt} + \beta_2 UB \text{ est. before } 1996_{ijkt} + \beta_3 UB \text{ est. before } 1996_{ijkt} \times After(1996)_t + \lambda_k + \psi_j + \epsilon_{ijkt},
\]

(24)

where \(outcome_{ijkt}\) is an outcome variable associated with bank \(k\)'s share of loan (package) \(j\) (subsuming the borrower firm \(i\)) at date \(t\), \(UB_{ijkt}\) and \(UB \text{ est. before } 1996_{ijkt}\) are indicator variables for whether at the time of the loan transaction the (participating or lead) bank was a universal bank anytime or before August 1, 1996, respectively, and \(After(1996)_t\) is an indicator variable for whether the loan was issued on or after August 1, 1996. \(\lambda_k\) denotes bank fixed effects, which we specify for all banks that were or eventually became universal banks (whereas all remaining commercial banks are grouped together), and \(\psi_j\) are package-level fixed effects. Standard errors are clustered at the package level.\(^6\)

Note that we can estimate a coefficient on \(UB_{ijkt}\) even in the presence of bank fixed effects, because we track commercial banks that may have opted to become universal banks after their first loan transaction in the data, so that \(UB_{ijkt}\) varies within banks. In doing so, we distinguish between universal banks established before and after 1996 to estimate a potential bias due to commercial banks' endogenous timing to become universal banks. The post-1996 effect for universal banks established after the deregulation is given by \(\beta_1\), whereas the post-1996 effect for universal banks established before the deregulation is given by the sum of \(\beta_1\), \(\beta_2\), and \(\beta_3\). The latter is also the group, which allows us to estimate the difference-in-differences effect in comparison to commercial banks before and after 1996.

\(^6\)Standard errors for all our estimates are virtually invariant to clustering at the bank level.
which is reflected by $\beta_3$.

The difference between these two groups of universal banks is given by the sum of $\beta_2$ and $\beta_3$, and indicates to what extent commercial banks timed their conversion into universal banks in a manner that is endogenous to our outcome variables of interest. As we will see, throughout all estimations, the post-1996 effect on lead-arranger probabilities is much stronger for universal banks established before 1996. This implies that universal banks that came into existence only after 1996 were unlikely to do so for considerations that were endogenous to their acting as lead arrangers following the deregulation of bank scope.

Note that we record each bank’s loan share separately within each package (loan), so we can include package fixed effects. These fixed effects capture many relevant loan characteristics, most importantly the loan date, borrower characteristics at the time of loan issue, and general characteristics of the syndicate, e.g., the number and the actual network of syndicate lenders. Including package fixed effects also alleviates concerns that would ultimately lead to a violation of the parallel-trends assumption between universal and commercial banks, such as bank-firm matching based on unobserved time-varying firm-level characteristics, as the latter are invariant within a package.

This empirical setup enables us to gauge the impact of bank scope on syndicate structure. In doing so, we connect with Sufi (2007) and Ivashina (2009) who also scrutinize the distribution of shares retained by syndicate lenders. The most important advance that we attempt to make is to account for heterogeneity in bank scope among syndicate lenders, differentiating at the very least between universal and commercial banks. This, in turn, allows us to exploit the variation in bank scope generated by the stepwise repeal of the Glass-Steagall Act, especially regarding the ability of universal banks to realize economies of scope through cross-selling. In this manner, we strengthen our causal interpretation that syndicate lenders with a wide bank scope are more likely to be chosen as lead arrangers.

When we scrutinize lead shares, however, we need to move from the package-bank ($ijk\!t$) level to the package ($ijt$) level, which no longer allows us to include package-level fixed
effects. We translate our difference-in-differences strategy to the analysis of loan shares retained by lead arrangers, as reflected by the following regression specification:

\[
outcome_{ijt} = \beta_1 UB_{ijt} + \beta_2 UB_{ijt} \times After(1996)_t + \beta_3 X_{it} + \theta_{it} + \mu_j + \epsilon_{ijt},
\]  

(25)

where \( outcome_{ijt} \) is an outcome variable associated with loan (package) \( j \) (subsuming the borrower firm \( i \)) at date \( t \), \( UB_{ijt} \) is an indicator variable for whether at the time of the loan transaction any one of the (participating or lead) banks was a universal bank, and \( After(1996)_t \) is an indicator variable for whether the loan was issued on or after August 1, 1996. \( X_{it} \) summarizes time-varying borrower characteristics, \( \theta_{it} \) denotes industry-year fixed effects, and \( \mu_j \) denotes syndicate fixed effects that are included for all participating and lead banks at the package level that were or eventually became universal banks, whereas all remaining commercial banks are grouped together in one category.

When we move from analyzing lead-arranger probabilities for all syndicate members to explaining lead shares at the aggregate package/loan level, we face the challenge that according to our model, universal banks are picked as lead arrangers precisely because of their smaller required lead shares. Thus, we cannot condition on loan shares being granted by lead-arranger universal banks. Instead, we define \( UB_{ijt} \) at the aggregate loan level, so that its indication of whether any bank in the syndicate was a universal bank instruments for the heightened probability that said universal bank was chosen as lead arranger.

As in specification (24), the omitted category consists of commercial banks that were unaffected by the 1996 deregulation. Given that we use a package-level indicator for the presence of any universal banks in the syndicate, \( UB_{ijt} \), it is more difficult to differentiate between effects being driven by universal banks established before vs. after the deregulation. However, as alluded to above, and as will become clear when we discuss the estimation results, the endogeneity of banks’ timing to become universal banks does not appear to bias upward at least their estimated propensity to become lead arrangers.
Data Description

Before presenting the results, we briefly describe our data. As our main data source, we use syndicated loans issued by publicly listed U.S. firms from 1985 to 2010 from the DealScan database. We complement our loan data with CRSP stock prices, SDC debt- and equity-underwriting as well as Compustat data.

We consider all completed loan transactions in the DealScan database involving publicly listed U.S. firms, with valid data on syndicate banks' lead-arranger status and/or loan shares. As described above, each loan (package) consists of multiple facilities, but multiple banks may participate in a single facility. Our observations are at the package-bank level, i.e., we build multiple observations per package, and within each package one observation per (participating or lead) bank. To calculate the share retained by each bank, we first determine the unique share retained by each bank in every role it has in the syndicate by dropping duplicate observations. We then sum up all loan shares for each bank within a package, and keep only one observation per bank, which includes the information whether the respective bank (also) acted as a lead arranger in the syndicate.

To identify all universal banks, we make use of our hand-collected data on all universal banks and their establishment dates in the DealScan database. For the above-described sample, we yield 43 universal banks, 40 of which overlap with the universal banks identified in Neuhann and Saidi (2014).\footnote{This is because we do not focus exclusively on lead arrangers in this paper. Furthermore, three additional universal banks appear in this data set, namely Republic New York (which was eventually acquired by HSBC), Swiss Bank Corp, and Union Bank of Switzerland (both of which merged in 1998).} We provide a list of these universal banks alongside a differentiation by their date and mode of establishment (opening of a Section 20 subsidiary or bank-scope-expanding M&A) in Table 23.

When we consider cross-selling of loans and corporate-securities-underwriting services (mostly debt and equity underwriting), we merge the DealScan data with the SDC underwriting data. This enables us to determine whether a loan share was accompanied by debt or equity issued through the same universal bank as the one in the loan syndicate.
To characterize the ex-ante riskiness of a firm, we use six-year, leading up to the year of the loan issue, stock-return volatilities, which are calculated using monthly CRSP data, and idiosyncratic volatilities estimated from the Fama and French (1993) three-factor model.

In the first panel of Table 24, we present summary statistics for our regression sample with data available for all variables used in the regressions, except for the loan share. The level of observation is the package-bank level. The banks’ lead-arranger status is more broadly available in DealScan: our sample drops from 170,758 to 76,582 observations when we condition on the availability of loan shares.

In the second panel of Table 24, we move to the package level, requiring data on lead arrangers and the distribution of loan shares within each syndicated loan. This restriction yields 11,852 packages, and implies that we have approximately 6.48 (participating or lead) banks per package. The vast majority of loans has only one lead arranger, namely 10,301 out of 11,852 packages. We also consider the concentration of loan shares, as captured by a Herfindahl Index, which is defined for all 11,852 packages, i.e., irrespective of the number of lead arrangers. Our sample drops to 7,250 when we require six years of stock-return data up to the year of loan issue for the calculation of volatilities, and drops to 7,171 when we consider bankruptcy-related reasons for being delisted within ten years. Overall, roughly two-thirds of all loans involved at least one universal bank as participant or lead arranger.

In addition, the first panel of Table 24 also provides information on the distribution of universal and commercial banks in our sample, and the depth of bank-firm interactions associated with these loan shares. 36.6% of the loan shares are given out by universal banks, more than one quarter of which (0.099/0.366) are cross-sold. We define cross-selling as the incidence of concurrent lending and corporate-securities underwriting by universal banks. We label a loan share as cross-sold if the same universal bank also served as a bookrunner in at least one underwriting mandate anytime from two years before to two years after the respective loan issue (implying a five-year circle). For comparison, 92.0% of all loan shares are associated with debtors that also received an equity- or debt-underwriting
product within said five-year circle from any universal or investment bank. This attests to the homogeneity within our sample of publicly listed firms in terms of their concurrent demand for loans and non-loan products.

4.4.3 Results

We now turn to the regression results for lead-arranger choices. In Table 25, we estimate regression specification (24) with an indicator for lead-arranger status as dependent variable. While always including bank fixed effects, we run this specification without package fixed effects in the first four columns, and include them in the last column. In the absence of package fixed effects, we include, instead, syndicate fixed effects for all (lead or participating) banks in the loan syndicate, as well as (industry-)year fixed effects. As pointed out previously, the inclusion of package fixed effects enables us to control for unobservable heterogeneity at the package level, ranging from loan characteristics to borrower characteristics at the time of the loan issue.

The difference-in-differences estimate is given by the coefficient on $UB_{est.\ before\ 1996}ijkt \times After(1996)_t$. It indicates to what extent universal banks established before 1996 were more likely to become lead arrangers after 1996, as compared to commercial banks before vs. after 1996. Across all columns of Table 25, this estimate is positive and significant at the 1% level, irrespective of whether we cluster standard errors at the package level, as we do in the tables shown in this paper, or at the bank level.

Overall, we find that treated universal banks were at least ten percentage points more likely to become lead arrangers following the 1996 deregulation than were commercial banks whose scope of banking activities was unaffected. Interestingly, the estimates suggest that universal banks established before 1996 were just as likely to become lead arrangers as were commercial banks before the deregulation. This is reflected by the fact that the sum of the coefficients on $UB_{ijkt}$ and $UB_{est.\ before\ 1996}ijkt$ is not different from zero after including syndicate fixed effects in the second column.
Furthermore, as alluded to before, the sum of the coefficients on $UB \text{ est. before} \ 1996_{ijkt}$ and $UB \text{ est. before} \ 1996_{ijkt} \times After(1996)_t$ is always positive, thereby indicating, that the positive effect on lead-arranger probabilities is stronger for our treatment group than for universal banks established after the deregulation. This renders it unlikely that the latter group’s timing to become a universal bank is endogenous to our outcome variable of interest.

These insights remain unaltered when we limit the sample to loans for which we have additional data on loan shares, rather than just the lead-arranger status of individual syndicate lenders, in Table 26. We view all of this as evidence in favor of our Empirical Prediction 1.

In Table 27, we re-run the same specifications as in Table 25 with actual loan shares as dependent variable. This is not our main test of interest regarding loan shares, as our model generates predictions regarding loan shares retained by lead arrangers, which – most of the time – correspond to a single observation per package. However, Table 25 already hints at the idea that treated universal banks, while, as just seen, they are more likely to be chosen as lead arrangers, retain smaller loan shares.

This manifests itself in two ways. First, after including package-level fixed effects in the last column, there is no difference in loan shares retained by treated universal banks, which were established before the deregulation, and commercial banks after 1996. This is due to the fact that the sum of the three coefficients in the last column is zero. Second, across the first four columns without package fixed effects, the difference-in-differences estimate, while positive and significant, does not appear to be commensurate with the treatment effects on the lead-arranger probability in Tables 25 and 26. Instead, the positive treatment effect reflects primarily universal banks’ increased probability to be chosen as lead arrangers.

To see this, we know from Table 24 that the average loan share retained by lead arrangers in our regression sample is 55.2%, and that by participants is 9.5%. Using the estimated treatment effect from the last column of Table 26 (to safeguard comparability, we use the
same sample), the expected treatment-implied increase in the loan share is 4.7 percentage points \((= (55.2\% - 9.5\%) \times 10.2\%)\). This exceeds the actual treatment effect of 1.1 percentage points, as implied by our difference-in-differences estimate in the last column of Table 27. This finding, which holds qualitatively also for all remaining specifications in Tables 26 and 27, can be interpreted as reflecting our theoretical mechanism that universal banks’ non-loan exposure to the firm – e.g., through cross-selling – allows the firm to provide relatively small lead shares to these banks while still maintaining monitoring incentives.

The inclusion of package fixed effects in the last column of Tables 25 to 27 implies that for the identification of our treatment effect, we can compare universal-bank and commercial-bank loan shares within a package, but the differential impact of the 1996 deregulation only across packages. This is because our treatment is defined at the bank-year level. As we argue that the 1996 deregulation spurred cross-selling by universal banks, which, in turn, enabled them to become lead arrangers at lower loan shares, this opens up an alternative identification approach, where we compare – within packages – cross-sold and non-cross-sold universal-bank loan shares.

To this end, we re-run the specifications from the last column of Tables 25, 26, and 27 in the first, third, and fifth column, respectively, of Table 28. We differentiate between commercial-bank loan shares granted to firms that concurrently received an underwriting product from any universal or investment bank – as captured by the coefficient on \(Underwritingu\) – universal-bank loan shares granted to firms that concurrently received such an underwriting product (but not necessarily from the same universal bank) and, finally, cross-sold universal-bank loan shares.

As the incidence of cross-selling is not necessarily exogenous, we have previously used the 1996 deregulation as a source of variation. In Table 28, we lack such variation, but always include package fixed effects, which – as argued before – control for unobserved time-varying firm-level characteristics. This, in turn, alleviates any concerns at least with respect to bank-firm matching based on unobserved firm characteristics. In addition, package fixed effects control for any shocks to firm-level demand, e.g., firms’ concurrent demand for loans and

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non-loan products.

Focussing on the more comparable sample conditional on the availability of loan shares in the third column, cross-sold universal-bank loan shares were significantly more – 47.5 percentage points – likely to be chosen as lead arrangers than non-cross-selling universal banks within the same package. The effect is larger in size than our previous difference-in-differences estimate of 10.2 percentage points in the last column of Table 26 because the 1996 deregulation increased only the capacity for cross-selling.

Comparing the estimates in the third and fifth columns in Table 28, we once again find that the cross-selling-implied increase in loan shares is not commensurate with the increase in the likelihood to become lead arranger, as \((55.2\% - 9.5\%) \times 47.5\% = 21.7\%\) percentage points, which is at least four times as large as the estimate – 4.8 percentage points – in the fifth column.

Finally, as cross-selling is not defined at the bank-year level, we can include bank-year fixed effects in the second, fourth, and sixth columns, which control for bank-level supply shocks. This yields a significantly positive (at the 1% level) effect of cross-sold universal-bank shares on the lead-arranger probability, compared to commercial-bank shares, as can be inferred from the sum of the four coefficients in the second and fourth column. On the other hand, the sum of the four coefficients in the sixth column is not significantly different from zero, implying that cross-selling universal banks were not assigned any larger shares than commercial banks. This further attests to our hypothesis that cross-selling universal banks were more likely to become lead arrangers because they were able to offer monitoring in exchange for lower loan shares.

To more explicitly test our Empirical Prediction 2, we move to the package level, and analyze the average loan share retained by lead arrangers. As the outcome variable of interest is defined at the package level, this does not allow us to include package-level fixed effects, which in our previous tests absorbed variation at the borrower-firm and loan-specific
Our model predicts the treatment effect of universal-banking deregulation on lead shares to be negative. To investigate this, in Table 29, we run specification (25) with syndicate and year fixed effects in the first column. At the package level, syndicate fixed effects constitute fixed effects for each participating or lead bank in the syndicate. We find that while syndicates comprising at least one universal bank generally had 29.2 percentage points smaller average lead shares than pure commercial-bank syndicates, the gap widened significantly by another 4.5 percentage points after 1996. These estimates mirror the developments in Figure 27.

This finding is robust to including industry-year fixed effects in the second column and borrower-firm-level explanatory variables in the third column. Finally, in the fourth column, we limit the sample to syndicates with only one lead arranger. We do this to safeguard that our results in the first three columns are not driven by a potential increase in the number of lead arrangers – and, thus, in the denominator of our dependent variable – in universal-bank syndicates after the 1996 deregulation. 86.9% of the loans in our sample had only one lead arranger, and when limiting our sample to the latter group, the difference-in-differences estimate remains virtually unaltered compared to that in the third column.

In Table 30, we repeat the same estimations as in Table 29, but use as dependent variable our loan-share concentration measure, which is a Herfindahl Index between 0 and 1. Since reduced loan shares allow for better diversification across the syndicate, the loan-share concentration should drop as well. In line with Empirical Prediction 2, we find the loan-share concentration to decrease in universal-bank syndicates following the 1996 deregulation. Furthermore, the difference-in-differences estimates are quantitatively very similar to those in Table 29.

*This weakness is in part exacerbated by both the imperfect availability of loan-share data in DealScan and the ownership fluctuations during the run-time of loans due to secondary-market transactions. These criticisms apply to studies using DealScan data in general. An alternative data source is the Shared National Credit program (SNC), which provides data on loan shares over the run-time of syndicated loans. As pointed out by Bord and Santos (2012), lead shares are relatively constant for credit lines, rather than term loans. In an attempt to cope with the criticism of not having loan-share data over the run-time of syndicated loans, we re-ran all regressions on the subset of credit lines, with robust results throughout.*
In Table 31, we re-run the same set of regressions, and use as dependent variable the average participant share. Our model does not predict any changes in participant shares due to bank-scope deregulation, which should translate into a zero difference-in-differences estimate. This is confirmed across all four columns of Table 31. Interestingly, syndicates with universal-bank participation were associated with up to 10 percentage points higher average participant shares. This effect is significant at the 1% level, and sheds light on our previously estimated negative coefficient of $UB_{ijt}$ on average lead shares (cf. Table 29). This is important insofar as it partially rules out that said estimated coefficients were due to extended means of information acquisition – other than cross-selling – available to universal banks even before the 1996 deregulation.

We next consider the comparative statics of lead shares with respect to firm characteristics, as given in Empirical Prediction 3, namely that the decrease in lead shares should be more pronounced for firms that are less risky. The basic rationale builds on our result that the value of information (or monitoring incentives) is higher for risky firms.

To test this, we split our sample into loans that were associated with a measure of pre-loan firm-level riskiness in the bottom vs. top 50% of the distribution in our loans sample, and re-run the regression from the third column of Table 29 on these subsamples. In the first two columns of Table 32, we use as a measure of pre-loan firm-level riskiness the borrower firm’s six-year stock-return volatility, $\sigma_{\text{return},i}^{t-5:t}$. We pick stock-return volatility and the corresponding data requirement for this test in order to achieve a relatively homogenous distribution of the private cost of monitoring $B$ in our sample. Keeping $B$ constant is all the more important in the context of our model, as the latter should have a positive effect on the lead share (see also Sufi (2007)).

In line with our prediction, the negative treatment is significant only in the sample of low-risk loans, and economically so at negative 6.7 percentage points (first column). This is in stark contrast to the virtually non-existing treatment effect for high-risk loans (in the second column). In the last two columns of Table 32, we show that these estimates hold up to, and become even more emphasized when, using splits based on idiosyncratic volatility,
calculated over the six years leading up to the year of the loan issue, $\sigma_{t-5, t}^{idiosyncratic, i}$.

Finally, we provide evidence that monitoring efficiency has, indeed, not deteriorated pursuant to bank-scope deregulation. This is to lend support to our hypothesis that due to richer bank-firm interactions, universal banks do not require large loan shares to have incentives to monitor, so falling universal-bank loan shares should not reflect any decline in monitoring efficiency. To this end, we re-run our package-level regressions from Table 29, and use as dependent variable an indicator for whether the borrowing company went bankrupt within ten years (our results are robust to variations in the horizon).

The results are in Table 33. We find that loans with universal-bank participants or lead arrangers were, on average, less likely to be associated with eventual bankruptcy (as indicated by the negative coefficient on $UB_{ijt}$). However, the difference-in-differences estimate is insignificant, which suggests that following the 1996 deregulation, this gap in borrower-level default risk remained unaltered between lending syndicates comprising universal banks and pure commercial-bank syndicated loans.

Altogether, our findings yield support for all of the model’s predictions. In particular, we have shown that bank scope is a key determinant of lead-arranger status and lead shares, and that the comparative statics in the data line up with those in the model.

### 4.5 Conclusion

In this paper, we investigate the provision of monitoring incentives in loan syndicates. Theoretically, we argue that non-loan interactions between banks and borrower firms are a key determinant of monitoring incentives in syndicates. In particular, non-loan interactions increase the bank’s exposure to firm performance and, thus, reduce the loan shares required within the syndicate to provide monitoring incentives to the bank. Since the repeal of the Glass-Steagall Act led to the growth of universal banks and resulted in richer and more complex bank-firm interactions, we provide a theory of syndicate structure that is
consistent with decreasing lead shares and continued efficient monitoring from the mid 1990s onwards.

We use our model to explicitly characterize the link between the value of information, monitoring incentives and firm characteristics, and show that firms are more likely to opt for banks of wide scope as their lead arrangers, but offer them lower loan shares conditional on becoming lead arrangers. Exploiting the gradual repeal of the Glass-Steagall Act to generate variation in bank scope and, thus, in the extent of bank-firm interactions, we find strong support for the model’s predictions.

Our findings speak to recent debates regarding the evolving nature of financial markets and corporate financing. In particular, while some commentators have highlighted the risk-sharing benefits of syndicated lending, Ivashina and Scharfstein (2010b) as well as Gorton and Metrick (2012) have argued that reduced lead shares, and the movement towards an originate-to-distribute business model for banks, may enhance lender moral hazard by discouraging diligent monitoring. While far from resolving this debate, we argue that understanding monitoring incentives may require taking a broader view of bank-firm interactions.
Chapter A

Appendix to “Macroeconomic Effects of Secondary Market Trading”

A.1 Proof of Lemma 2

Fix the financier’s outstanding debt $b_f$ and assets $k = w_f + Q_b b_f$. By risk-neutrality, the solution must be bang-bang: the financier invests all his assets in either risky claims or the safe technology. By investing $k$ in secondary markets at price $Q_a(\mu^*)$, the financier obtains an expected profit of $v_f^R = \pi_h \left( \frac{y_R(h) k - b_f}{Q_a(\mu^*)} \right) + (1 - \pi_h) \max \left\{ \frac{y_R(l) k - b_f}{Q_a(\mu^*)}, 0 \right\}$. Hence $v_f^R \geq v_f^S \equiv \pi_h \left( \frac{y_R(h) k - b_f}{Q_a(\mu^*)} \right) + (1 - \pi_h) \left( \frac{y_R(l) k - b_f}{Q_a(\mu^*)} \right)$. If the financier invests $k$ units in the safe technology instead, he receives an expected profit of $v_f^S = \bar{y}_S k - b_f$. It follows from the definitions of $k$ and $R^\text{unlev}(\mu^*)$ that $v_f^R = R^\text{unlev}(\mu^*) k - b_f$, while $v_f^R > v_f^S$ if and only if $b_f > \frac{y_R(l) w_f}{Q_a(\mu^*) - Q_b y_R(l) \bar{y}_S}$. Accordingly, $v_f^R > v_f^S$ if at least one of the stated conditions is not satisfied. \qed

A.2 Proof of Lemma 3

Fix the banker’s outstanding debt $b_b$ and assets $k = w_b + Q_b b_b$. By risk-neutrality, the solution must be bang-bang: the banker invests all his assets in either the risky technology or the safe technology. By investing $k$ in the risky technology, the banker obtains an expected profit of $v_b^R = \pi_h \left( y_R(h) k - b_b \right) + (1 - \pi_h) \max \left\{ y_R(l) k - b_b, 0 \right\} \geq \pi_h \left( y_R(h) k - b_b \right) + (1 - \pi_h) \left( y_R(l) k - b_b \right) \equiv v_b^R$. By investing $k$ in the safe technology instead, the banker receives an expected profit of $v_b^S = \bar{y}_S k - b_b$. Since $E_z y_R(z) > \bar{y}_S$, $v_b^R > v_b^S$ for all $k$ and $b_b$. \qed
A.3 Proof of Proposition 2

Consider the following candidate equilibrium. Bankers and depositors choose bond and investment quantities as in there were no secondary markets. Every banker sets $a_b = a_f = 0$. Every financier bids $a_f(\mu) = 0$ and $Q_a(\mu) = 0$ for all $\mu$ and sets $k_{sf} = w_f$. We want to show that this is an equilibrium. Specifically, we want to show that there is no profitable deviations that lead to positive trade on secondary markets. Since $Q_a(\mu) < Q_a (Q_b) \leq \hat{y}_R$ for all $\mu$ and all $Q_b \in [\frac{1}{y_R}, 1]$, no banker has an incentive to sell risky claims at the given prices. Since $a_b = 0$ for all bankers, a financier can induce a banker to sell assets under limited commitment only by offering $Q_a = \hat{y}_R$. But doing so yields no greater return than investing in the safe technology. $\square$

A.4 Proof of Proposition 5

Begin with the first part of the proposition, and fix a full-monitoring equilibrium with high secondary market liquidity. Assume first that financiers are fully levered ($\gamma = 1$). The optimal banker portfolio satisfies $b_b = Q_a a_b$, while the secondary market clearing condition is $a_b = a_f$. Since the financier portfolio satisfies $b_f = y_R(l)a_f$, the funding market clearing condition in an interior equilibrium can be written as. $Q_a a_f + y_R(l)a_f = \frac{w_f}{Q_b}$. Rearranging gives the bond price as $Q_b(Q_a) = \min \left( \frac{Q_a w_f}{Q_a + y_R(l)w_f + y_R(l)w_d}, \frac{1}{y_S} \right)$. The secondary market clearing condition in turn gives the secondary market price as $Q_a = \frac{w_f + w_3 \tilde{y}_R(l)Q_b}{m w_b + m Q_a w_f}$. Assume first that $Q_b = \frac{1}{y_S}$. Then $Q_a^* = \frac{w_f + w_3 \tilde{y}_R(l)\frac{1}{y_S}}{\tilde{m} w_b + m \frac{1}{y_S} w_f}$. Differentiating yields that $Q_a^*$ is increasing in $w_f$ if and only if $w_b > m w_b \frac{y_R(l)}{y_S}$, which always holds because $\tilde{m} \in (0, 1)$ and $y_R(l) < y_S$. Moreover, $k_{R,b} = \frac{w_b}{m Q_a Q_b}$ is increasing because $Q_a$ is increasing and $Q_b$ is a constant. Since all bankers monitor, expected output also increases. Now assume that $Q_b < \frac{1}{y_S}$. Solving the system of two unknowns generated by the market clearing conditions gives the secondary market price as

$$Q_a^* = \frac{w_f - \tilde{m} y_R(l)w_b + \sqrt{(w_f - \tilde{m} y_R(l)w_b)^2 + 4\tilde{m} (w_b + w_d) y_R(l) (w_f + w_d)}}{2 \tilde{m} (w_b + w_d)}$$

which is clearly increasing in $w_f$. Next, we need to show that $k_{R,b}$ is strictly increasing in $w_f$. Given the optimal banker portfolio, $k_{R,b} = \frac{1}{m} a_b$. By market clearing, $k_{R,b} = \frac{1}{m} a_f$. Since $a_f$ is strictly increasing in $w_f$, the result follows. Moreover, expected output is increasing because all bankers monitor. Next, assume that financiers do not borrow ($\gamma = 0$). Then the market clearing conditions yield $Q_a^* = \min \left( \frac{w_f}{Q_a (m(w_b + w_d))}, \frac{1}{y_S} \right)$ and $Q_a^* = \frac{w_d}{m (w_b + w_d) y_R(l)}$. If $Q_a^* = \frac{1}{y_S}$, then $Q_a$ is clearly increasing in $w_f$. If $Q_b < \frac{1}{y_S}$, then $Q_a^* = \frac{w_d y_R(l)}{m (w_b + w_d)}$ which is again increasing in $w_f$. Next, note that $Q_a^* Q_a^* = \frac{w_d}{m (w_b + w_d)}$. Hence $k_{R,b} = \frac{w_b}{1 - Q_b Q_a m}$ which is non-decreasing in $w_f$. Next, assume that financiers are indifferent between borrowing and lending ($\gamma \in (0, 1]$). Then by definition, $Q_a^* = \hat{y}_R Q_b^*$, and $b_f = \gamma y_R(l) a_f$. The secondary market clearing condition is $\frac{\tilde{m} w_b}{1 - Q_b^2} = \frac{w_f}{Q_a (1 - \frac{y_R(l)}{y_S})}$. Suppose for a contradiction that $Q_a$ is
decreasing in \( w_f \). Then \( a_b = \frac{\tilde{a} \tilde{m} w_b}{1 - Q_a^* \tilde{m} / \tilde{y}_R} \) is also decreasing in \( w_f \). To maintain market clearing, \( a_f \) must be decreasing in \( w_f \), and hence \( \gamma \), \( b_b = Q_a a_b \) and \( b_f = \gamma y_R(l)a_f \) must also be decreasing. But if \( b_b \) and \( b_f \) are decreasing in \( w_f \), then \( Q_b \) must be increasing in \( w_f \). This is a contradiction with the fact that \( Q_b \) must decrease because \( Q_a^* = \tilde{y}_R Q_b^* \) and \( Q_a \) was presumed to be decreasing. It then follows that \( k_{R,b} = \frac{w_b}{1 - Q_a^* \tilde{m} / \tilde{y}_R} \) is increasing in \( w_f \). Because all bankers monitor, expected output is increasing in \( w_f \) also.

Now turn to the second part of the proposition, and fix a full-monitoring equilibrium with low liquidity. By definition, \( Q_a^* = Q_a^*(Q_b) = \frac{\tilde{y}_R - y_R(l) + y_R Q_b \tilde{m}^*}{Q_b^* (y_R - y_R(l) + \tilde{m}^*)} \) so that \( Q_a^* \) is decreasing in \( Q_b \). To show that \( Q_a^* \) is increasing in \( w_f \) it is therefore to show that \( Q_b \) is decreasing in \( w_f \). Note first that the proposition is trivial when financiers are indifferent toward leverage. In that case, \( Q_a = \tilde{y}_R Q_b \) and so both prices are constants. Moreover, \( k_{R,b} \) is strictly increasing because \( a_b = a_f \) is increasing. If the financial system is highly constrained, then \( Q_b^* = \frac{1}{y_b^*} \). Hence \( Q_a \) and \( Q_b \) are constants, and \( k_{R,b} \) is strictly increasing in \( w_f \). It remains to be shown that \( Q_a \) increasing in \( w_f \) if the financial system is not highly constrained and financiers are either fully levered or do not borrow. To this end, recall financier demand is \( a_f = \frac{w_f}{Q_a^*(Q_b)} \). Suppose for a contradiction that \( Q_b \) is increasing in \( w_f \). We first show that \( a_f \) must strictly increase. Suppose for a contradiction that \( a_f \) weakly decreases. Then \( Q_b \) must strictly decrease given that \( w_f \) increased. But if \( a_f \) is weakly decreasing, so is \( b_f \). Similarly, strictly lower \( Q_b \) and weakly lower \( a_f \) imply that \( b_b \) is strictly smaller. But if \( b_f \) and \( b_b \) both weakly decrease, then \( Q_b \) cannot fall, yielding a contradiction. Hence \( a_f \) is strictly increasing in \( w_f \). But \( b_b \) and \( b_f \) are both strictly increasing in \( a_f \). Hence \( Q_b \) must fall, and \( Q_a \) must increase.

Next, consider shirking equilibria. Given the optimal portfolios of bankers, it is straightforward to show that \( Q_a^* = Q_a = \tilde{y}_R^* \) when liquidity is high. The secondary market price is a constant. If the financial system is highly constrained, then \( Q_b \) is fixed at \( \frac{1}{y_b^*} \), and prices are constants. As a result, \( k_{R,b} \) is a constant. To clear secondary markets at fixed prices, \( \Phi \) must be increasing in \( w_f \). Given that \( k_{R,b} \) is constant, expected output must be declining. If the financial system is not highly constrained, then the market clearing conditions are:

\[
\frac{\tilde{y}_R \tilde{m} W_b}{1 - Q_b \tilde{y}_R \tilde{m}} + \frac{\gamma (1 - \phi) y_R(l) W_f}{\tilde{y}_R - (1 - \phi) y_R(l) \tilde{m}} = \frac{W_d}{Q_b}
\]

and

\[
\left( \frac{\Phi + (1 - \Phi) \tilde{m}}{1 - Q_b \tilde{y}_R \tilde{m}} \right) W_b = \frac{W_f}{\tilde{y}_R - (1 - \phi) y_R(l) \tilde{m}}.
\]

Suppose first that financiers are indifferent toward leverage (\( \gamma \in (0, 1) \)). Then \( Q_b^* = \frac{Q_a}{y_R} \) is a constant. It follows immediately that \( \Phi \) is increasing in \( w_f \), while \( k_{R,b} \) is independent of \( w_f \). Hence expected output must decline. Next, suppose financiers do not borrow (\( \gamma = 0 \)). In this case, the bond market clearing condition is independent of \( w_f \), and so \( Q_b \) is a constant. Hence \( k_{R,b} \) is a constant, and expected output must decline. Finally, assume that financiers

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are fully levered \((\gamma = 1)\). Imposing bond market clearing reveals that \(Q_b\) must satisfy
\[
Q_{b,PM}^*(\Phi, w_f) = \frac{w_d}{\tilde{m} \left[ \tilde{y}_R(w_b + w_d) + (1 - \Phi) y_R(l)w_f \right]}.
\]

Note that \(Q_{b,PM}^*(\Phi, w_f)\) is strictly increasing in \(\Phi\) and strictly decreasing in \(w_f\). Similarly, the bond price that clears the secondary market is
\[
Q_{b,SM}^*(\Phi) = \frac{w_f - w_b \tilde{y}_R(\Phi + (1 - \Phi)\tilde{m})}{\tilde{m} \left[ (w_b + w_f) y_R(l) + w_b y_R(l)\Phi \right]}.
\]

Note that \(Q_{b,SM}^*(\Phi, w_f)\) is strictly increasing in \(w_f\) but strictly decreasing in \(\Phi\). It is then straightforward to show that \(\Phi\) must be strictly increasing in \(w_f\). Suppose for a contradiction that is decreasing. By bond market clearing, an increase in \(w_f\) and a decrease in \(\Phi\) leads to fall in \(Q_b\). But by secondary market clearing, an increase in \(w_f\) and a decrease in \(\Phi\) leads to an increase in \(Q_b\). Hence both markets do not clear simultaneously, leading to a contradiction. The result then follows.

Next consider a low-liquidity equilibrium. I will first show that whenever the financial system is highly constrained, or financiers weakly prefer to not borrow, then \(Q_a^*, Q_a^*, k_{R,b}^H\) and \(a_{b}^H\) are all invariant to \(w_f\). Suppose first that the financial system is highly constrained, so that \(Q_b^* = \frac{1}{\tilde{y}_S}\). Then \(Q_a^* = Q_a(Q_b^*)\) is a constant, and thus invariant to \(w_f\). Since
\[
k_{R,b}^H = \frac{w_b + Q_{b}^*(Q_a^*-y_R(l))a_{b}^H}{1-y_R(l)Q_{b}^*\tilde{m}}
\]
in any shirking equilibrium, \(k_{R,b}^H\) and \(Q_a^* = \hat{Q}_a = \hat{y}_R - m \frac{k_{R,b}^H}{k_{R,b}^H - a_{b}^H}\) in any shirking equilibrium, \(k_{R,b}^H\) and \(a_{b}^H\) are also invariant to \(w_f\). Now suppose that financiers do not borrow. The market-clearing condition in the bond market is then given by
\[
b_{b}^H = \frac{y_R(l)\tilde{m}w_b + (Q_a^*-y_R(l))a_{b}^H}{1-y_R(l)Q_{b}^*\tilde{m}} = \frac{w_d}{Q_b}.
\]
Hence \(a_{b}^H\) is fixed conditional on \(Q_b\). Since \(Q_a^* = \hat{Q}_a = \hat{y}_R - m \frac{k_{R,b}^H}{k_{R,b}^H - a_{b}^H}\) and \(k_{R,b}^H\) is fixed once \(Q_b\) is determined, the condition \(Q_a = Q_a(Q_b)\) suffices to pin down \(Q_b, Q_a, k_{R,b}^H\) and \(a_{b}^H\) independently of \(w_f\). But given that all quantities are pinned down independently of \(w_f\), it must be the case that \(\Phi\) increases in \(w_f\) to ensure secondary market clearing. Moreover, given fixed \(k_{R,b}\), expected output must decline. Now assume that financiers are fully levered and that the financial system is not highly constrained. Then the market clearing conditions are:
\[
\frac{y_R(l)\tilde{m}w_b + (Q_a - y_R(l))a_{b}^H}{1-Q_b y_R(l)\tilde{m}} + \frac{y_R(l)w_f}{Q_a - (1-\phi)Q_b y_R(l)} = \frac{w_d}{Q_b}
\]
and
\[
\Phi \left( \frac{w_b + Q_{b}(Q_a - y_R(l))a_{b}^H}{1-Q_b y_R(l)\tilde{m}} \right) + (1-\Phi)a_{b}^H = \frac{w_f}{Q_a - (1-\phi)Q_b y_R(l)}.
\]
The secondary market price must satisfy \(Q_a = Q_a(Q_b)\), and is thus fixed for given \(Q_b\). The high-type banker’s investment is given by:
\[
k_{R,b}^H = \frac{w_b}{1-Q_b y_R(l)\tilde{m}} + \left( \frac{\hat{y}_R - y_R(l)}{\hat{y}_R - y_R(l)\tilde{m}} \right) a_{b}^H.
\]
Hence, \( k_{R,b}^H \) is a function of \( a_b^H \) and \( Q_b \) only. Given that we are in a shirking equilibrium, \( Q_a = Q_a(k_{R,b}^H, a_b^H) \), and so \( Q_a \) and \( Q_b \) are fixed for a given \( a_b^H \). It is easy to verify that \( Q_a \) is strictly decreasing in \( a_b^H \). We can then show that \( \Phi \) must be strictly increasing in \( w_f \). Suppose for a contradiction that \( \Phi \) is weakly decreasing. For the bond market to clear, either \( Q_b \) and/or \( a_b^H \) must decrease. Since \( Q_a = Q_a \), if \( Q_b \) falls, then \( Q_a \) must increase. Since \( Q_a = \bar{Q}_a \) and \( \bar{Q}_a \) is strictly decreasing in \( a_b^H \), it follows that \( Q_b \) and \( a_b^H \) must both decrease. Since \( b_b \) and \( Q_b \) are decreasing, it follows that \( k_{R,b} \) must decrease. Since \( k_{R,b}, a_b^H \), and \( \Phi \) are all decreasing, total secondary market supply must decrease. Yet \( a_f \) is weakly increasing. Hence secondary markets cannot clear, yielding a contradiction.

### A.5 Proof of Corollary 4

Inspecting the optimal intermediary portfolios, it follows that aggregate investment in a full-monitoring low-liquidity equilibrium is proportional to \( W_b - \Delta + \frac{Q_a(Q_a^{*}) - y_R(l)}{Q_a^{*} - Q_b y_R(l)}[W_f + \Delta] \). The coefficient on \( \Delta \) is equal to zero when \( Q_b^{*} = 1 \) and strictly positive when \( Q_b^{*} > 1 \). When the financial sector is highly constrained, then \( Q_b^{*} = \frac{1}{\tilde{y}_s} \) independent of \( \Delta \) for \( \Delta \) sufficiently small.

### A.6 Proof of Proposition 6

Fix a full-monitoring low-liquidity equilibrium with a highly constrained financial system. The expected return on equity earned by bankers and financiers, respectively, is

\[
\hat{ROE}_b = \frac{\hat{y}_R - y_R(l)}{1 - Q_b y_R(l)\bar{m}} \quad \text{and} \quad \hat{ROE}_f = \frac{\hat{y}_R - y_R(l)}{Q_a^{*} - Q_b y_R(l)}
\]

Moreover, \( \hat{ROE}_f > \hat{ROE}_b \) if \( Q_b^{*} > 1 \) and \( \hat{ROE}_f \leq \hat{ROE}_b \) if \( Q_b^{*} \leq 1 \).

Since liquidity is low, the secondary market price is given by \( Q_a^{*} = Q_a(Q_b^{*}) \). Moreover, bankers receive no rents from secondary market trading by definition. Bankers’ expected return on equity is therefore equal to bankers’ expected return on equity in an equilibrium without secondary markets. This gives the first result:

\[
\hat{ROE}_b = \frac{\hat{y}_R - y_R(l)}{1 - Q_b y_R(l)\bar{m}}
\]

Next, turn to financiers’ return on equity. Since financiers are fully levered, the expected utility of financiers is

\[
v_f = \hat{y}_R a_f - b_f = \frac{\hat{y}_R - y_R(l)}{Q_a^{*} - Q_b y_R(l)w_f} w_f
\]

Hence \( \hat{ROE}_f = \frac{\hat{y}_R - y_R(l)}{Q_a^{*} - Q_b y_R(l)} \). To show the remaining results, I begin by showing that
RÔE\(f\) = RÔE\(b\) if \(Q_b = 1\). To this, write the expected returns on equity of both intermediaries at \(Q_b = 1\) and for a generic \(Q_a\) as:

\[
\begin{align*}
RÔE_b &= \frac{\hat{y}_R - y_R(l)\hat{m}}{1 - y_R(l)\hat{m}}, \quad \text{and} \quad RÔE_f = \frac{\hat{y}_R - y_R(l)}{Q_a - y_R(l)}
\end{align*}
\]

Algebra reveals that \(\hat{RÔE}_b = RÔE_f\) at \(Q_b = 1\) if and only if

\[
Q_a = \frac{\hat{y}_R - y_R(l) + (1 - \hat{m})y_R(l)\hat{y}_R}{\hat{y}_R - y_R(l)\hat{m}} = Q_a(1).
\]

To show that \(\hat{RÔE}_f > RÔE_b\) when \(Q_b > 1\) and \(\hat{RÔE}_f \leq RÔE_b\) otherwise, it then suffices to show that \(\frac{\partial \hat{RÔE}_f}{\partial Q_b} > \frac{\partial RÔE_b}{\partial Q_b}\). To this end, note first that \(\hat{RÔE}_f = (\hat{y}_R - y_R(l))\lambda_f\) and \(RÔE_f = (\hat{y}_R - y_R(l)\hat{m})\lambda_b\), where \(\lambda_f = \frac{Q_a}{Q_a - q_by_R(l)}\) and \(\lambda_b = \frac{1}{1 - q_by_R(l)\hat{m}}\) denotes the leverage of financiers and bankers, respectively. Since \(\hat{m} \in (0, 1)\), it follows immediately that \(\lambda_f > \lambda_b\) if \(Q_b = 1\). That is, financiers have higher leverage than bankers when \(Q_b = 1\). Finally, note that

\[
\frac{\partial \hat{RÔE}_f}{\partial Q_b} = \left(y_R(l) - \frac{\partial Q_a(Q_b)}{\partial Q_b}\right)\lambda_f^2 \quad \text{and} \quad \frac{\partial RÔE_b}{\partial Q_b} = y_R(l)\hat{m}\lambda_b^2
\]

Since \(\frac{\partial Q_a(Q_b)}{\partial Q_b} < 0\) and \(\hat{m} \in (0, 1)\), the result follows. \(\square\)

### A.7 Proof of Corollary 5

Fix a full-monitoring equilibrium. Note that for any \(Q_b, Q_a, a_f^* \geq \frac{w_f}{Q_a}\), while \(Q_a(k_{R,b}, a_b) \leq \hat{y}_R - m\). Because financiers strictly prefer risky claims to the safe technology at \(Q_a\), it is sufficient to show that there exists a \(w_f^*\) such that there is excess demand on secondary markets at price \(\hat{y}_R - m\), given that all bankers monitor. This is the case whenever \(\frac{w_f^*}{\hat{y}_R - m} > \frac{\hat{m}w_b}{1 - q_b\hat{m}(\hat{y}_R - m)}\). Since the RHS is bounded, there always exists a \(w_f^*\) large enough.

### A.8 Proof of Corollary 6

Suppose first that secondary market liquidity is high. In a high-liquidity shirking equilibrium, \(Q_{a}^* = \gamma_{R}^*\), which is a constant. Furthermore, \(Q_{b}^*\) must also be invariant to reductions in \(w_f\), either because financiers do not borrow (so that \(w_f\) does not impact the bond market clearing condition, given that \(Q_{a}^*\) is a constant), or because the financial system is highly constrained so that \(Q_{b}^* = \frac{1}{\gamma_{S}}\) and further reductions in \(w_f\) increase excess demand in the bond market. Hence \(k_{R,b}^*\) is invariant to \(w_f\). Since \(Q_{b}^*\) is constant, so is depositor utility. By construction, banker utility is \((1 - \hat{m})k_{R,b}^*\), which is constant. If financiers do not borrow, financier utility is \((\Phi\hat{y}_{R} + (1 - \Phi)\hat{m}\hat{y}_{R})k_{R,b}^*\), and is strictly decreasing in \(w_f\). If financiers do borrow, financier utility is \((\Phi\hat{y}_{R} + (1 - \Phi)\hat{m}(\hat{y}_{R} - y_R(l))k_{R,b}^*\), which is again strictly decreasing in \(w_f\).
Now suppose that secondary market liquidity is low. I will first show that whenever the financial system is highly constrained, or financiers do not borrow, then $Q_a^*$, $Q_b^*$, $k_{R,b}^H$ and $a_b^H$ are all invariant to reductions in $w_f$. Suppose first that the financial system is highly constrained, so that $Q_b^* = \frac{1}{y_s}$. Then $Q_a^* = Q_a(Q_b^*)$ is a constant, and thus invariant to reductions in $w_f$. Since $k_{R,b}^H = \frac{w_d + \hat{Q}_a(Q_a^*) - y_R(l)w_a}{1 - y_R(l)Q_b^m}$ in any shirking equilibrium, $k_{R,b}^H$ and $Q_a^* = \hat{Q}_a = y_R - m\frac{k_{R,b}^H}{k_{R,b}^H - a_b^H}$ in any shirking equilibrium, $k_{R,b}^H$ and $a_b^H$ are also invariant to $w_f$. Now suppose that financiers do not borrow. The market-clearing condition in the bond market is then given by $b_l^H = \frac{y_R(l)\tilde{m}w_a + (Q_a^* - y_R(l))a_b^H}{1 - y_R(l)Q_b^m} = \frac{w_d}{Q_b^*}$. Hence $a_b^H$ is fixed conditional on $Q_b^*$. Since $Q_a^* = \tilde{Q}_a = y_R - m\frac{a_b^H}{k_{R,b}^H - a_b^H}$ and $k_{R,b}^H$ is fixed once $Q_b^*$ is determined, the condition $Q_a = Q_a(Q_b)$ suffices to pin down $Q_b^*$, $Q_a$, $k_{R,b}^H$ and $a_b^H$ independently of $w_f$. Given these preliminaries, we can now show that reductions in $w_f$ are Pareto-improving. First, note that the utility of depositors is given by $v_d = \frac{w_d}{Q_b^*}$ if $Q_b^* > \frac{1}{y_s}$ and $v_d = y_s w_d$ otherwise. Since high-type bankers are indifferent towards selling assets on secondary markets in a low-liquidity equilibrium, their utility is unchanged by the presence of secondary markets: $v_b^L = v_b^H = v_b$. By construction, the utility of the low-type banker satisfies $v_b^L = v_b^H = v_b$. Since $Q_b^*$ is invariant to $w_f$, so are $v_b$ and $v_d$. Next, turn to the equilibrium utility of financiers. When financiers borrow, it is $v_f = (\phi \dot{y}_R + (1 - \phi)(\dot{y}_R - y_R(l)))a_f^*$. When they do not borrow, it is $v_f = (\phi \dot{y}_R + (1 - \phi)\dot{y}_R)a_f^*$. Market clearing requires that $\Phi a_b^H + (1 - \Phi)k_{R,b}^H = a_f = \frac{w_f}{\tilde{Q}_a - (1 - \Phi)\dot{y}_R(l)Q_b^*}$, where we have established that $Q_b^*$, $Q_a^*$, $k_{R,b}^H$ and $a_b^H$ are all constant. By the definition of $\phi$, the utility of financiers then is $v_f = \Phi \dot{y}_R k_{R,b}^H + (1 - \Phi)\dot{y}_R a_b^H$ when they do not borrow, and $v_f = \Phi \dot{y}_R k_{R,b}^H + (1 - \Phi)(\dot{y}_R - y_R(l))a_b^H$ when they do. Since $k_{R,b}^H$ and $a_b^H$ are constants and $\Phi$ is strictly increasing in $w_f$, $v_f$ is strictly decreasing in $W_f$ in equilibrium.

**A.9 Proof of Proposition 8**

Fix an equilibrium with high secondary market liquidity. The bond market clearing condition uniquely determines $Q_b$ as a function of the wealth distribution $w = (w_d, w_b, w_f)$, the secondary market price $Q_a$ and the fraction of shirking bankers $\Phi$. Hence we can write $Q_b = Q_b^*(w, Q_a, \Phi)$. The first step is to show that $Q_a$ (in a full-monitoring equilibrium) and $\Phi$ (in a shirking equilibrium) are increasing in the wealth shock $\xi$ if and only if

$$\lambda_f \frac{\partial W_f}{\partial \xi} + W_f \left( \frac{\partial \lambda_f}{\partial Q_b} + \frac{Q_a^*}{\partial \xi} \right) \geq \lambda_b \frac{\partial W_b}{\partial \xi} + W_b \left( \frac{\partial \lambda_b}{\partial Q_b} + \frac{Q_b^*}{\partial \xi} \right)$$

(26)

\text{Change in Financier Secondary Market Demand} \quad \text{Change in Banker Secondary Market Supply}

To this end, define the leverage of bankers and financiers as $\lambda_b(Q_a, Q_b) = \frac{\Phi - (1 - \Phi)\tilde{m}}{1 - Q_a Q_b}$ and $\lambda_f(Q_a, Q_b) = \frac{Q_a - \gamma(1 - \phi)Q_b \dot{y}_R(l)}{Q_a - (1 - \phi)Q_b \dot{y}_R(l)}$, respectively. Then the secondary market clearing condition is $\lambda_b(Q_b, Q_a) w_b = \lambda_f(Q_a, Q_b) w_f$. Start by fixing a full-monitoring equilibrium. Then $\Phi = \frac{\partial \Phi}{\partial \xi} = 0$. Totally differentiating the secondary market clearing condition and rearranging
\[
\frac{\partial Q_a}{\partial \xi} \left[ \frac{\partial \lambda_b \partial Q^*_b w_b}{\partial Q_a \partial Q_b} + \frac{\partial \lambda_b \partial Q^*_b w_b}{\partial Q_b \partial Q_a} - \left( \frac{\partial \lambda_f \partial Q^*_f w_f}{\partial Q_a \partial \Phi} + \frac{\partial \lambda_f \partial Q^*_b w_f}{\partial Q_b \partial \Phi} \right) \right] = A
\]

\[
\left( \lambda_f w_f + \frac{\partial \lambda_f \partial Q^*_f}{\partial Q_b \partial \xi} w_f - \left( \lambda_b w_b + \frac{\partial \lambda_b \partial Q^*_b}{\partial Q_b \partial \xi} w_b \right) \right).
\]

where \( A \) is the excess supply on secondary markets induced by a marginal increase in \( Q_a \). Since banker supply is increasing in \( Q_a \) and financier supply is decreasing in \( Q_a \), \( A > 0 \) and the result follows. Next, consider a shirking equilibrium. Now \( Q_a = \hat{y} \) and so \( \frac{\partial Q_a}{\partial \xi} = 0 \). Totally differentiating the secondary market clearing condition and rearranging now yields

\[
\frac{\partial \Phi}{\partial \xi} \left[ \frac{\partial \lambda_b}{\partial \Phi} w_b + \frac{\partial \lambda_b \partial Q^*_b}{\partial Q_b \partial \Phi} w_b - \left( \frac{\partial \lambda_f \partial Q^*_f}{\partial \Phi w_f} + \frac{\partial \lambda_f \partial Q^*_b}{\partial Q_b \partial \Phi} w_f \right) \right] = B
\]

\[
\left( \lambda_f w_f + \frac{\partial \lambda_f \partial Q^*_f}{\partial Q_b \partial \xi} w_f - \left( \lambda_b w_b + \frac{\partial \lambda_b \partial Q^*_b}{\partial Q_b \partial \xi} w_b \right) \right).
\]

where \( B \) is the excess supply on secondary markets induced by a marginal increase in \( \Phi \). Since banker supply is increasing in \( \Phi \) and financier supply is decreasing in \( \Phi \), \( B > 0 \) and the result follows. The next step is to show that condition (26) is equivalent to the condition stated in the text. To this end, divide (26) through by \( w_f \) and impose the market clearing condition \( \lambda_b w_b = \lambda_f w_f \). This yields the condition \( \lambda_f \frac{\partial w_f}{\partial \xi} + \frac{\partial \lambda_f \partial Q^*_f w_f}{\partial Q_b \partial \xi} \geq \frac{\partial \lambda_f \partial Q^*_b w_b}{\partial Q_b \partial \xi} \). Now suppose that the financier is fully leveraged. Then, by definition, \( \frac{\partial \lambda_f}{\partial Q_b} = \frac{\partial \lambda_b}{\partial Q_b} = Q_a \lambda_b^2 \), and \( \frac{\partial \lambda_f}{\partial Q_b} = y_F(l) \lambda_f^2 \). Moreover, secondary market clearing implies that \( \lambda_b = \frac{\lambda_f w_f}{w_b} \). Imposing these conditions gives the first part of the corollary. Next, suppose that the financier does not borrow. Then \( \lambda_f = \frac{1}{Q_a} \) and thus \( \frac{\partial \lambda_f}{\partial Q_b} = 0 \). Canceling out \( Q_a \) and rearranging gives the second part of the corollary.

\[\square\]

\section*{A.10 Proof of Proposition 9}

By construction. Consider a low-liquidity equilibrium in which the financial system is highly constrained. Such an equilibrium always exists for \( w_d \) large enough and \( w_f \) small enough. In such an equilibrium, \( Q_b^* = \frac{1}{y_S} \) and \( Q_a = Q_a \left( Q_b^* \right) \). Let \( \lambda_f = \frac{1}{Q_a - Q_b^{BR(l)}} \) and \( \lambda_b = \frac{1}{1 - Q_b^{BR(l)m}} \) denotes the equilibrium leverage of financiers and bankers in a full-monitoring equilibrium, respectively. From the optimal banker portfolio and the definition of \( Q_a \left( Q_b \right) \), it follows that

\[k_{BR,b}^* = \lambda_b w_b + \chi a_f^*\]
where \( \chi = (\frac{\hat{y}_R - y_R(\hat{m})}{\hat{y}_R - y_R(l)m}) \in (0, 1) \) and \( a^*_f = \lambda f_w f \). Hence, the upper bound on the secondary market price stemming from the implementability constraint (IMP) is

\[
Q_a = \hat{y}_R - \hat{m}  \left( \frac{\lambda_b w_b + \chi \lambda_f w_f}{\lambda_b w_b - (1 - \chi) \lambda_f w_f} \right) = \hat{y}_R - \hat{m}  \left( \frac{\lambda_b + \chi \lambda_f \hat{w}}{\lambda_b - (1 - \chi) \lambda_f \hat{w}} \right)
\]

Note that \( Q_a = \hat{y}_R - m \) if \( \hat{w} = 0 \) and that \( Q_a \) is strictly decreasing in \( \hat{w} \). It follows that as long as \( Q^*_a < \hat{y}_R - m \) there exists, for small enough \( w_f \), a full-monitoring low-liquidity equilibrium in which the financial system is highly constrained. This parametric condition is equivalent to

\[
y_S < \frac{1}{\chi} (\hat{y}_R - m) - \frac{(1 - \hat{m}) y_R(l) \hat{y}_R}{\hat{y}_R - y_R(l)} \tag{27}
\]

Next, note that \( Q_a \geq \hat{y}'_R \) because \( a_b \leq \hat{m} k_{R,b} \). For a shirking equilibrium to exist for sufficiently large \( w_f \), we therefore require that \( Q^*_a \geq \hat{y}'_R \). This parametric condition is equivalent to

\[
y_S > \frac{1}{\chi} \hat{y}' - \frac{(1 - \hat{m}) y_R(l) \hat{y}_R}{\hat{y}_R - y_R(l)} \tag{28}
\]

It is easy to see that there exist parameters such conditions (27) and (28) are jointly satisfied. For example, set \( \hat{y}'_R = y_S - \epsilon \) for \( \epsilon \) and \( m \) sufficiently small. Hence there exist parameters such that \( Q_a \in [\hat{y}'_R, \hat{y}_R - m) \). Assume a set of such parameters from now on, and choose initial financier net worth \( w_0 \) such that the economy is initially in a full-monitoring equilibrium. We now want to show that the economy may transition into a shirking equilibrium after a sufficiently long sequence of large shocks. Note first that because intermediary net worth is bounded after any finite sequence of good aggregate shocks, there always exists a level of depositor net worth such that the financial system is highly constrained after any such sequence. Hence, we can construct a destabilizing secondary market boom under the presumption that the financial system is highly constrained throughout. As a result, prices are fixed throughout and \( Q^*_b > 1 \) because \( y_S \leq \hat{y}_S = 1 \). By Proposition 7, relative financier net worth \( \hat{w} \) thus grows after a good shock for any \( \hat{w} \). By the parametric condition (28), a sufficiently long sequence of good aggregate shocks therefore triggers a shirking equilibrium. We then only need to show that there exist parameters such that expected return on equity is higher for financiers than for bankers throughout. Recall from Proposition (6) that, in a full-monitoring equilibrium, ROE\(_f\) > ROE\(_b\) for \( Q_b > 1 \). Hence ROE\(_f\) > ROE\(_b\) in a full-monitoring equilibrium when the financial system is highly constrained if \( y_S < 1 \). Next, turn to a shirking equilibrium. By construction, the return on equity of bankers is independent of the fraction of shirking bankers \( \Phi \), while the return on equity of financiers is strictly decreasing in \( \Phi \). As long as the return-on-equity for financiers is strictly higher in a full-monitoring equilibrium, there exists a \( \Phi^* \) such that the return on equity is also strictly higher in a shirking equilibrium in which \( \Phi^* \) bankers shirk. This is the case when \( y_S < 1 \).
A.11 Proof of Proposition 10

Begin with the growth rate of relative financier net worth after a good shock. In the given equilibrium, it is given by:

\[
\frac{\dot{w}'}{\dot{w}} = \frac{y_{R(h)} - y_{R(l)}}{\frac{Q_a(Q_b) - Q_b y_{R(l)}}{Q_a(Q_b) - Q_b y_{R(l)}}} - \frac{\dot{m} y_{R(l)}}{y_{R(h)} - y_{R(l)}} \frac{\dot{\bar{w}}}{Q_a(Q_b) - Q_b y_{R(l)}}.
\]

Let the relative levered return \( \tilde{LR} \equiv \left[ \frac{y_{R(h)} - y_{R(l)}}{y_{R(h)} - y_{R(l)}} \right] \left[ \frac{1 - Q_a \bar{m} y_{R(l)}}{Q_a(Q_b) - Q_b y_{R(l)}} \right] \) denote the ratio of financier and banker levered returns on equity. Let \( RT \equiv \frac{\dot{m} (y_{R(h)} - y_{R(l)})}{y_{R(h)} - y_{R(l)}} \frac{\dot{\bar{w}}}{Q_a(Q_b) - Q_b y_{R(l)}} \) denote the degree of risk transfer from bankers to financiers. \( RT \) is increasing in \( Q_b \) and thus decreasing in \( \rho \); lower bond prices allow financiers to expand borrowing and purchase more risky claims. Hence, the growth rate of relative financier net worth after a good shock is increasing in risk transfer. For \( \frac{\dot{w}'}{\dot{w}} \) to be decreasing in \( \rho \) for all \( \dot{w} > 0 \), we thus require that it to be decreasing in \( \rho \) even when risk transfer \( RT \) is close to zero (i.e. when \( \dot{w} \) is close to zero). Hence, we require \( \tilde{LR} \) to be increasing in \( Q_b \). Differentiating \( \tilde{LR} \) w.r.t to \( Q_b \) reveals that \( \frac{\partial Q_b \tilde{LR}}{\partial Q_b} \geq 0 \) if and only if \( \frac{\bar{m} y_{R(l)}}{\frac{Q_a(Q_b) - Q_b y_{R(l)}}{Q_a Q_b} - Q_b y_{R(l)}} \leq \tilde{LR} \) where \( Q'_a \) denotes the derivative of \( Q_a(Q_b) \) w.r.t. \( Q_b \). Since \( Q'_a < 0 \) and \( \bar{m} < 1 \), the LHS is strictly less than unity. It remains to be shown that \( \tilde{LR} \geq 1 \), i.e. financiers lever more than bankers in a low-liquidity equilibrium in which the financial system is highly constrained. Rearranging \( \tilde{LR} \) implies that \( \tilde{LR} \geq 1 \) if and only if \( Q_b y_{R(l)}(1 - \bar{m}) \geq Q'_a (Q_b) - 1 \). The LHS is strictly increasing in \( Q_b \), while the RHS is strictly decreasing in \( Q_b \). Since \( Q_b \geq 1 \) when the financial system is highly constrained, the result follows if \( y_{R(l)}(1 - \bar{m}) \geq Q'_a (Q_b) - 1 \). This always holds under the assumption \( y_{R(l)} < \bar{y}_S < 1 \).

Next, turn to investment. In a low-liquidity full-monitoring equilibrium with low liquidity, it is given by \( K_{R,b} = \left[ Q^*_b \left( Q_a(Q_b) - Q_b y_{R(l)} \right) W_f \right] \left[ Q^*_b \left( Q_a(Q_b) - Q_b y_{R(l)} \right) \right]^{-1} \). Since \( Q^*_b \) is decreasing in \( \rho \), a sufficient condition for the desired result is that \( \chi_0 \equiv \frac{Q_b Q_a(Q_b) - Q_b y_{R(l)}}{Q_a(Q_b) - Q_b y_{R(l)}} \) is decreasing in \( Q_b \). Differentiating \( \chi_0 \) with respect to \( Q_b \) implies that \( \chi_0 \) is increasing in \( Q_b \) if \( (Q_a + Q_b Q'_a - y_{R(l)})(Q_a - Q_b y_{R(l)}) > (Q'_a - y_{R(l)})(Q_b Q_a - Q_b y_{R(l)}) \) where it is understood that \( Q_a = Q^*_a (Q_b) \) and \( Q'_a \) denotes the derivative w.r.t. \( Q_b \). By definition of \( Q^*_a \), it follows that \( 0 > Q'_a + Q_b Q'_a - y_{R(l)} > Q'_a - y_{R(l)} \) or \( Q_b Q_a - Q_b y_{R(l)} \geq Q_a - Q_b y_{R(l)} > 0 \) for \( Q_b \geq 1 \). Since \( y_{S} \leq 1 \), \( Q_b \geq 1 \) and the result follows.

A.12 Proof of Proposition 11

Assume for a contradiction that all bankers monitor. Let \( Q^*_a \) denote the equilibrium secondary market price. Since all bankers monitor, \( Q^*_b < \bar{y}_R \). Since the financial system is highly constrained, \( Q^*_b = 1 \) with and without leverage constraints. As a result, financiers are fully levered, and the demand for risky claims is \( a_f = \frac{w_f}{Q_{z} - y_{R(l)}} \). From the optimal banker portfolios, the supply of risky assets is \( a_b = \frac{w_a(L_a(1 - y_{R(l)}))}{Q_{z} - y_{R(l)}} \). Since secondary markets clear
in the absence of capital requirements, \( a_f > a_b \) for any \( Q^*_a \) if \( \bar{L}_b < L^*_b \). Hence, there is excess demand for risky claims. To restore market clearing, financiers must be indifferent between risky claims the safe technology. But this requires \( Q_a = \hat{y}_R \).

\[ \text{A.13 Ruling out Separating Equilibria with Active Secondary Markets} \]

I now state and prove a claim from Section 1.2.5 regarding separating equilibria.

**Proposition (No Separation).** If financier bids satisfy bid consistency, then there does not exist a separating equilibrium in which the high-type banker sells a strictly positive amount of risky claims on secondary markets.

**Proof.** Begin with the first claim. Suppose for a contradiction that both low-type and high-type bankers sell assets on secondary markets (\( a^H_b, a^L_b > 0 \)) but issue different bond quantities. As a result, the two types of bankers trade on separate secondary sub-markets - \( \mu^H \) and \( \mu^L \), say. Let \( Q^H_a \) and \( Q^L_a \) denote asset prices on the respective sub-markets. Because low-quality assets cannot be levered against by financiers (their low-state payoff is zero), financiers receive rate of return \( R^L = \frac{\hat{y}_R}{Q^L_a} \) when they buy claims from the low type. When they buy assets from the high type, they receive a return of

\[
R^H = \max \left\{ \frac{\hat{y}_R}{Q^H_a}, \frac{\hat{y}_R - y_R(l)}{Q^H_a - Q^L_a y_R(l)} \right\}.
\]

No arbitrage requires that \( R^H = R^L \). The implementability condition \( \text{IMP} \) implies that \( Q^H_a < \hat{y}_R \) – else, the high-type banker would prefer to sell and shirk. It follows that \( Q^L_a < \hat{y}_R \).

If this is the case, ex-post optimality in asset sales requires that the low-type banker sells exactly \( a^L_b \) in risky assets – i.e. he sells no more than he needs to do because asset prices are below the expected value of claims. When setting the asset sale commitment \( a^L_b \), he thus promises to sell no more than is required to guarantee that he shirks in equilibrium. As a result, the incentive constraint for shirking must hold with equality, and the low-type banker is exactly indifferent between shirking and monitoring at \( a^L_b \). Now consider a deviation by the low-type banker to an asset sale commitment \( a^L_b - \epsilon \) for small but positive \( \epsilon \). Conditional on this deviation, the low-type banker strictly prefers to monitor, and trades on sub-market \( \mu' \). Since all bankers on sub-market \( \mu' \) have incentives to monitor, bid consistency implies that the secondary market price must satisfy \( Q^L_a = Q^H_a \). Because \( a^L_b \) is an arbitrarily small deviation from \( a^L_b \), the deviating banker must only scale back borrowing and investment by an arbitrarily small amount. Yet the secondary market price he obtains after a deviation is strictly higher for any \( \epsilon \), and it applies to all infra-marginal asset sales. Since \( y_R(l) > y_R(l) \), he also maintains solvency in all states of the world. Hence, there always exists a profitable deviation for a low-type banker.

\[ \text{A.14 A Dynamic Model with Endogenous Risk Aversion} \]

In this section, I study a variant of the dynamic model in Section 1.3 in which old intermediaries have full bargaining power (\( \theta = 1 \)). This choice of parameters implies that the old appropriate the entire value of their end-of-life stock of net worth. Generically, this value of net worth is state-contingent, with intermediaries valuing a dollar of equity more highly
in states of the world where intermediation rents are large. Intermediation rents are large when intermediaries are not well-capitalized in the aggregate. The health of intermediary balance sheets will in turn depend on the realization of aggregate risk. Forward-looking behavior thus leads to endogenous risk preferences.

The main goal of this section is to show that the forces that drove secondary market booms in the baseline dynamic model are not overturned by considerations of endogenous risk aversion. To do so, I construct examples in which financiers grow even in the presence of endogenous risk aversion. For simplicity, I focus on the special case $T = 3$. The key simplification inherent in this assumption is that intermediaries face a finite horizon. This allows me to characterize the value of equity capital in the final period in closed form. Since intermediaries appropriate the entire value of their end-of-life net worth, I can then analyze the problem as if the initial generation of intermediaries lived for three periods rather than two, and intermediates capital in the latter two periods. I denote the final-period value of $w$ units of equity capital to an intermediary of type $\tau$ when the net worth distribution is $w$ by $v_\tau(w, w)$. Since all intermediaries are risk-neutral, the following proposition follows immediately:

**Proposition (The Value of Equity Capital).** The final-period value of $w$ units of equity capital to an intermediary of type $\tau$ when the net worth distribution is $w$ is linear in $w$:

$$v_\tau(w, w) = \alpha_\tau(w)w$$

**Proof.** Follows directly from all policy functions in the static game being linear in net worth.

Since there are only three periods, there are only two generations of intermediaries and one intergenerational equity market. The second (and final) generation of intermediaries chooses the same portfolios as in the static model. The key stage of analysis is thus the initial generation’s portfolio choice, taking into account that they maximize the market value of equity capital. I suppress time subscripts for simplicity. Since financiers and bankers have endogenous risk preferences, they may value a risky claim differentially even in the absence of borrowing constraints. Specifically, a risky claim is of little value to an intermediary that highly values net worth conditional on a negative aggregate shock. This gives rise to a trading motive separate from selling assets to relax borrowing constraints.

Disregarding borrowing constraints, the banker weakly prefers to sell the asset at price $Q_a$ if and only if

$$\frac{\alpha_b(l)}{\alpha_b(h)} \geq \frac{\pi(y_R(h) - Q_a)}{\pi_l(Q_a - y_R(l))}$$

A financier strictly prefers to purchase the risky asset at price $Q_a$ rather than hold the safe asset if and only

$$\frac{\alpha_f(l)}{\alpha_f(h)} < \frac{\pi(y_R(h) - Q_a)}{\pi_l(Q_a - y_R(l))}$$

I say that a given intermediary is the **natural bearer of risk** when his valuation of a risky claim is the highest among all intermediaries.
Lemma (Natural Bearer of Risk). Intermediary $\tau$ is the natural bearer of risk if and only if

$$\tau = \arg \min_{\tau'} \frac{\alpha_{\tau'}(l)}{\alpha_{\tau'}(h)}$$

Going forward, I will use $\sigma_{\tau} \equiv \frac{\alpha_{\tau}(l)}{\alpha_{\tau}(h)}$ to summarize the risk attitude of the type-$\tau$ intermediary. As long as $\sigma_f < \sigma_b$, there exists a $Q_a$ such that financiers are willing to purchase the risky asset and bankers are willing to sell. When instead $\sigma_f = \sigma_b$, there are no endogenous differences in risk-preference and intermediaries trade assets as in the static model. To show that the results from the baseline model are robust, I now construct an example in which the economy with endogenous risk aversion admits secondary market booms as in Section 1.3.

**Proposition.** If, after any shock, the competitive equilibrium in the final period is a full-monitoring equilibrium with low secondary market liquidity and a highly constrained financial system then $\sigma_f = \sigma_b = 1$.

**Proof.** In a low-liquidity equilibrium in which the financial system is highly constrained we have $Q_b^* = \frac{1}{y_s}$ and $Q_a^* Q_a(Q_b^*)$. By Proposition 6, $\text{ROE}_f = \frac{\hat{y}_R - y_R(l)}{Q_a^*(Q_b^*) - Q_b^* y_R(l)}$ and $\text{ROE}_f = \frac{\hat{y}_R - y_R(l)\tilde{m}}{1 - Q_b^* y_R(l)\tilde{m}}$. Given that the financial system is highly constrained after any shock, the result follows.

Proposition 9 provides an example of destabilizing secondary market booms when the financial system is highly constrained and secondary market liquidity is low. The above proposition implies that the evolution of the economy under endogenous risk aversion is identical to that example as long as the economy is in a full-monitoring equilibrium. What remains to be shown is that the economy also transitions into a shirking equilibrium after a sequence of good shocks.

**Proposition.** If the competitive equilibrium in the final period is a full-monitoring equilibrium with low secondary market liquidity and a highly constrained financial system after a bad shock, and a shirking equilibrium with low secondary market liquidity and a highly constrained financial system after a good shock, then

$$\sigma_b = 1 \quad \text{and} \quad \sigma_f = \frac{\hat{y}_R - y_R(l)}{Q_a^* - (1 - \phi) Q_b^* y_R(l)} \leq 1$$

where $Q_b^* = \frac{1}{y_s}$ and $Q_a^* = Q_a(Q_b^*)$.

**Proof.** For bankers, the result follows from the fact that return on equity is independent of $\Phi$ by construction. For financiers, the result follows from a straightforward computation of expected utility in the shirking equilibrium.

It follows that the economy with endogenous risk aversion must also transition into a shirking equilibrium. To see this, suppose first that the economy with endogenous risk aversion
does not transition into a shirking equilibrium after a good shock, while the economy without endogenous risk aversion does. Then $\Phi = 0$ after a good shock. But then the above proposition implies that $\sigma_f = \sigma_b = 1$, and there is no endogenous risk aversion. As a result, the economy must transition into a shirking equilibrium, yielding a contradiction. Note that $Q_a$ is the same in the presence of endogenous risk aversion as in its absence because $\sigma_b = 1$ throughout. Moreover, financiers are willing to buy risky assets when $\Phi$ is sufficiently small tomorrow because they receive strictly positive rents from doing so when $\sigma_f = 1$.

More generally of course, endogenous risk aversion contributes to a slower build-up of risk and fragility. Intermediaries’ endogenous preference to preserve capital for downturns makes them less willing to hold risk exposure. Accounting for the channel is thus important in a quantitative sense. In a qualitative sense, however, the previous proposition shows that the model admits the same dynamics as without endogenous risk aversion.
Chapter B

Appendix to “Does Universal Banking Affect the Risk and Productivity of Firms?”

B.1 Figures

Figure 28

**Loan-weighted Average Six-Year \([t,t+5]\) Sales-growth Volatility associated with Loans granted to Public Firms by Universal Banks** (1991-2005).

Notes: Loans by universal banks are split into cross-sold and non-cross-sold loans, where cross-sold loans are defined as loans whose debtor firms also received an underwriting product from the same universal bank anytime within the last three years. Source: own analysis based on CRSP/Compustat, DealScan loan data, and SDC underwriting data.
Figure 29

**Loan-weighted Average Six-Year \([t,t+5]\) Sales-growth Volatility associated with Loans granted to Public Firms by Universal and Commercial Banks (1991-2005).**

Source: own analysis based on CRSP/Compustat, DealScan loan data, and SDC underwriting data.

Figure 30

**Market-value-weighted Average Age of Firm at IPO vs. Fraction of IPOs run by Universal Banks (1976-2006).**

Notes: Source: own analysis based on SDC IPOs and firm-age data from Loughran and Ritter (2004).

B.2 Tables
Table 2

<table>
<thead>
<tr>
<th>Timeline of Universal Banks</th>
<th>M&amp;A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Established before August 1, 1996</strong></td>
<td></td>
</tr>
<tr>
<td>BankBoston (later acquired by Fleet)</td>
<td>Crédit Suisse (First Boston)</td>
</tr>
<tr>
<td>Bankers Trust (later acquired by Bank of America)</td>
<td>Deutsche Bank USA</td>
</tr>
<tr>
<td>Bank of America</td>
<td>Equitable (later acquired by SunTrust)</td>
</tr>
<tr>
<td>Bank of New England (defunct since 1991)</td>
<td>HSBC Bank USA</td>
</tr>
<tr>
<td>Bank One (later acquired by J.P. Morgan)</td>
<td>Sovran Bank</td>
</tr>
<tr>
<td>BankSouth</td>
<td>(later acquired by NationsBank)</td>
</tr>
<tr>
<td>Barnett Bank (later acquired by NationsBank)</td>
<td>Travelers Group∗</td>
</tr>
<tr>
<td>Chase Manhattan (later acquired by J.P. Morgan)</td>
<td></td>
</tr>
<tr>
<td>Chemical Bank (later acquired by Chase Manhattan)</td>
<td></td>
</tr>
<tr>
<td>Citicorp∗</td>
<td></td>
</tr>
<tr>
<td>Dauphin Deposit Corp.</td>
<td></td>
</tr>
<tr>
<td>First Chicago NBD</td>
<td></td>
</tr>
<tr>
<td>First Union</td>
<td></td>
</tr>
<tr>
<td>Fleet (later acquired by Bank of America)</td>
<td></td>
</tr>
<tr>
<td>Huntington Bancshares</td>
<td></td>
</tr>
<tr>
<td>J.P. Morgan</td>
<td></td>
</tr>
<tr>
<td>Liberty National Bank</td>
<td></td>
</tr>
<tr>
<td>Marine Midland Bank (later acquired by HSBC Bank USA)</td>
<td></td>
</tr>
<tr>
<td>Mellon (later acquired by BNY)</td>
<td></td>
</tr>
<tr>
<td>National City (later acquired by PNC)</td>
<td></td>
</tr>
<tr>
<td>National Westminster Bank USA (later acquired by Fleet)</td>
<td></td>
</tr>
<tr>
<td>NationsBank (later acquired by Bank of America)</td>
<td></td>
</tr>
<tr>
<td>Norstar (later acquired by Fleet)</td>
<td></td>
</tr>
<tr>
<td>Norwest (later acquired by Wells Fargo)</td>
<td></td>
</tr>
<tr>
<td>PNC</td>
<td></td>
</tr>
<tr>
<td>Security Pacific Bank (later acquired by Bank of America)</td>
<td></td>
</tr>
<tr>
<td>SouthTrust (later acquired by Wachovia/First Union)</td>
<td></td>
</tr>
<tr>
<td>SunTrust</td>
<td></td>
</tr>
<tr>
<td><strong>Established on or after August 1, 1996</strong></td>
<td></td>
</tr>
<tr>
<td>BB&amp;T</td>
<td>Citigroup∗</td>
</tr>
<tr>
<td>BNY</td>
<td>Wells Fargo</td>
</tr>
<tr>
<td>Commerce Bancshares</td>
<td></td>
</tr>
<tr>
<td>CoreStates/Philadelphia National Bank</td>
<td></td>
</tr>
<tr>
<td>(later acquired by First Union)</td>
<td></td>
</tr>
<tr>
<td>Crestar Bank</td>
<td></td>
</tr>
<tr>
<td>First Tennessee</td>
<td></td>
</tr>
<tr>
<td>KeyBank</td>
<td></td>
</tr>
<tr>
<td>U.S. Bancorp</td>
<td></td>
</tr>
<tr>
<td>Wachovia (first acquired by First Union and later by Wells Fargo)</td>
<td></td>
</tr>
</tbody>
</table>

* Citigroup emerged as a result of the merger of Travelers Group and Citicorp on October 8, 1998. Before, Travelers Group became a universal bank by our definition through a series of mergers, most notably with investment banks Smith Barney and Salomon Brothers, and Citicorp had registered a Section 20 subsidiary. Given the size of this merger of equals, we do not treat either one as the surviving entity and, instead, label Citigroup as a separate universal bank established through M&A in 1998.
### Table 3

**Summary Statistics**

<table>
<thead>
<tr>
<th>Loans sample (1987 – 2010)</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal-bank (UB) loan</td>
<td>0.641</td>
<td>0.480</td>
<td>0</td>
<td>1</td>
<td>19,053</td>
</tr>
<tr>
<td>Investment-bank (IB) loan</td>
<td>0.108</td>
<td>0.311</td>
<td>0</td>
<td>1</td>
<td>19,053</td>
</tr>
<tr>
<td>Deal size/assets</td>
<td>0.275</td>
<td>0.475</td>
<td>0.000</td>
<td>39.604</td>
<td>19,053</td>
</tr>
<tr>
<td>Refinancing</td>
<td>0.501</td>
<td>0.500</td>
<td>0</td>
<td>1</td>
<td>19,053</td>
</tr>
<tr>
<td>No. of lead arrangers</td>
<td>1.122</td>
<td>0.343</td>
<td>1</td>
<td>6</td>
<td>19,053</td>
</tr>
<tr>
<td>All-in-drawn spread in bps</td>
<td>186.879</td>
<td>137.681</td>
<td>0.700</td>
<td>1490.020</td>
<td>16,967</td>
</tr>
<tr>
<td>Loan cross-sold by UB or IB</td>
<td>0.791</td>
<td>0.407</td>
<td>0</td>
<td>1</td>
<td>12,061</td>
</tr>
<tr>
<td>Cross-sold with debt underwriting</td>
<td>0.851</td>
<td>0.357</td>
<td>0</td>
<td>1</td>
<td>11,863</td>
</tr>
<tr>
<td>Cross-sold with equity underwriting</td>
<td>0.190</td>
<td>0.392</td>
<td>0</td>
<td>1</td>
<td>4,008</td>
</tr>
<tr>
<td>(all conditional on loan &amp; underwriting)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of UBs M&amp;A</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of UBs M&amp;A before Aug. 1, 1996</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of UBs Section 20</td>
<td>37</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of UBs Section 20 before Aug. 1, 1996</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of IBs</td>
<td>95</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of CBs</td>
<td>449</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Firm-loan-years sample (1987 – 2006)</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>∆ln(σ_i[6y])</td>
<td>-0.020</td>
<td>0.850</td>
<td>-3.586</td>
<td>2.656</td>
<td>3,362</td>
</tr>
<tr>
<td>∆ln(σ_i[6y])</td>
<td>0.006</td>
<td>0.390</td>
<td>-2.234</td>
<td>1.759</td>
<td>3,362</td>
</tr>
<tr>
<td>∆ln(σ_i[6y])</td>
<td>0.006</td>
<td>0.404</td>
<td>-2.374</td>
<td>1.754</td>
<td>3,362</td>
</tr>
<tr>
<td>Bankruptcy in the next ten years</td>
<td>0.234</td>
<td>0.423</td>
<td>0</td>
<td>1</td>
<td>6,393</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Compustat sample (1987 – 2010)</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFP_{i,t+1}</td>
<td>0.664</td>
<td>0.344</td>
<td>0.006</td>
<td>9.957</td>
<td>52,435</td>
</tr>
<tr>
<td>CapEx_{it} (in 2010 $bn)</td>
<td>0.173</td>
<td>1.026</td>
<td>0.000</td>
<td>59.283</td>
<td>91,686</td>
</tr>
<tr>
<td>MarketCap_{it} (in 2010 $bn)</td>
<td>2.398</td>
<td>13.842</td>
<td>0.000</td>
<td>780.502</td>
<td>92,665</td>
</tr>
<tr>
<td>σ_i^{implied}</td>
<td>0.572</td>
<td>0.384</td>
<td>0.023</td>
<td>5.447</td>
<td>24,779</td>
</tr>
<tr>
<td>Sales in 2010 $bn</td>
<td>1.941</td>
<td>9.655</td>
<td>0.000</td>
<td>430.402</td>
<td>93,181</td>
</tr>
<tr>
<td>No. employees in thousands</td>
<td>7.510</td>
<td>34.640</td>
<td>0.001</td>
<td>2100.001</td>
<td>93,181</td>
</tr>
<tr>
<td>Loan from CB, underwriting from IB, both merged</td>
<td>0.035</td>
<td>0.184</td>
<td>0</td>
<td>1</td>
<td>93,181</td>
</tr>
<tr>
<td>Loan from CB that merged</td>
<td>0.318</td>
<td>0.466</td>
<td>0</td>
<td>1</td>
<td>93,181</td>
</tr>
<tr>
<td>Underwriting from IB that merged</td>
<td>0.205</td>
<td>0.404</td>
<td>0</td>
<td>1</td>
<td>93,181</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IPO sample (1976 – 2006)</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPO age in years</td>
<td>14.371</td>
<td>20.230</td>
<td>0.000</td>
<td>165.000</td>
<td>3,835</td>
</tr>
<tr>
<td>UB</td>
<td>0.166</td>
<td>0.372</td>
<td>0</td>
<td>1</td>
<td>3,835</td>
</tr>
<tr>
<td>Eventually UB M&amp;A</td>
<td>0.311</td>
<td>0.463</td>
<td>0</td>
<td>1</td>
<td>3,835</td>
</tr>
<tr>
<td>Sales in 2010 $bn</td>
<td>0.309</td>
<td>1.395</td>
<td>0.000</td>
<td>41.698</td>
<td>3,835</td>
</tr>
<tr>
<td>No. of employees in thousands</td>
<td>1.461</td>
<td>6.204</td>
<td>0.001</td>
<td>203.001</td>
<td>3,835</td>
</tr>
<tr>
<td>Book-value leverage</td>
<td>0.192</td>
<td>0.209</td>
<td>0.000</td>
<td>0.890</td>
<td>3,835</td>
</tr>
<tr>
<td>Gross spread in %</td>
<td>7.484</td>
<td>1.336</td>
<td>0.700</td>
<td>20.250</td>
<td>3,835</td>
</tr>
<tr>
<td>IPO count</td>
<td>69.154</td>
<td>100.402</td>
<td>1</td>
<td>582</td>
<td>3,835</td>
</tr>
<tr>
<td>No. of UBs M&amp;A</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of UBs M&amp;A before Aug. 1, 1996</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of UBs Section 20</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of UBs Section 20 before Aug. 1, 1996</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of IBs</td>
<td>460</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4  
**Impact of Universal-bank Financing on Sales-growth Volatility – Firm-loan-years Sample**

<table>
<thead>
<tr>
<th></th>
<th>Δₜ ln(σ(salesₗ)⁶ᵧ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal-bank loan × After(1996)</td>
<td>0.153*** 0.138*** 0.179** 0.236*** 0.237**</td>
</tr>
<tr>
<td></td>
<td>(0.045) (0.048) (0.076) (0.087) (0.099)</td>
</tr>
<tr>
<td>Universal-bank loan</td>
<td>-0.049 -0.054 -0.043 -0.069 -0.069</td>
</tr>
<tr>
<td></td>
<td>(0.050) (0.057) (0.072) (0.099) (0.099)</td>
</tr>
<tr>
<td>Investment-bank loan × After(1996)</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>(0.157)</td>
</tr>
</tbody>
</table>

Controls: N Y Y Y Y
Bank FE: Y Y Y Y Y
Year FE: Y Y N N N
State-year FE: N N Y Y Y
Industry FE: N Y Y N N
Firm FE: N N N Y Y

N 3,362 3,362 3,362 3,362 3,362

Notes: All regressions are run at the firm-year level it, limited to years in which firm i received at least one loan from bank(s) j, where the loans sample consists of all completed syndicated loans of publicly listed firms. For firm-loan year t, Δₜ ln(σ(salesₗ)⁶ᵧ) is the difference between the logged six-year standard deviation of firm i's sales growth from t to t+5 and that from t−6 to t−1. Universal-bank loanjₜt is an indicator variable for whether at the time of any loan transaction in year t any one of the lead arrangers j was a universal bank. Investment-bank loanjₜt is an indicator variable for whether at the time of any loan transaction in year t any one of the lead arrangers j was an investment bank. After(1996)t is an indicator for whether the firm’s loan year in question was in 1997 or later. Control variables are measured in year t, and include the log of firm i's sales, the log of its number of employees, the log of the ratio of the average deal size across all loans in a given year over firm i's assets, and the average value of the refinancing indicator. Bank fixed effects are included for all lead arrangers – i.e., all commercial, universal, and investment banks – of all loans in a given year. State-year fixed effects are based on firm i's headquarter in year t. Industry fixed effects are based on SIC2 codes. Public-service, energy, and financial-services firms are dropped. Robust standard errors (clustered at the bank level) are in parentheses.
Table 5

**Impact of Universal-bank Financing on Stock-return Volatility – Firm-loan-years Sample**

<table>
<thead>
<tr>
<th></th>
<th>$\Delta_t \ln(\sigma(return_{i})^{9y})$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.124*** 0.110*** 0.142*** 0.115*** 0.104***</td>
</tr>
<tr>
<td></td>
<td>(0.028) (0.027) (0.036) (0.036) (0.041)</td>
</tr>
<tr>
<td>Universal-bank loan × After(1996)</td>
<td>-0.055** -0.053** -0.054 -0.020 -0.016</td>
</tr>
<tr>
<td></td>
<td>(0.025) (0.026) (0.034) (0.043) (0.044)</td>
</tr>
<tr>
<td>Investment-bank loan × After(1996)</td>
<td>-0.055</td>
</tr>
<tr>
<td></td>
<td>(0.065)</td>
</tr>
<tr>
<td>Controls</td>
<td>N Y Y Y Y</td>
</tr>
<tr>
<td>Bank FE</td>
<td>Y Y Y Y Y</td>
</tr>
<tr>
<td>Year FE</td>
<td>Y Y N N N</td>
</tr>
<tr>
<td>State-year FE</td>
<td>N N Y Y Y</td>
</tr>
<tr>
<td>Industry FE</td>
<td>N Y Y N N</td>
</tr>
<tr>
<td>Firm FE</td>
<td>N N N Y Y</td>
</tr>
<tr>
<td>N</td>
<td>3,556 3,556 3,556 3,556 3,556</td>
</tr>
</tbody>
</table>

Notes: All regressions are run at the firm-year level $it$, limited to years in which firm $i$ received at least one loan from bank(s) $j$, where the loans sample consists of all completed syndicated loans of publicly listed firms. For firm-loan year $t$, $\Delta_t \ln(\sigma(return_{i})^{9y})$ is the difference between the logged six-year standard deviation of firm $i$’s stock returns from $t$ to $t + 5$ and that from $t - 6$ to $t - 1$. Universal-bank loan$_{it}$ is an indicator variable for whether at the time of any loan transaction in year $t$ any one of the lead arrangers $j$ was a universal bank. Investment-bank loan$_{it}$ is an indicator variable for whether at the time of any loan transaction in year $t$ any one of the lead arrangers $j$ was an investment bank. After(1996)$_i$ is an indicator for whether the firm’s loan year in question was in 1997 or later. Control variables are measured in year $t$, and include the log of firm $i$’s sales, the log of its number of employees, the log of the ratio of the average deal size across all loans in a given year over firm $i$’s assets, and the average value of the refinancing indicator. Bank fixed effects are included for all lead arrangers – i.e., all commercial, universal, and investment banks – of all loans in a given year. State-year fixed effects are based on firm $i$’s headquarter in year $t$. Industry fixed effects are based on SIC2 codes. Public-service, energy, and financial-services firms are dropped. Robust standard errors (clustered at the bank level) are in parentheses.
<table>
<thead>
<tr>
<th></th>
<th>$\Delta \ln(\sigma_{idiosyncratic,i}^{6y})$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal-bank loan $\times$ After(1996)</td>
<td>0.077*** 0.062** 0.078** 0.095*** 0.090**</td>
</tr>
<tr>
<td></td>
<td>(0.029) (0.028) (0.034) (0.036) (0.042)</td>
</tr>
<tr>
<td>Universal-bank loan</td>
<td>-0.039 -0.039 -0.031 -0.044 -0.042</td>
</tr>
<tr>
<td></td>
<td>(0.035) (0.034) (0.038) (0.045) (0.047)</td>
</tr>
<tr>
<td>Investment-bank loan $\times$ After(1996)</td>
<td>-0.029</td>
</tr>
<tr>
<td></td>
<td>(0.063)</td>
</tr>
<tr>
<td>Controls</td>
<td>N Y Y Y Y</td>
</tr>
<tr>
<td>Bank FE</td>
<td>Y Y Y Y</td>
</tr>
<tr>
<td>Year FE</td>
<td>Y Y N N</td>
</tr>
<tr>
<td>State-year FE</td>
<td>N N Y Y</td>
</tr>
<tr>
<td>Industry FE</td>
<td>N Y Y N</td>
</tr>
<tr>
<td>Firm FE</td>
<td>N N N Y</td>
</tr>
<tr>
<td>N</td>
<td>3,556 3,556 3,556 3,556 3,556</td>
</tr>
</tbody>
</table>

Notes: All regressions are run at the firm-year level $it$, limited to years in which firm $i$ received at least one loan from bank(s) $j$, where the loans sample consists of all completed syndicated loans of publicly listed firms. For firm-loan year $t$, $\Delta \ln(\sigma_{idiosyncratic,i}^{6y})$ is the difference between the logged six-year idiosyncratic volatility of firm $i$’s stock returns from $t$ to $t + 5$ and that from $t - 6$ to $t - 1$, estimated from the Fama and French (1993) three-factor model and expressed in annualized terms. Universal-bank loan$_{jt}$ is an indicator variable for whether at the time of any loan transaction in year $t$ any one of the lead arrangers $j$ was a universal bank. Investment-bank loan$_{jt}$ is an indicator variable for whether at the time of any loan transaction in year $t$ any one of the lead arrangers $j$ was an investment bank. After(1996)$_{it}$ is an indicator for whether the firm’s loan year in question was in 1997 or later. Control variables are measured in year $t$, and include the log of firm $i$’s sales, the log of its number of employees, the log of the ratio of the average deal size across all loans in a given year over firm $i$’s assets, and the average value of the refinancing indicator. Bank fixed effects are included for all lead arrangers – i.e., all commercial, universal, and investment banks – of all loans in a given year. State-year fixed effects are based on firm $i$’s headquarter in year $t$. Industry fixed effects are based on SIC2 codes. Public-service, energy, and financial-services firms are dropped. Robust standard errors (clustered at the bank level) are in parentheses.
## Table 7

**Impact of Universal-bank Financing on Bankruptcy – Firm-loan-years Sample**

<table>
<thead>
<tr>
<th></th>
<th>Bankruptcy in the next ten years ∈ {0, 1}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal-bank loan × After(1996)</td>
<td>0.014 0.031 0.031 -0.038** -0.016</td>
</tr>
<tr>
<td></td>
<td>(0.022) (0.024) (0.022) (0.017) (0.017)</td>
</tr>
<tr>
<td>Universal-bank loan</td>
<td>-0.045* -0.029 -0.045* 0.004 -0.003</td>
</tr>
<tr>
<td></td>
<td>(0.025) (0.023) (0.025) (0.015) (0.015)</td>
</tr>
<tr>
<td>Investment-bank loan × After(1996)</td>
<td>0.102***</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
</tr>
<tr>
<td>Controls</td>
<td>N Y Y Y Y</td>
</tr>
<tr>
<td>Bank FE</td>
<td>Y Y Y Y Y</td>
</tr>
<tr>
<td>Year FE</td>
<td>Y Y N N N</td>
</tr>
<tr>
<td>State-year FE</td>
<td>N N Y Y Y</td>
</tr>
<tr>
<td>Industry FE</td>
<td>N Y Y N N</td>
</tr>
<tr>
<td>Firm FE</td>
<td>N N N Y Y</td>
</tr>
<tr>
<td>N</td>
<td>6,393 6,393 6,393 6,393 6,393</td>
</tr>
</tbody>
</table>

Notes: All regressions are run at the firm-year level it, limited to years in which firm i received at least one loan from bank(s) j, where the loans sample consists of all completed syndicated loans of publicly listed firms. For firm-loan year t, the dependent variable is an indicator variable for whether the borrowing company went bankrupt (according to CRSP delisting codes) in the ten years following the loan issue (i.e., t + 1 to t + 10). Universal-bank loan$_{jt}$ is an indicator variable for whether at the time of any loan transaction in year t any one of the lead arrangers j was a universal bank. Investment-bank loan$_{jt}$ is an indicator variable for whether at the time of any loan transaction in year t any one of the lead arrangers j was an investment bank. After(1996)$_{it}$ is an indicator for whether the firm’s loan year in question was in 1997 or later. Control variables are measured in year t, and include the log of firm i’s sales, the log of its number of employees, the log of the ratio of the average deal size across all loans in a given year over firm i’s assets, and the average value of the refinancing indicator. Bank fixed effects are included for all lead arrangers – i.e., all commercial, universal, and investment banks – of all loans in a given year. State-year fixed effects are based on firm i’s headquarter in year t. Industry fixed effects are based on SIC2 codes. Public-service, energy, and financial-services firms are dropped. Robust standard errors (clustered at the bank level) are in parentheses.
### Table 8

**Impact of Universal-bank Financing on Total Factor Productivity – Compustat Sample, Long-run Within-firm Effects**

<table>
<thead>
<tr>
<th></th>
<th>ln($TFP_{i,t+1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal-bank loan × After(1996)</td>
<td>0.032*** 0.029*** 0.029*** 0.028***</td>
</tr>
<tr>
<td></td>
<td>(0.008) (0.008) (0.008) (0.008)</td>
</tr>
<tr>
<td>Universal-bank loan</td>
<td>-0.013* -0.012* -0.013* -0.013*</td>
</tr>
<tr>
<td></td>
<td>(0.007) (0.007) (0.007) (0.007)</td>
</tr>
<tr>
<td>Investment-bank loan × After(1996)</td>
<td>-0.018</td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
</tr>
<tr>
<td>Controls</td>
<td>N Y Y Y</td>
</tr>
<tr>
<td>Firm FE</td>
<td>Y Y Y Y</td>
</tr>
<tr>
<td>Bank FE</td>
<td>Y Y Y Y</td>
</tr>
<tr>
<td>Year FE</td>
<td>Y Y N N</td>
</tr>
<tr>
<td>State-year FE</td>
<td>N N Y Y</td>
</tr>
</tbody>
</table>

N  52,435  52,435  52,435  52,435

Notes: The sample consists of all available firm-year observations from Compustat, the unit of observation is the firm-year level. $TFP_{i,t+1}$ is firm $i$’s total factor productivity in year $t+1$ from Imrohoroglu and Tuzel (2014). Universal-bank loan$_{j,t}$ is an indicator variable for whether, given any loans received by firm $i$ from year $t-4$ to $t$, at the time of any loan transaction any one of the lead arrangers $j$ was a universal bank. Investment-bank loan$_{j,t}$ is an indicator variable for whether, given any loans received by firm $i$ from year $t-4$ to $t$, at the time of any loan transaction any one of the lead arrangers $j$ was an investment bank. After(1996)$_t$ is an indicator for whether the year in question was in 1997 or later. Control variables are measured in year $t$, and include the log of firm $i$’s sales, the log of its number of employees, the log of the average ratio of deal size across all loans over firm $i$’s assets from $t-4$ to $t$, and the proportion of refinancing loans from $t-4$ to $t$. Bank fixed effects are included for all lead arrangers – i.e., all commercial, universal, and investment banks – of all loans granted to firm $i$ from year $t-4$ to $t$. State-year fixed effects are based on firm $i$’s headquarter in year $t$. Public-service, energy, and financial-services firms are dropped. Robust standard errors (clustered at the firm-year level) are in parentheses.
Table 9

**Impact of Bank Information Acquisition on Total Factor Productivity – Compustat Sample, Long-run Within-firm Effects**

<table>
<thead>
<tr>
<th></th>
<th>ln(TFP_{i,t+1})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loan from CB, underwriting from IB, both merged</td>
<td>0.034*** 0.029*** 0.021*** 0.021**</td>
</tr>
<tr>
<td></td>
<td>(0.008) (0.008) (0.008) (0.008)</td>
</tr>
<tr>
<td>Loan from CB that merged × Underwriting from IB that merged</td>
<td>0.007 0.007 0.008 0.007</td>
</tr>
<tr>
<td></td>
<td>(0.010) (0.010) (0.010) (0.010)</td>
</tr>
<tr>
<td>Loan from CB that merged</td>
<td>-0.020*** -0.020*** -0.026*** -0.026***</td>
</tr>
<tr>
<td></td>
<td>(0.008) (0.007) (0.008) (0.008)</td>
</tr>
<tr>
<td>Underwriting from IB that merged</td>
<td>0.001 -0.008 -0.013 -0.014</td>
</tr>
<tr>
<td></td>
<td>(0.009) (0.009) (0.009) (0.009)</td>
</tr>
<tr>
<td>Any loan × Any underwriting</td>
<td>0.029*** 0.029*** 0.028*** 0.028***</td>
</tr>
<tr>
<td></td>
<td>(0.009) (0.009) (0.009) (0.009)</td>
</tr>
<tr>
<td>Any loan</td>
<td>-0.021** -0.034*** -0.032*** -0.030***</td>
</tr>
<tr>
<td></td>
<td>(0.009) (0.010) (0.010) (0.010)</td>
</tr>
<tr>
<td>Any underwriting</td>
<td>-0.042*** -0.042*** -0.044*** -0.042***</td>
</tr>
<tr>
<td></td>
<td>(0.007) (0.007) (0.007) (0.007)</td>
</tr>
<tr>
<td>Controls</td>
<td>N Y Y Y</td>
</tr>
<tr>
<td>Firm FE</td>
<td>Y Y Y Y</td>
</tr>
<tr>
<td>Year FE</td>
<td>Y Y N N</td>
</tr>
<tr>
<td>State-year FE</td>
<td>N N Y Y</td>
</tr>
<tr>
<td>Industry-year FE</td>
<td>N N N Y</td>
</tr>
<tr>
<td>N</td>
<td>52,435 52,435 52,435 52,435</td>
</tr>
</tbody>
</table>

Notes: The sample consists of all available firm-year observations from Compustat, the unit of observation is the firm-year level it. TFP_{i,t+1} is firm i’s total factor productivity in year t + 1 from Imrohoroglu and Tuzel (2014). Loan from CB that merged_{jt} is an indicator variable for whether anytime from t − 10 to t − 1, firm i received a loan from a commercial or universal bank that merged with an investment bank thereafter. Underwriting from IB that merged_{jt} is an indicator variable for whether anytime from t − 10 to t − 1, firm i received an underwriting product from an investment bank that merged with a commercial or universal bank thereafter. The interaction of the latter two indicator variables is to be distinguished from the explanatory variable of interest in the first row, which indicates whether anytime from t − 10 to t − 1, firm i received a loan from a commercial or universal bank, an underwriting product from an investment bank, and both banks merged with each other until year t. Any loan_{it} and Any underwriting_{it} are indicator variables for whether firm i received any loan or any underwriting product, respectively, from any commercial, universal, or investment bank anytime from t − 10 to t − 1. Unless mentioned otherwise, control variables are measured in year t, and include the log of firm i’s sales, the log of its number of employees, the log of the average ratio of deal size across all loans over firm i’s assets from t − 10 to t − 1, and the proportion of refinancing loans from t − 10 to t − 1. State-year fixed effects are based on firm i’s headquarters in year t. Industry-year fixed effects are based on SIC1 codes. Public-service, energy, and financial-services firms are dropped. Robust standard errors (clustered at the firm-year level) are in parentheses.
Table 10  
**IMPACT OF UNIVERSAL-BANK UNDERWRITING ON AGE OF FIRMS AT THEIR IPOs**

<table>
<thead>
<tr>
<th></th>
<th>IPO age in years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(3.156) (1.742) (2.686)</td>
</tr>
<tr>
<td>UB × Est.(1996)</td>
<td>12.164***</td>
</tr>
<tr>
<td></td>
<td>(3.619)</td>
</tr>
<tr>
<td>UB</td>
<td>-3.910*</td>
</tr>
<tr>
<td></td>
<td>(2.291)</td>
</tr>
<tr>
<td>Eventually UB through M&amp;A</td>
<td>2.450**</td>
</tr>
<tr>
<td></td>
<td>(1.207)</td>
</tr>
<tr>
<td>UB M&amp;A × After(1996)</td>
<td>-10.435*** -10.178***</td>
</tr>
<tr>
<td></td>
<td>(2.564) (3.878)</td>
</tr>
<tr>
<td>UB M&amp;A × IPO count</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.003</td>
</tr>
<tr>
<td></td>
<td>(0.024)</td>
</tr>
<tr>
<td>UB Section 20 × After(1996)</td>
<td>-2.095 -5.624*</td>
</tr>
<tr>
<td></td>
<td>(2.455) (2.990)</td>
</tr>
<tr>
<td>UB Section 20 × IPO count</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.017</td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
</tr>
<tr>
<td>After(Aug. 1, 1996)</td>
<td>1.287 1.087 -0.147 0.016 0.144</td>
</tr>
<tr>
<td></td>
<td>(1.361) (1.746) (2.676) (2.646) (2.867)</td>
</tr>
<tr>
<td>IPO count</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.004</td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
</tr>
<tr>
<td>Log of sales in 2010 $</td>
<td>2.090*** 1.917*** 1.868*** 1.901***</td>
</tr>
<tr>
<td></td>
<td>(0.398) (0.504) (0.519) (0.530)</td>
</tr>
<tr>
<td>Log of no. employees</td>
<td>2.597*** 2.209*** 2.276*** 2.265***</td>
</tr>
<tr>
<td></td>
<td>(0.646) (0.518) (0.535) (0.531)</td>
</tr>
<tr>
<td>Book-value leverage</td>
<td>5.826*** 4.635 4.528 4.578</td>
</tr>
<tr>
<td></td>
<td>(2.017) (3.613) (3.625) (3.630)</td>
</tr>
<tr>
<td>Gross spread in %</td>
<td>-1.559** -2.998*** -3.022*** -3.010***</td>
</tr>
<tr>
<td></td>
<td>(0.692) (0.923) (0.922) (0.901)</td>
</tr>
<tr>
<td>Bank FE</td>
<td>N Y Y Y Y</td>
</tr>
<tr>
<td>Industry FE</td>
<td>Y Y Y Y Y</td>
</tr>
<tr>
<td>Year FE</td>
<td>Y Y N N N</td>
</tr>
<tr>
<td>State-year FE</td>
<td>N N Y Y Y</td>
</tr>
<tr>
<td>N</td>
<td>3,835 3,835 2,471 2,471 2,471</td>
</tr>
</tbody>
</table>

Notes: The unit of observation is a firm’s IPO. The dependent variable is firm i’s age in years at the time t of its IPO with bank j as bookrunner. UBj (M&A or Section 20) is an indicator variable for whether the bookrunner was a universal bank (formed through a merger or through opening a Section 20 subsidiary). Est.(1996), indicates whether a universal bank (through M&A or Section 20) was established prior to August 1, 1996. After(1996), is an indicator for whether the IPO date was on or after August 1, 1996. Eventually UB through M&Aj is an indicator variable for whether the bookrunner, which was still an investment bank, eventually becomes a universal bank through M&A. IPO countjt denotes the number of IPOs accompanied by universal or investment bank j, up to and including the current IPO. Book-value leverage is winsorized at the 1st and 99th percentiles. All firm-level explanatory variables are measured at the end of the IPO year. Industry fixed effects are based on two-digit SIC codes. State-year fixed effects are based on firm i’s headquarter in year t. Public-service, energy, and financial-services firms are dropped. Robust standard errors (clustered at the bookrunner level) are in parentheses.
B.3 Supplementary Figures

Figure 31
PRE-TRENDS AMONG TREATMENT AND CONTROL FIRMS CONTRACTING WITH UNIVERSAL BANKS.

Notes: The graphs in the top, middle, and bottom panel plot, respectively, the average TFP, capital expenditure in 2010 $bn, and market capitalization in 2010 $bn by firms in the treatment and the control group over five years prior to the respective universal-bank mergers in year 0.
## B.4 Supplementary Tables

### Table 11
**Impact of Universal-bank Financing on Sales-growth Volatility – Placebo, Firm-loan-years Sample**

<table>
<thead>
<tr>
<th></th>
<th>$\Delta_t \ln(\sigma(sales_i)^{6y})$</th>
<th>Universal-bank loan $\times$ After(1993)</th>
<th>Universal-bank loan</th>
<th>Investment-bank loan $\times$ After(1993)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.047 0.034 0.116 -0.028 -0.042</td>
<td>0.006 -0.010 -0.034 0.056 0.064</td>
<td>-0.006 -0.010 -0.034 0.056 0.064</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.060) (0.059) (0.080) (0.104) (0.112)</td>
<td>(0.054) (0.058) (0.079) (0.127) (0.128)</td>
<td>(0.084)</td>
</tr>
<tr>
<td>Controls</td>
<td></td>
<td>N Y Y Y Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bank FE</td>
<td></td>
<td>Y Y Y Y Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year FE</td>
<td></td>
<td>Y Y N N N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>State-year FE</td>
<td></td>
<td>N N Y Y Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry FE</td>
<td></td>
<td>N Y Y N N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firm FE</td>
<td></td>
<td>N N N Y Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td></td>
<td>3,362 3,362 3,362 3,362 3,362</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: All regressions are run at the firm-year level $it$, limited to years in which firm $i$ received at least one loan from bank(s) $j$, where the loans sample consists of all completed syndicated loans of publicly listed firms. For firm-loan year $t$, $\Delta_t \ln(\sigma(sales_i)^{6y})$ is the difference between the six-year standard deviation of firm $i$’s sales growth from $t$ to $t+5$ and that from $t-6$ to $t-1$. Universal-bank loan$_{jt}$ is an indicator variable for whether at the time of any loan transaction in year $t$ any one of the lead arrangers $j$ was a universal bank. Investment-bank loan$_{jt}$ is an indicator variable for whether at the time of any loan transaction in year $t$ any one of the lead arrangers $j$ was an investment bank. After$_t$(1993) is an indicator for whether the firm’s loan year in question was in 1994 or later. Control variables are measured in year $t$, and include the log of firm $i$’s sales, the log of its number of employees, the log of the ratio of the average deal size across all loans in a given year over firm $i$’s assets, and the average value of the refinancing indicator. Bank fixed effects are included for *all* lead arrangers — i.e., all commercial, universal, and investment banks — of all loans in a given year. State-year fixed effects are based on firm $i$’s headquarter in year $t$. Industry fixed effects are based on SIC2 codes. Public-service, energy, and financial-services firms are dropped. Robust standard errors (clustered at the bank level) are in parentheses.
Table 12

Universal Banking and Likelihood of Cross-selling – Loans Sample

<table>
<thead>
<tr>
<th></th>
<th>Cross-sold loan conditional on loan &amp; underwriting ∈ {0, 1}</th>
</tr>
</thead>
<tbody>
<tr>
<td>UB × After(1996)</td>
<td>0.059* 0.061** 0.064***</td>
</tr>
<tr>
<td></td>
<td>(0.031) (0.027) (0.022)</td>
</tr>
<tr>
<td>UB Section 20 × After(1996)</td>
<td>0.074** 0.073** 0.067***</td>
</tr>
<tr>
<td></td>
<td>(0.036) (0.036) (0.022)</td>
</tr>
<tr>
<td>Log of sales at close</td>
<td>0.031*** 0.030*** 0.003</td>
</tr>
<tr>
<td></td>
<td>(0.005) (0.005) (0.007)</td>
</tr>
<tr>
<td>Log of no. employees</td>
<td>0.020*** 0.021*** 0.045*** 0.016** 0.017** 0.032***</td>
</tr>
<tr>
<td></td>
<td>(0.006) (0.006) (0.013) (0.006) (0.007) (0.010)</td>
</tr>
<tr>
<td>Log of deal size/assets</td>
<td>0.052*** 0.051*** 0.038*** 0.049*** 0.048*** 0.039***</td>
</tr>
<tr>
<td></td>
<td>(0.007) (0.006) (0.007) (0.008) (0.008) (0.007)</td>
</tr>
<tr>
<td>Refinancing ∈ {0, 1}</td>
<td>0.017 0.015 0.012 0.010 0.009 0.006</td>
</tr>
<tr>
<td></td>
<td>(0.011) (0.010) (0.009) (0.010) (0.010) (0.009)</td>
</tr>
<tr>
<td>Bank FE</td>
<td>Y Y Y Y Y Y</td>
</tr>
<tr>
<td>Year FE</td>
<td>Y N N Y N N</td>
</tr>
<tr>
<td>State-year FE</td>
<td>N Y Y N Y Y</td>
</tr>
<tr>
<td>Industry FE</td>
<td>Y Y N Y Y N</td>
</tr>
<tr>
<td>Firm FE</td>
<td>N N Y N N Y</td>
</tr>
<tr>
<td>Sample</td>
<td>Universal and investment banks Universal banks only</td>
</tr>
<tr>
<td>N</td>
<td>12,061 12,061 12,061 10,773 10,773 10,773</td>
</tr>
</tbody>
</table>

Notes: The sample consists of all completed syndicated loans (package level) of publicly listed firms, conditional on the borrower firm $i$ of the respective loan granted in year $t$ also receiving an underwriting product from any universal or investment bank (in the first three columns) or from any universal bank only (in the last three columns) anytime from the beginning of year $t - 2$ to the end of year $t + 2$. The dependent variable is an indicator for whether a given loan in year $t$ was associated with a cross-sold underwriting product by the same bank from $t - 2$ to $t + 2$. $\text{UB}_jt$ is an indicator variable for whether at date $t$ of the respective loan any one of the lead arrangers $j$ was a universal bank. $\text{UB Section 20}_jt$ is an indicator variable for whether at date $t$ of the respective loan any one of the lead arrangers $j$ was a universal bank established through a Section 20 subsidiary, rather than through mergers and acquisitions. $\text{After}(1996)_t$ is an indicator for whether the loan in question was issued on or after August 1, 1996. Bank fixed effects are included for all lead arrangers, i.e., all commercial, universal, and investment banks. State-year fixed effects are based on firm $i$’s headquarters in year $t$. Industry fixed effects are based on SIC2 codes. Public-service, energy, and financial-services firms are dropped. Robust standard errors (clustered at the bank level) are in parentheses.
### Table 13

**Impact of Universal-bank Financing on Loan Rates – Loans Sample**

<table>
<thead>
<tr>
<th></th>
<th>ln(All-in-drawn spread)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Universal-bank loan × After(1996)</strong></td>
<td>0.016 0.006 -0.044</td>
</tr>
<tr>
<td></td>
<td>(0.045) (0.043) (0.042)</td>
</tr>
<tr>
<td><strong>Universal-bank loan</strong></td>
<td>-0.019 -0.005 0.018</td>
</tr>
<tr>
<td></td>
<td>(0.067) (0.064) (0.039)</td>
</tr>
<tr>
<td><strong>Log of sales at close</strong></td>
<td>-0.196*** -0.189*** -0.102***</td>
</tr>
<tr>
<td></td>
<td>(0.012) (0.011) (0.010)</td>
</tr>
<tr>
<td><strong>Log of no. employees</strong></td>
<td>-0.079*** -0.083*** -0.096***</td>
</tr>
<tr>
<td></td>
<td>(0.009) (0.009) (0.012)</td>
</tr>
<tr>
<td><strong>Log of deal size/assets</strong></td>
<td>0.037*** 0.036*** -0.016*</td>
</tr>
<tr>
<td></td>
<td>(0.013) (0.013) (0.010)</td>
</tr>
<tr>
<td><strong>Refinancing indicator ∈ {0, 1}</strong></td>
<td>0.054*** 0.051*** -0.015</td>
</tr>
<tr>
<td></td>
<td>(0.012) (0.012) (0.010)</td>
</tr>
<tr>
<td><strong>Bank FE</strong></td>
<td>Y Y Y</td>
</tr>
<tr>
<td><strong>Year FE</strong></td>
<td>Y N N</td>
</tr>
<tr>
<td><strong>State-year FE</strong></td>
<td>N Y Y</td>
</tr>
<tr>
<td><strong>Industry FE</strong></td>
<td>Y Y N</td>
</tr>
<tr>
<td><strong>Firm FE</strong></td>
<td>N N Y</td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>16,967 16,967 16,967</td>
</tr>
</tbody>
</table>

Notes: The sample consists of all completed syndicated loans (package level) of publicly listed firms, subject to availability of the dependent variable. The dependent variable is the natural logarithm of the all-in-drawn spread (in bps), which is the sum of the spread over LIBOR and any annual fees paid to the lender syndicate. *Universal-bank loan* _jt_ is an indicator variable for whether at date _t_ of the respective loan any one of the lead arrangers _j_ was a universal bank. *After(1996)_ _t_ is an indicator for whether the loan in question was issued on or after August 1, 1996. Bank fixed effects are included for *all* lead arrangers, i.e., all commercial, universal, and investment banks. State-year fixed effects are based on firm _i_’s headquarter in year _t_. Industry fixed effects are based on SIC2 codes. Public-service, energy, and financial-services firms are dropped. Robust standard errors (clustered at the bank level) are in parentheses.
Table 14
IMPACT OF UNIVERSAL-BANK FINANCING ON CAPITAL EXPENDITURE – COMPUSTAT
SAMPLE, LONG-RUN WITHIN-FIRM EFFECTS

<table>
<thead>
<tr>
<th></th>
<th>ln(CapEx_{it})</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal-bank loan × After(1996)</td>
<td>0.037**</td>
<td>0.017</td>
<td>0.023(*)</td>
<td>0.023(*)</td>
</tr>
<tr>
<td></td>
<td>(0.018)</td>
<td>(0.015)</td>
<td>(0.015)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>Universal-bank loan</td>
<td>0.106***</td>
<td>0.039***</td>
<td>0.037***</td>
<td>0.037***</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.013)</td>
<td>(0.014)</td>
<td>(0.014)</td>
</tr>
<tr>
<td>Investment-bank loan × After(1996)</td>
<td>0.013</td>
<td></td>
<td></td>
<td>(0.019)</td>
</tr>
</tbody>
</table>

| Controls                  | N              | Y | Y | Y |
| Bank FE                   | Y              | Y | Y | Y |
| Year FE                   | Y              | Y | N | N |
| State-year FE             | N              | N | Y | Y |
| N                         | 91,686         | 91,686 | 91,686 | 91,686 |

Notes: The sample consists of all available firm-year observations from Compustat, the unit of observation is the firm-year level $it$. $CapEx_{it}$ is firm $i$’s capital expenditure in year $t$. $Universal-bank\ loan_{jt}$ is an indicator variable for whether, given any loans received by firm $i$ from year $t - 4$ to $t$, at the time of any loan transaction any one of the lead arrangers $j$ was a universal bank. $Investment-bank\ loan_{jt}$ is an indicator variable for whether, given any loans received by firm $i$ from year $t - 4$ to $t$, at the time of any loan transaction any one of the lead arrangers $j$ was an investment bank. $After(1996)_t$ is an indicator for whether the year in question was in 1997 or later. Control variables are measured in year $t$, and include the log of firm $i$’s sales, the log of its number of employees, the log of the average ratio of deal size across all loans over firm $i$’s assets from $t - 4$ to $t$, and the proportion of refinancing loans from $t - 4$ to $t$. Bank fixed effects are included for all lead arrangers – i.e., all commercial, universal, and investment banks – of all loans granted to firm $i$ from year $t - 4$ to $t$. State-year fixed effects are based on firm $i$’s headquarter in year $t$. Public-service, energy, and financial-services firms are dropped. Robust standard errors (clustered at the firm-year level) are in parentheses.
Table 15

| Impact of Universal-bank Financing on Market Capitalization – Compustat Sample, Long-run Within-firm Effects |
|-----------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|
| ln(MarketCap$_{it}$)                                | ln(MarketCap$_{it}$) | ln(MarketCap$_{it}$) | ln(MarketCap$_{it}$) |
| Universal-bank loan × After(1996)                   | 0.098*** 0.092*** 0.113*** 0.112*** | (0.017) (0.016) (0.016) (0.016) | |
| Universal-bank loan                                 | 0.060*** 0.016 0.007 0.007 | (0.016) (0.014) (0.014) (0.014) | |
| Investment-bank loan × After(1996)                  | -0.017 0.020 | (0.020) | |
| Controls                                            | N Y Y Y | |
| Firm FE                                             | Y Y Y Y | |
| Bank FE                                             | Y Y Y Y | |
| Year FE                                             | Y Y N N | | |
| State-year FE                                       | N N Y Y | |
| N                                                    | 92,665 92,665 92,665 92,665 | | |

Notes: The sample consists of all available firm-year observations from Compustat, the unit of observation is the firm-year level $it$. MarketCap$_{it}$ is firm $i$’s market value of equity in year $t$. Universal-bank loan$_{jt}$ is an indicator variable for whether, given any loans received by firm $i$ from year $t−4$ to $t$, at the time of any loan transaction any one of the lead arrangers $j$ was a universal bank. Investment-bank loan$_{jt}$ is an indicator variable for whether, given any loans received by firm $i$ from year $t−4$ to $t$, at the time of any loan transaction any one of the lead arrangers $j$ was an investment bank. After(1996)$_t$ is an indicator for whether the year in question was in 1997 or later. Control variables are measured in year $t$, and include the log of firm $i$’s sales, the log of its number of employees, the log of the average ratio of deal size across all loans over firm $i$’s assets from $t−4$ to $t$, and the proportion of refinancing loans from $t−4$ to $t$. Bank fixed effects are included for all lead arrangers – i.e., all commercial, universal, and investment banks – of all loans granted to firm $i$ from year $t−4$ to $t$. State-year fixed effects are based on firm $i$’s headquarter in year $t$. Public-service, energy, and financial-services firms are dropped. Robust standard errors (clustered at the firm-year level) are in parentheses.
<table>
<thead>
<tr>
<th>Loan from CB, underwriting from IB, both merged</th>
<th>ln(CapEx_{it})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.114***</td>
</tr>
<tr>
<td></td>
<td>(0.019)</td>
</tr>
<tr>
<td>Loan from CB that merged</td>
<td>-0.091***</td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
</tr>
<tr>
<td>× Underwriting from IB that merged</td>
<td>-0.040**</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
</tr>
<tr>
<td>Loan from CB that merged</td>
<td>0.144***</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
</tr>
<tr>
<td>Underwriting from IB that merged</td>
<td>0.063***</td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
</tr>
<tr>
<td>Any loan × Any underwriting</td>
<td>-0.003</td>
</tr>
<tr>
<td></td>
<td>(0.019)</td>
</tr>
<tr>
<td>Any loan</td>
<td>-0.041**</td>
</tr>
<tr>
<td></td>
<td>(0.019)</td>
</tr>
<tr>
<td>Any underwriting</td>
<td>0.207***</td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
</tr>
<tr>
<td>Firm FE</td>
<td>Y</td>
</tr>
<tr>
<td>Year FE</td>
<td>Y</td>
</tr>
<tr>
<td>State-year FE</td>
<td>N</td>
</tr>
<tr>
<td>Industry-year FE</td>
<td>N</td>
</tr>
<tr>
<td>N</td>
<td>91,686</td>
</tr>
</tbody>
</table>

Notes: The sample consists of all available firm-year observations from Compustat, the unit of observation is the firm-year level at. CapEx_{it} is firm i’s capital expenditure in year t. Loan from CB that merged_{it} is an indicator variable for whether anytime from t − 10 to t − 1, firm i received a loan from a commercial or universal bank that merged with an investment bank thereafter. Underwriting from IB that merged_{it} is an indicator variable for whether anytime from t − 10 to t − 1, firm i received an underwriting product from an investment bank that merged with a commercial or universal bank thereafter. The interaction of the latter two indicator variables is to be distinguished from the explanatory variable of interest in the first row, which indicates whether anytime from t − 10 to t − 1, firm i received a loan from a commercial or universal bank, an underwriting product from an investment bank, and both banks merged with each other until year t. Any loan_{it} and Any underwriting_{it} are indicator variables for whether firm i received any loan or any underwriting product, respectively, from any commercial, universal, or investment bank anytime from t − 10 to t − 1. Unless mentioned otherwise, control variables are measured in year t, and include the log of firm i’s sales, the log of its number of employees, the log of the average ratio of deal size across all loans over firm i’s assets from t − 10 to t − 1, and the proportion of refinancing loans from t − 10 to t − 1. State-year fixed effects are based on firm i’s headquarter in year t. Industry-year fixed effects are based on SIC1 codes. Public-service, energy, and financial-services firms are dropped. Robust standard errors (clustered at the firm-year level) are in parentheses.
<table>
<thead>
<tr>
<th>Variable</th>
<th>$\ln(MarketCap_{it})$</th>
<th>$\ln(MarketCap_{it})$</th>
<th>$\ln(MarketCap_{it})$</th>
<th>$\ln(MarketCap_{it})$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loan from CB, underwriting from IB, both merged</td>
<td>0.067***</td>
<td>0.042***</td>
<td>0.016</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>(0.019)</td>
<td>(0.016)</td>
<td>(0.016)</td>
<td>(0.016)</td>
</tr>
<tr>
<td>Loan from CB that merged $\times$ Underwriting from IB that merged</td>
<td>-0.037*</td>
<td>-0.007</td>
<td>-0.002</td>
<td>-0.004</td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
<td>(0.018)</td>
<td>(0.018)</td>
<td>(0.018)</td>
</tr>
<tr>
<td>Loan from CB that merged</td>
<td>0.078***</td>
<td>0.021</td>
<td>0.023*</td>
<td>0.029**</td>
</tr>
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<td></td>
<td>(0.015)</td>
<td>(0.013)</td>
<td>(0.013)</td>
<td>(0.013)</td>
</tr>
<tr>
<td>Underwriting from IB that merged</td>
<td>0.116***</td>
<td>0.012</td>
<td>0.014</td>
<td>0.015</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.015)</td>
<td>(0.015)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>Any loan $\times$ Any underwriting</td>
<td>0.118***</td>
<td>0.142***</td>
<td>0.135***</td>
<td>0.136***</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.015)</td>
<td>(0.015)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>Any loan</td>
<td>-0.184***</td>
<td>-0.238***</td>
<td>-0.233***</td>
<td>-0.224***</td>
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<tr>
<td></td>
<td>(0.017)</td>
<td>(0.016)</td>
<td>(0.016)</td>
<td>(0.016)</td>
</tr>
<tr>
<td>Any underwriting</td>
<td>-0.040***</td>
<td>-0.181***</td>
<td>-0.176***</td>
<td>-0.170***</td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
<td>(0.011)</td>
<td>(0.011)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Firm FE</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Year FE</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>State-year FE</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Industry-year FE</td>
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<td>N</td>
<td>N</td>
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</tr>
<tr>
<td>N</td>
<td>92,665</td>
<td>92,665</td>
<td>92,665</td>
<td>92,665</td>
</tr>
</tbody>
</table>

Notes: The sample consists of all available firm-year observations from Compustat, the unit of observation is the firm-year level $it$. $MarketCap_{it}$ is firm $i$’s market value of equity in year $t$. $Loan from CB that merged_{jt}$ is an indicator variable for whether anytime from $t−10$ to $t−1$, firm $i$ received a loan from a commercial or universal bank that merged with an investment bank thereafter. $Underwriting from IB that merged_{jt}$ is an indicator variable for whether anytime from $t−10$ to $t−1$, firm $i$ received an underwriting product from an investment bank that merged with a commercial or universal bank thereafter. The interaction of the latter two indicator variables is to be distinguished from the explanatory variable of interest in the first row, which indicates whether anytime from $t−10$ to $t−1$, firm $i$ received a loan from a commercial or universal bank, an underwriting product from an investment bank, and both banks merged with each other until year $t$. Any loan$_{it}$ and Any underwriting$_{it}$ are indicator variables for whether firm $i$ received any loan or any underwriting product, respectively, from any commercial, universal, or investment bank anytime from $t−10$ to $t−1$. Unless mentioned otherwise, control variables are measured in year $t$, and include the log of firm $i$’s sales, the log of its number of employees, the log of the average ratio of deal size across all loans over firm $i$’s assets from $t−10$ to $t−1$, and the proportion of refinancing loans from $t−10$ to $t−1$. State-year fixed effects are based on firm $i$’s headquarter in year $t$. Industry-year fixed effects are based on SIC1 codes. Public-service, energy, and financial-services firms are dropped. Robust standard errors (clustered at the firm-year level) are in parentheses.
Table 18

<table>
<thead>
<tr>
<th>Impact of Bank Information Acquisition on Total Factor Productivity: Robustness – Compustat Sample, Long-run Within-firm Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln((TFP_{i,t+1}))</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Loan from CB that merged \times Underwriting from IB that merged</td>
</tr>
<tr>
<td>(0.010)</td>
</tr>
<tr>
<td>Loan from CB that merged</td>
</tr>
<tr>
<td>(0.007)</td>
</tr>
<tr>
<td>Underwriting from IB that merged</td>
</tr>
<tr>
<td>(0.010)</td>
</tr>
<tr>
<td>Any loan \times Any underwriting</td>
</tr>
<tr>
<td>(0.009)</td>
</tr>
<tr>
<td>Any loan</td>
</tr>
<tr>
<td>(0.008)</td>
</tr>
<tr>
<td>Any underwriting</td>
</tr>
<tr>
<td>(0.006)</td>
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<tr>
<td>Controls</td>
</tr>
<tr>
<td>Firm FE</td>
</tr>
<tr>
<td>Year FE</td>
</tr>
<tr>
<td>State-year FE</td>
</tr>
<tr>
<td>Industry-year FE</td>
</tr>
<tr>
<td>N</td>
</tr>
</tbody>
</table>

Notes: The sample consists of all available firm-year observations from Compustat, the unit of observation is the firm-year level \(it\). \(TFP_{i,t+1}\) is firm \(i\)'s total factor productivity in year \(t+1\) from Imrohoroglu and Tuzel (2014). Loan from CB that merged \(_{jt}\) is an indicator variable for whether anytime from \(t−8\) to \(t−1\), firm \(i\) received a loan from a commercial or universal bank that merged with an investment bank thereafter. Underwriting from IB that merged \(_{jt}\) is an indicator variable for whether anytime from \(t−8\) to \(t−1\), firm \(i\) received an underwriting product from an investment bank that merged with a commercial or universal bank thereafter. The interaction of the latter two indicator variables is to be distinguished from the explanatory variable of interest in the first row, which indicates whether anytime from \(t−8\) to \(t−1\), firm \(i\) received a loan from a commercial or universal bank, an underwriting product from an investment bank, and both banks merged with each other until year \(t\). Any loan \(_{it}\) and Any underwriting \(_{it}\) are indicator variables for whether firm \(i\) received any loan or any underwriting product, respectively, from any commercial, universal, or investment bank anytime from \(t−8\) to \(t−1\). Unless mentioned otherwise, control variables are measured in year \(t\), and include the log of firm \(i\)'s sales, the log of its number of employees, the log of the average ratio of deal size across all loans over firm \(i\)'s assets from \(t−8\) to \(t−1\), and the proportion of refinancing loans from \(t−8\) to \(t−1\). State-year fixed effects are based on firm \(i\)'s headquarter in year \(t\). Industry-year fixed effects are based on SIC1 codes. Public-service, energy, and financial-services firms are dropped. Robust standard errors (clustered at the firm-year level) are in parentheses.
| Loan from CB, underwriting from IB, both merged | ln(CapEx$_{it}$) |
|---|---|---|---|
| | 0.108*** | 0.073*** | 0.052*** | 0.039*** |
| | (0.020) | (0.015) | (0.015) | (0.015) |
| Loan from CB that merged × Underwriting from IB that merged | -0.100*** | -0.055*** | -0.056*** | -0.053*** |
| | (0.022) | (0.017) | (0.017) | (0.017) |
| Loan from CB that merged | 0.146*** | 0.064*** | 0.056*** | 0.056*** |
| | (0.015) | (0.012) | (0.013) | (0.013) |
| Underwriting from IB that merged | 0.195*** | 0.043*** | 0.045*** | 0.038*** |
| | (0.019) | (0.015) | (0.015) | (0.015) |
| Any loan × Any underwriting | -0.020 | 0.017 | 0.016 | 0.014 |
| | (0.018) | (0.015) | (0.015) | (0.015) |
| Any loan | -0.030* | -0.106*** | -0.099*** | -0.086*** |
| | (0.018) | (0.015) | (0.015) | (0.015) |
| Any underwriting | 0.196*** | 0.010 | 0.008 | 0.007 |
| | (0.013) | (0.010) | (0.010) | (0.010) |

<table>
<thead>
<tr>
<th>Controls</th>
<th>N</th>
<th>Y</th>
<th>Y</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm FE</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Year FE</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>State-year FE</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Industry-year FE</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
</tbody>
</table>

| N | 91,686 | 91,686 | 91,686 | 91,686 |

Notes: The sample consists of all available firm-year observations from Compustat, the unit of observation is the firm-year level $it$. $CapEx_{it}$ is firm $i$’s capital expenditure in year $t$. $Loan from CB that merged_{jt}$ is an indicator variable for whether anytime from $t-8$ to $t-1$, firm $i$ received a loan from a commercial or universal bank that merged with an investment bank thereafter. $Underwriting from IB that merged_{jt}$ is an indicator variable for whether anytime from $t-8$ to $t-1$, firm $i$ received an underwriting product from an investment bank that merged with a commercial or universal bank thereafter. The interaction of the latter two indicator variables is to be distinguished from the explanatory variable of interest in the first row, which indicates whether anytime from $t-8$ to $t-1$, firm $i$ received a loan from a commercial or universal bank, an underwriting product from an investment bank, and both banks merged with each other until year $t$. $Any loan_{it}$ and $Any underwriting_{it}$ are indicator variables for whether firm $i$ received any loan or any underwriting product, respectively, from any commercial, universal, or investment bank anytime from $t-8$ to $t-1$. Unless mentioned otherwise, control variables are measured in year $t$, and include the log of firm $i$’s sales, the log of its number of employees, the log of the average ratio of deal size across all loans over firm $i$’s assets from $t-8$ to $t-1$, and the proportion of refinancing loans from $t-8$ to $t-1$. State-year fixed effects are based on firm $i$’s headquarter in year $t$. Industry-year fixed effects are based on SIC1 codes. Public-service, energy, and financial-services firms are dropped. Robust standard errors (clustered at the firm-year level) are in parentheses.
### Table 20

**Impact of Bank Information Acquisition on Market Capitalization: Robustness – Compustat Sample, Long-run Within-firm Effects**

<table>
<thead>
<tr>
<th></th>
<th>( \ln(\text{MarketCap}_{it}) )</th>
<th>( \ln(\text{MarketCap}_{it}) )</th>
<th>( \ln(\text{MarketCap}_{it}) )</th>
<th>( \ln(\text{MarketCap}_{it}) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loan from CB, underwriting from IB, both merged</td>
<td>0.061***</td>
<td>0.034**</td>
<td>0.008</td>
<td>0.001</td>
</tr>
<tr>
<td>Loan from CB that merged \times Underwriting from IB that merged</td>
<td>-0.069***</td>
<td>-0.042**</td>
<td>-0.028</td>
<td>-0.026</td>
</tr>
<tr>
<td>Loan from CB that merged</td>
<td>0.091***</td>
<td>0.034***</td>
<td>0.035***</td>
<td>0.039***</td>
</tr>
<tr>
<td>Underwriting from IB that merged</td>
<td>0.156***</td>
<td>0.053***</td>
<td>0.050***</td>
<td>0.049***</td>
</tr>
<tr>
<td>Any loan \times Any underwriting</td>
<td>0.099***</td>
<td>0.124***</td>
<td>0.116***</td>
<td>0.118***</td>
</tr>
<tr>
<td>Any loan</td>
<td>-0.177***</td>
<td>-0.232***</td>
<td>-0.225***</td>
<td>-0.215***</td>
</tr>
<tr>
<td>Any underwriting</td>
<td>0.032**</td>
<td>0.162***</td>
<td>0.158***</td>
<td>0.154***</td>
</tr>
<tr>
<td>Controls</td>
<td>N Y Y Y</td>
<td>N Y Y Y</td>
<td>N Y Y Y</td>
<td>N Y Y Y</td>
</tr>
<tr>
<td>Firm FE</td>
<td>Y Y Y Y</td>
<td>Y Y Y Y</td>
<td>Y Y Y Y</td>
<td>Y Y Y Y</td>
</tr>
<tr>
<td>Year FE</td>
<td>Y Y N N</td>
<td>Y Y N N</td>
<td>Y Y N N</td>
<td>Y Y N N</td>
</tr>
<tr>
<td>State-year FE</td>
<td>N N Y Y</td>
<td>N N Y Y</td>
<td>N N Y Y</td>
<td>N N Y Y</td>
</tr>
<tr>
<td>Industry-year FE</td>
<td>N N N N</td>
<td>N N N N</td>
<td>N N N N</td>
<td>N N N N</td>
</tr>
<tr>
<td>N</td>
<td>92,665</td>
<td>92,665</td>
<td>92,665</td>
<td>92,665</td>
</tr>
</tbody>
</table>

Notes: The sample consists of all available firm-year observations from Compustat, the unit of observation is the firm-year level \( it \). \( \text{MarketCap}_{it} \) is firm \( i \)'s market value of equity in year \( t \). \( \text{Loan from CB that merged}_{it} \) is an indicator variable for whether anytime from \( t-8 \) to \( t-1 \), firm \( i \) received a loan from a commercial or universal bank that merged with an investment bank thereafter. \( \text{Underwriting from IB that merged}_{it} \) is an indicator variable for whether anytime from \( t-8 \) to \( t-1 \), firm \( i \) received an underwriting product from an investment bank that merged with a commercial or universal bank thereafter. The interaction of the latter two indicator variables is to be distinguished from the explanatory variable of interest in the first row, which indicates whether anytime from \( t-8 \) to \( t-1 \), firm \( i \) received a loan from a commercial or universal bank, an underwriting product from an investment bank, and both banks merged with each other until year \( t \). \( \text{Any loan}_{it} \) and \( \text{Any underwriting}_{it} \) are indicator variables for whether firm \( i \) received any loan or any underwriting product, respectively, from any commercial, universal, or investment bank anytime from \( t-8 \) to \( t-1 \). Unless mentioned otherwise, control variables are measured in year \( t \), and include the log of firm \( i \)'s sales, the log of its number of employees, the log of the average ratio of deal size across all loans over firm \( i \)'s assets from \( t-8 \) to \( t-1 \), and the proportion of refinancing loans from \( t-8 \) to \( t-1 \). State-year fixed effects are based on firm \( i \)'s headquarter in year \( t \). Industry-year fixed effects are based on SIC1 codes. Public-service, energy, and financial-services firms are dropped. Robust standard errors (clustered at the firm-year level) are in parentheses.
Table 21
IMPACT OF BANK INFORMATION ACQUISITION ON OPTION-IMPLIED VOLATILITY – COMPUSTAT SAMPLE, LONG-RUN WITHIN-FIRM EFFECTS

<table>
<thead>
<tr>
<th>Term</th>
<th>ln($\sigma_{implied}^{i,t}$)</th>
<th>ln($\sigma_{implied}^{i,t}$)</th>
<th>ln($\sigma_{implied}^{i,t}$)</th>
<th>ln($\sigma_{implied}^{i,t}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loan from CB, underwriting from IB, both merged</td>
<td>0.055***</td>
<td>0.051***</td>
<td>0.027**</td>
<td>0.023**</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.011)</td>
<td>(0.011)</td>
<td>(0.011)</td>
</tr>
<tr>
<td>Loan from CB that merged × Underwriting from IB that merged</td>
<td>-0.045***</td>
<td>-0.042***</td>
<td>-0.034**</td>
<td>-0.031**</td>
</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td>(0.014)</td>
<td>(0.014)</td>
<td>(0.014)</td>
</tr>
<tr>
<td>Loan from CB that merged</td>
<td>-0.005</td>
<td>-0.011</td>
<td>-0.023*</td>
<td>-0.024*</td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
<td>(0.013)</td>
<td>(0.014)</td>
<td>(0.013)</td>
</tr>
<tr>
<td>Underwriting from IB that merged</td>
<td>0.028**</td>
<td>0.032***</td>
<td>0.018</td>
<td>0.015</td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
<td>(0.012)</td>
<td>(0.012)</td>
<td>(0.012)</td>
</tr>
<tr>
<td>Any loan × Any underwriting</td>
<td>0.072***</td>
<td>0.060***</td>
<td>0.052***</td>
<td>0.057***</td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.019)</td>
<td>(0.020)</td>
<td>(0.019)</td>
</tr>
<tr>
<td>Any loan</td>
<td>-0.046**</td>
<td>-0.057***</td>
<td>-0.036*</td>
<td>-0.037*</td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
<td>(0.021)</td>
<td>(0.022)</td>
<td>(0.021)</td>
</tr>
<tr>
<td>Any underwriting</td>
<td>-0.033***</td>
<td>-0.023**</td>
<td>-0.018*</td>
<td>-0.016</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.011)</td>
<td>(0.011)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Firm FE</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Year FE</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>State-year FE</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Industry-year FE</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>N</td>
<td>24,779</td>
<td>24,779</td>
<td>24,779</td>
<td>24,779</td>
</tr>
</tbody>
</table>

Notes: The sample consists of all available firm-year observations from Compustat, the unit of observation is the firm-year level. $\sigma_{implied}^{i,t}$ is firm $i$’s three-month implied volatility in year $t$, calculated using the volatility surface from option prices (source: Option Metrics), which is available only starting in 1996. Loan from CB that merged is an indicator variable for whether anytime from $t-10$ to $t-1$, firm $i$ received a loan from a commercial or universal bank that merged with an investment bank thereafter. Underwriting from IB that merged is an indicator variable for whether anytime from $t-10$ to $t-1$, firm $i$ received an underwriting product from an investment bank that merged with a commercial or universal bank thereafter. The interaction of the latter two indicator variables is to be distinguished from the explanatory variable of interest in the first row, which indicates whether anytime from $t-10$ to $t-1$, firm $i$ received a loan from a commercial or universal bank, an underwriting product from an investment bank, and both banks merged with each other until year $t$. Any loan and Any underwriting are indicator variables for whether firm $i$ received any loan or any underwriting product, respectively, from any commercial, universal, or investment bank anytime from $t-10$ to $t-1$. Unless mentioned otherwise, control variables are measured in year $t$, and include the log of firm $i$’s sales, the log of its number of employees, the log of the average ratio of deal size across all loans over firm $i$’s assets from $t-10$ to $t-1$, and the proportion of refinancing loans from $t-10$ to $t-1$. State-year fixed effects are based on firm $i$’s headquarters in year $t$. Industry-year fixed effects are based on SIC1 codes. Public-service, energy, and financial-services firms are dropped. Robust standard errors (clustered at the firm-year level) are in parentheses.
Table 22

**Summary Statistics for Universal Banks established through M&A and Section 20 Subsidiaries**

<table>
<thead>
<tr>
<th></th>
<th>M&amp;A</th>
<th>Section 20</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$t = -1$</td>
<td>$t = 0$</td>
<td>$t = 1$</td>
<td>$t = -1$</td>
<td>$t = 0$</td>
<td>$t = 1$</td>
<td></td>
</tr>
<tr>
<td>Total assets in 2010 $bn</td>
<td>513.7</td>
<td>1,110.2</td>
<td>1,101.0</td>
<td>47.82</td>
<td>51.54</td>
<td>52.33</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(129.3)</td>
<td>(305.3)</td>
<td>(230.4)</td>
<td>(33.11)</td>
<td>(35.26)</td>
<td>(36.22)</td>
<td></td>
</tr>
<tr>
<td>Total equity/assets in %</td>
<td>7.547</td>
<td>6.977</td>
<td>7.959</td>
<td>8.670</td>
<td>8.648</td>
<td>8.903</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.032)</td>
<td>(0.833)</td>
<td>(1.455)</td>
<td>(1.994)</td>
<td>(1.772)</td>
<td>(2.659)</td>
<td></td>
</tr>
<tr>
<td>Cash balance/assets in %</td>
<td>4.944</td>
<td>5.177</td>
<td>4.776</td>
<td>5.484</td>
<td>5.768</td>
<td>5.338</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.571)</td>
<td>(2.764)</td>
<td>(2.040)</td>
<td>(1.663)</td>
<td>(2.320)</td>
<td>(2.027)</td>
<td></td>
</tr>
<tr>
<td>Total loans/assets in %</td>
<td>65.78</td>
<td>51.77</td>
<td>51.86</td>
<td>66.95</td>
<td>67.03</td>
<td>67.96</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(7.724)</td>
<td>(23.02)</td>
<td>(20.76)</td>
<td>(6.654)</td>
<td>(6.744)</td>
<td>(6.349)</td>
<td></td>
</tr>
<tr>
<td>Net income in 2010 $bn</td>
<td>6.675</td>
<td>5.227</td>
<td>12.69</td>
<td>0.330</td>
<td>0.333</td>
<td>0.350</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.542)</td>
<td>(3.591)</td>
<td>(0.308)</td>
<td>(0.275)</td>
<td>(0.285)</td>
<td>(0.375)</td>
<td></td>
</tr>
<tr>
<td>EBIT in 2010 $bn</td>
<td>10.17</td>
<td>8.415</td>
<td>20.15</td>
<td>0.525</td>
<td>0.544</td>
<td>0.560</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.248)</td>
<td>(6.264)</td>
<td>(1.618)</td>
<td>(0.458)</td>
<td>(0.482)</td>
<td>(0.607)</td>
<td></td>
</tr>
<tr>
<td>No. of employees in thousands</td>
<td>132.2</td>
<td>227.9</td>
<td>228.2</td>
<td>14.20</td>
<td>15.44</td>
<td>15.34</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(39.06)</td>
<td>(60.74)</td>
<td>(55.33)</td>
<td>(9.815)</td>
<td>(10.13)</td>
<td>(10.18)</td>
<td></td>
</tr>
</tbody>
</table>

Notes: This table reports means with standard deviations in parentheses, for universal banks established through M&A in the first three columns and for Section 20 subsidiaries in the last three columns. The data are taken from the respective banks’ call reports. $t$ indicates the year of the respective call report, and $t = 0$ denotes the first call report after the bank becomes a universal bank, and $t = -1$ and $t = 1$ correspond to the call reports one year before and after the call report used for $t = 0$, respectively. Cash balance is the sum of non-interest-bearing balances and currency and coin, and interest-bearing balances in U.S. offices. EBIT is net income before income taxes, extraordinary items, and other adjustments on a fully taxable equivalent basis.
Chapter C

Appendix to “Does Bank Scope Improve Monitoring Incentives in Syndicated Lending?”

C.1 Tables

Table 23
Overview of Universal Banks
## Section 20

<table>
<thead>
<tr>
<th>Established before August 1, 1996</th>
<th>M&amp;A</th>
</tr>
</thead>
<tbody>
<tr>
<td>BankBoston (later acquired by Fleet)</td>
<td>Credit Suisse (First Boston)</td>
</tr>
<tr>
<td>Bankers Trust (later acquired by Bank of America)</td>
<td>Deutsche Bank USA</td>
</tr>
<tr>
<td>Bank of America</td>
<td>Equitable (later acquired by SunTrust)</td>
</tr>
<tr>
<td>Bank One (later acquired by J.P. Morgan)</td>
<td>HSBC Bank USA</td>
</tr>
<tr>
<td>Barnett Bank (later acquired by NationsBank)</td>
<td>Travelers Group*</td>
</tr>
<tr>
<td>Chase Manhattan (later acquired by J.P. Morgan)</td>
<td></td>
</tr>
<tr>
<td>Chemical Bank (later acquired by Chase Manhattan)</td>
<td>Citicorp*</td>
</tr>
<tr>
<td>Dauphin Deposit Corp.</td>
<td></td>
</tr>
<tr>
<td>First Chicago NBD</td>
<td></td>
</tr>
<tr>
<td>First Union</td>
<td></td>
</tr>
<tr>
<td>Fleet (later acquired by Bank of America)</td>
<td></td>
</tr>
<tr>
<td>Huntington Bancshares</td>
<td></td>
</tr>
<tr>
<td>J.P. Morgan</td>
<td></td>
</tr>
<tr>
<td>KeyBank</td>
<td></td>
</tr>
<tr>
<td>Marine Midland Bank (later acquired by HSBC Bank USA)</td>
<td></td>
</tr>
<tr>
<td>Mellon (later acquired by BNY)</td>
<td></td>
</tr>
<tr>
<td>National City (later acquired by PNC)</td>
<td></td>
</tr>
<tr>
<td>National Westminster Bank USA (later acquired by Fleet)</td>
<td></td>
</tr>
<tr>
<td>NationsBank (later acquired by Bank of America)</td>
<td></td>
</tr>
<tr>
<td>Norstar (later acquired by Fleet)</td>
<td></td>
</tr>
<tr>
<td>Norwest (later acquired by Wells Fargo)</td>
<td></td>
</tr>
<tr>
<td>PNC</td>
<td></td>
</tr>
<tr>
<td>Republic New York (later acquired by HSBC Bank USA)</td>
<td></td>
</tr>
<tr>
<td>SouthTrust (later acquired by Wachovia/First Union)</td>
<td></td>
</tr>
<tr>
<td>SunTrust</td>
<td></td>
</tr>
<tr>
<td>Union Bank of Switzerland</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Established on or after August 1, 1996</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BB&amp;T</td>
<td>Citigroup*</td>
</tr>
<tr>
<td>BNY</td>
<td>Swiss Bank Corp (later acquired by Union Bank of Switzerland)</td>
</tr>
<tr>
<td>Commerce Bancshares</td>
<td>Wells Fargo</td>
</tr>
<tr>
<td>CoreStates/Philadelphia National Bank (later acquired by First Union)</td>
<td></td>
</tr>
<tr>
<td>Crestar Bank</td>
<td></td>
</tr>
<tr>
<td>First Tennessee</td>
<td></td>
</tr>
<tr>
<td>U.S. Bancorp</td>
<td></td>
</tr>
<tr>
<td>Wachovia (first acquired by First Union and later by Wells Fargo)</td>
<td></td>
</tr>
</tbody>
</table>

*Citigroup emerged as a result of the merger of Travelers Group and Citicorp on October 8, 1998. Before, Travelers Group became a universal bank through M&A (e.g., with Smith Barney), and Citicorp had registered a Section 20 subsidiary. Given this merger of equals, we do not treat either one as the surviving entity and, instead, label Citigroup as a separate universal bank established through M&A in 1998.
<table>
<thead>
<tr>
<th>Package-bank level</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead arranger ∈ {0, 1}</td>
<td>0.180</td>
<td>0.384</td>
<td>0</td>
<td>1</td>
<td>170,578</td>
</tr>
<tr>
<td>Loan share ∈ [0, 1]</td>
<td>0.159</td>
<td>0.239</td>
<td>0.000</td>
<td>1</td>
<td>76,852</td>
</tr>
<tr>
<td>UB ∈ {0, 1}</td>
<td>0.366</td>
<td>0.482</td>
<td>0</td>
<td>1</td>
<td>170,578</td>
</tr>
<tr>
<td>UB × Cross-selling ∈ {0, 1}</td>
<td>0.099</td>
<td>0.299</td>
<td>0</td>
<td>1</td>
<td>170,578</td>
</tr>
<tr>
<td>Underwriting ∈ {0, 1}</td>
<td>0.920</td>
<td>0.271</td>
<td>0</td>
<td>1</td>
<td>170,578</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Package/loan level</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of unique package-bank observations</td>
<td>6.484</td>
<td>8.333</td>
<td>1</td>
<td>174</td>
<td>11,852</td>
</tr>
<tr>
<td>Average lead share ∈ [0, 1]</td>
<td>0.552</td>
<td>0.378</td>
<td>0.002</td>
<td>1</td>
<td>11,852</td>
</tr>
<tr>
<td>Loan share of single lead arranger ∈ [0, 1]</td>
<td>0.604</td>
<td>0.373</td>
<td>0.012</td>
<td>1</td>
<td>10,301</td>
</tr>
<tr>
<td>No. of lead arrangers</td>
<td>1.143</td>
<td>0.395</td>
<td>1</td>
<td>6</td>
<td>11,852</td>
</tr>
<tr>
<td>Concentration of loan shares ∈ [0, 1]</td>
<td>0.514</td>
<td>0.397</td>
<td>0.013</td>
<td>1</td>
<td>11,852</td>
</tr>
<tr>
<td>Average participant share ∈ [0, 1]</td>
<td>0.095</td>
<td>0.123</td>
<td>0.000</td>
<td>0.920</td>
<td>11,852</td>
</tr>
<tr>
<td>Bankruptcy within ten years ∈ {0, 1}</td>
<td>0.222</td>
<td>0.416</td>
<td>0</td>
<td>1</td>
<td>7,171</td>
</tr>
<tr>
<td>UB ∈ {0, 1}</td>
<td>0.672</td>
<td>0.470</td>
<td>0</td>
<td>1</td>
<td>11,852</td>
</tr>
<tr>
<td>Sales at close in 2010 $</td>
<td>3.011</td>
<td>10.634</td>
<td>0</td>
<td>377.110</td>
<td>11,852</td>
</tr>
<tr>
<td>No. of employees in thousands</td>
<td>10.195</td>
<td>29.993</td>
<td>0.001</td>
<td>487.901</td>
<td>11,852</td>
</tr>
<tr>
<td>$\sigma_{t-5, t}^{\text{return, }i}$</td>
<td>0.428</td>
<td>0.207</td>
<td>0.114</td>
<td>3.886</td>
<td>7,250</td>
</tr>
<tr>
<td>$\sigma_{t-5, t}^{\text{idiosyncratic, }i}$</td>
<td>0.384</td>
<td>0.201</td>
<td>0.104</td>
<td>3.928</td>
<td>7,250</td>
</tr>
</tbody>
</table>

Notes: The sample consists of all loans successfully issued by publicly listed firms. In the first panel, observations are at the package-bank level, i.e., each package comprises multiple observations, but only one observation per (participating or lead) bank. In the second panel, observations are at the (aggregate) package/loan level. In general, summary statistics are shown for our regression sample with data available on participating and lead-arranger banks, excluding the availability of data for sales, no. of employees, and deal size/assets. Only in the second panel, the regression sample is furthermore conditioned on the availability of data for Loan share, which is the share (between 0 and 1) of the loan retained by a bank. Lead arranger is an indicator variable for whether the bank in question is a lead arranger. UB is an indicator variable for whether at the time of the loan transaction the (participating or lead) bank was a universal bank. Cross-selling is an indicator for whether the universal bank’s loan share in year $t$ was associated with a cross-sold underwriting product by the same universal bank from $t - 2$ to $t + 2$. Underwriting indicates whether the borrower firm received an underwriting product from any universal or investment bank from $t - 2$ to $t + 2$. At the package level, Concentration of loan shares is a Herfindahl index which is equal to the sum of the squared loan shares of all (participating or lead) banks in the syndicate, and varies from zero to one (maximal concentration). Bankruptcy within ten years ∈ {0, 1} is an indicator variable for whether the borrowing company was delisted for bankruptcy-related reasons in the ten years following the loan-issue year. Bankruptcy is identified using the following CRSP delisting codes: any type of liquidation (400-490); price fell below acceptable level; insufficient capital, surplus, and/or equity; insufficient (or non-compliance with rules of) float or assets; company request, liquidation; bankruptcy, declared insolvent; delinquent in filing; non-payment of fees; does not meet exchange’s financial guidelines for continued listing; protection of investors and the public interest; corporate governance violation; and delist required by Securities Exchange Commission (SEC). $\sigma_{t-5, t}^{\text{return, }i}$ is the six-year standard deviation of borrower firm $i$’s stock return from year $t - 5$ to year $t$, and is expressed in annualized terms. $\sigma_{t-5, t}^{\text{idiosyncratic, }i}$ is firm $i$’s corresponding idiosyncratic volatility, estimated from the Fama and French (1993) three-factor model using monthly CRSP data, and is also expressed in annualized terms.
Table 25

**Impact of Universal-bank Financing on Lead-arranger Status – Package-bank Level**

<table>
<thead>
<tr>
<th></th>
<th>Lead arranger ∈ {0, 1}</th>
</tr>
</thead>
<tbody>
<tr>
<td>UB</td>
<td>0.020*** 0.045*** 0.044*** 0.043*** 0.022***</td>
</tr>
<tr>
<td></td>
<td>(0.009) (0.008) (0.008) (0.008) (0.009)</td>
</tr>
<tr>
<td>UB est. before 1996</td>
<td>-0.002 -0.050*** -0.042*** -0.039*** -0.022*</td>
</tr>
<tr>
<td></td>
<td>(0.011) (0.010) (0.010) (0.010) (0.012)</td>
</tr>
<tr>
<td>UB est. before 1996 × After(1996)</td>
<td>0.097*** 0.116*** 0.115*** 0.115*** 0.115***</td>
</tr>
<tr>
<td></td>
<td>(0.006) (0.006) (0.005) (0.005) (0.006)</td>
</tr>
<tr>
<td>Log of sales at close in 2010 $</td>
<td>-0.029***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
</tr>
<tr>
<td>Log of no. employees</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
</tr>
<tr>
<td>Bank FE</td>
<td>Y Y Y Y Y Y</td>
</tr>
<tr>
<td>Package FE</td>
<td>N N N N N Y</td>
</tr>
<tr>
<td>Industry-year FE</td>
<td>N N Y Y N</td>
</tr>
<tr>
<td>Syndicate FE</td>
<td>N Y Y Y N</td>
</tr>
<tr>
<td>Year FE</td>
<td>Y Y N N N</td>
</tr>
<tr>
<td>N</td>
<td>170,578 170,578 170,578 170,578 170,578</td>
</tr>
</tbody>
</table>

Notes: The sample consists of all loans successfully issued by publicly listed firms. Observations are at the package-bank level, i.e., each package comprises multiple observations, but only one observation per (participating or lead) bank. *Lead arranger* is an indicator variable for whether the bank in question is a lead arranger. *UB* and *UB est. before 1996* are indicator variables for whether at the time of the loan transaction the (participating or lead) bank was a universal bank anytime or before August 1, 1996, respectively. *After(1996)* is an indicator variable for whether the loan was issued on or after August 1, 1996. Bank fixed effects, which are defined at the package-bank level, and syndicate fixed effects for all participating and lead banks at the package level are included for all banks that were or eventually became universal banks, whereas all remaining commercial banks are grouped together in one category. Industry-year fixed effects are based on two-digit SIC codes of borrower firms. Robust standard errors (clustered at the package level) are in parentheses.
Table 26
**Impact of Universal-bank Financing on Lead-arranger Status – Package-bank Level, Robustness**

<table>
<thead>
<tr>
<th>Lead arranger ∈ {0, 1}</th>
<th>UB</th>
<th>UB est. before 1996</th>
<th>UB est. before 1996 × After(1996)</th>
<th>Log of sales at close in 2010 $</th>
<th>Log of no. employees</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.042***</td>
<td>-0.053***</td>
<td>0.100***</td>
<td>-0.041***</td>
<td>-0.000</td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
<td>(0.015)</td>
<td>(0.008)</td>
<td>(0.003)</td>
<td>(0.002)</td>
</tr>
<tr>
<td></td>
<td>0.059***</td>
<td>-0.069***</td>
<td>0.136***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
<td>(0.014)</td>
<td>(0.008)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.054***</td>
<td>-0.058***</td>
<td>0.134***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
<td>(0.014)</td>
<td>(0.008)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.053***</td>
<td>-0.057***</td>
<td>0.131***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
<td>(0.014)</td>
<td>(0.007)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.007</td>
<td>-0.009</td>
<td>0.102***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
<td>(0.016)</td>
<td>(0.008)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Bank FE                   | Y        | Y        | Y        | Y        | Y        |
| Pack. FE                 | N        | N        | N        | N        | Y        |
| Industry-year FE         | N        | N        | Y        | Y        | N        |
| Syndicate FE             | N        | Y        | Y        | Y        | N        |
| Year FE                  | Y        | Y        | N        | N        | N        |

N 76,852 76,852 76,852 76,852 76,852

Notes: The sample consists of all loans successfully issued by publicly listed firms. Observations are at the package-bank level, i.e., each package comprises multiple observations, but only one observation per (participating or lead) bank. Only observations with valid loan-share data are included, as in Table 27. Lead arranger is an indicator variable for whether the bank in question is a lead arranger. UB and UB est. before 1996 are indicator variables for whether at the time of the loan transaction the (participating or lead) bank was a universal bank anytime or before August 1, 1996, respectively. After(1996) is an indicator variable for whether the loan was issued on or after August 1, 1996. Bank fixed effects, which are defined at the package-bank level, and syndicate fixed effects for all participating and lead banks at the package level are included for all banks that were or eventually became universal banks, whereas all remaining commercial banks are grouped together in one category. Industry-year fixed effects are based on two-digit SIC codes of borrower firms. Robust standard errors (clustered at the package level) are in parentheses.
Table 27

<table>
<thead>
<tr>
<th></th>
<th>Loan share ∈ [0, 1]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.009</td>
</tr>
<tr>
<td></td>
<td>0.033***</td>
</tr>
<tr>
<td></td>
<td>0.029***</td>
</tr>
<tr>
<td></td>
<td>0.027***</td>
</tr>
<tr>
<td></td>
<td>-0.011***</td>
</tr>
<tr>
<td>UB</td>
<td>(0.007)</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
</tr>
<tr>
<td>UB est. before 1996</td>
<td>-0.022***</td>
</tr>
<tr>
<td></td>
<td>-0.043***</td>
</tr>
<tr>
<td></td>
<td>-0.034***</td>
</tr>
<tr>
<td></td>
<td>-0.034***</td>
</tr>
<tr>
<td></td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
</tr>
<tr>
<td>UB est. before 1996 ×</td>
<td>0.010*</td>
</tr>
<tr>
<td>After(1996)</td>
<td>0.052***</td>
</tr>
<tr>
<td></td>
<td>0.049***</td>
</tr>
<tr>
<td></td>
<td>0.046***</td>
</tr>
<tr>
<td></td>
<td>0.011***</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
</tr>
<tr>
<td>Log of sales at close</td>
<td>0.001</td>
</tr>
<tr>
<td>in 2010 $</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Log of no. employees</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
</tr>
<tr>
<td>Bank FE</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>Package FE</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>Industry-year FE</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Syndicate FE</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Year FE</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td>N</td>
<td>76,852</td>
</tr>
<tr>
<td></td>
<td>76,852</td>
</tr>
<tr>
<td></td>
<td>76,852</td>
</tr>
<tr>
<td></td>
<td>76,852</td>
</tr>
<tr>
<td></td>
<td>76,852</td>
</tr>
</tbody>
</table>

Notes: The sample consists of all loans successfully issued by publicly listed firms. Observations are at the package-bank level, i.e., each package comprises multiple observations, but only one observation per (participating or lead) bank. Lead arranger is an indicator variable for whether the bank in question is a lead arranger. Loan share is the share (between 0 and 1) of the loan retained by a bank. UB and UB est. before 1996 are indicator variables for whether at the time of the loan transaction the (participating or lead) bank was a universal bank anytime or before August 1, 1996, respectively. After(1996) is an indicator variable for whether the loan was issued on or after August 1, 1996. Bank fixed effects, which are defined at the package-bank level, and syndicate fixed effects for all participating and lead banks at the package level are included for all banks that were or eventually became universal banks, whereas all remaining commercial banks are grouped together in one category. Industry-year fixed effects are based on two-digit SIC codes of borrower firms. Robust standard errors (clustered at the package level) are in parentheses.
### Table 28
**Impact of Cross-selling by Universal Banks on Syndicate Structure – Package-bank Level**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Lead arranger $\in {0,1}$</th>
<th>Lead arranger $\in {0,1}$</th>
<th>Loan share $\in [0,1]$</th>
<th>Availability of loan shares</th>
</tr>
</thead>
<tbody>
<tr>
<td>UB</td>
<td>0.094*** 0.029 0.081*** 0.052 0.001 0.013**</td>
<td>(0.010) (0.025) (0.015) (0.033) (0.004) (0.007)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UB $\times$ Cross-selling</td>
<td>0.470*** 0.475*** 0.475*** 0.488*** 0.048*** 0.049***</td>
<td>(0.005) (0.005) (0.008) (0.008) (0.002) (0.002)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UB $\times$ Underwriting</td>
<td>-0.134*** -0.141*** -0.128*** -0.136*** -0.015*** -0.017***</td>
<td>(0.009) (0.008) (0.013) (0.012) (0.004) (0.003)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underwriting</td>
<td>-0.002 0.025 0.045 -0.007 -0.068*** -0.041</td>
<td>(0.040) (0.040) (0.135) (0.146) (0.024) (0.042)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bank FE</td>
<td>Y N Y N Y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bank-year FE</td>
<td>N Y N Y N</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Package FE</td>
<td>Y Y Y Y Y</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N: 170,578 170,578 76,852 76,852 76,852 76,852

Notes: The sample consists of all loans successfully issued by publicly listed firms. Observations are at the package-bank level, i.e., each package comprises multiple observations, but only one observation per (participating or lead) bank. In the last four columns, only observations with valid loan-share data are included, as in Tables 26 and 27. Loan share is the share (between 0 and 1) of the loan retained by a bank. UB is an indicator variable for whether at the time of the loan transaction the (participating or lead) bank was a universal bank. Cross-selling is an indicator for whether the universal bank’s loan share in year $t$ was associated with a cross-sold underwriting product by the same universal bank from $t-2$ to $t+2$. Underwriting indicates whether the borrower firm received an underwriting product from any universal or investment bank from $t-2$ to $t+2$. Bank(-year) fixed effects are included for all banks that were or eventually became universal banks, whereas all remaining commercial banks are grouped together in one category. Robust standard errors (clustered at the package level) are in parentheses.
### Table 29
**Impact of Universal-bank Financing on Lead Shares – Package Level**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Average lead share ∈ [0,1]</th>
<th>All</th>
<th>All</th>
<th>All</th>
<th>One LA</th>
</tr>
</thead>
<tbody>
<tr>
<td>UB</td>
<td></td>
<td>-0.292***</td>
<td>-0.284***</td>
<td>-0.264***</td>
<td>-0.263***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>UB × After(1996)</td>
<td></td>
<td>-0.045***</td>
<td>-0.039***</td>
<td>-0.027***</td>
<td>-0.020**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.010)</td>
<td>(0.010)</td>
<td>(0.010)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Log of sales at close in 2010 $</td>
<td></td>
<td>-0.043***</td>
<td>-0.042***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.002)</td>
<td>(0.003)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log of no. employees</td>
<td></td>
<td>0.003</td>
<td>0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Syndicate FE</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Industry-year FE</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Year FE</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>11,852</td>
<td>11,852</td>
<td>11,852</td>
<td>10,301</td>
<td></td>
</tr>
</tbody>
</table>

Notes: In general, the sample consists of all loans successfully issued by publicly listed firms. Observations are at the (aggregate) package/loan level. The sample in the fourth column is limited to loans with one lead arranger. The dependent variable corresponds to the (average) share of the loan retained by the lead arranger(s), and is defined between 0 and 1. UB is an indicator variable for whether at the time of the loan transaction any one of the (participating or lead) banks was a universal bank. After(1996) is an indicator variable for whether the loan was issued on or after August 1, 1996. Syndicate fixed effects for all participating and lead banks at the package level are included for all banks that were or eventually became universal banks, whereas all remaining commercial banks are grouped together in one category. Industry-year fixed effects are based on two-digit SIC codes of borrower firms. Robust standard errors (clustered at the package level) are in parentheses.
Table 30

**Impact of Universal-bank Financing on Concentration of Loan Shares – Package Level**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Concentration of loan shares ∈ [0, 1]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
</tr>
<tr>
<td>UB</td>
<td>-0.331***</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
</tr>
<tr>
<td>UB × After(1996)</td>
<td>-0.050***</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
</tr>
<tr>
<td>Log of sales at close in 2010 $</td>
<td>-0.039***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
</tr>
<tr>
<td>Log of no. employees</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
</tr>
<tr>
<td>Syndicate FE</td>
<td>Y</td>
</tr>
<tr>
<td>Industry-year FE</td>
<td>N</td>
</tr>
<tr>
<td>Year FE</td>
<td>Y</td>
</tr>
<tr>
<td>N</td>
<td>11,852</td>
</tr>
</tbody>
</table>

Notes: In general, the sample consists of all loans successfully issued by publicly listed firms. Observations are at the (aggregate) package/loan level. The sample in the fourth column is limited to loans with one lead arranger. The dependent variable is a Herfindahl index which is equal to the sum of the squared loan shares of all (participating or lead) banks in the syndicate, and varies from zero to one (maximal concentration). UB is an indicator variable for whether at the time of the loan transaction any one of the (participating or lead) banks was a universal bank. After(1996) is an indicator variable for whether the loan was issued on or after August 1, 1996. Syndicate fixed effects for all participating and lead banks at the package level are included for all banks that were or eventually became universal banks, whereas all remaining commercial banks are grouped together in one category. Industry-year fixed effects are based on two-digit SIC codes of borrower firms. Robust standard errors (clustered at the package level) are in parentheses.
Table 31

**Impact of Universal-bank Financing on Participant Shares – Package Level**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Average participant share $\in [0, 1]$</th>
<th>All</th>
<th>All</th>
<th>All</th>
<th>One LA</th>
</tr>
</thead>
<tbody>
<tr>
<td>UB</td>
<td>0.099***</td>
<td>0.098***</td>
<td>0.095***</td>
<td>0.099***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.005)</td>
<td></td>
</tr>
<tr>
<td>UB \times After(1996)</td>
<td>0.009</td>
<td>0.007</td>
<td>0.005</td>
<td>0.010</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td></td>
</tr>
<tr>
<td>Log of sales at close in 2010 $\text{$}$</td>
<td>0.007***</td>
<td>0.009***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.002)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log of no. employees</td>
<td>0.001</td>
<td>0.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Syndicate FE</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Industry-year FE</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Year FE</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
</tbody>
</table>

| N               | 11,852 | 11,852 | 11,852 | 10,301 |

Notes: In general, the sample consists of all loans successfully issued by publicly listed firms. Observations are at the (aggregate) package/loan level. The sample in the fourth column is limited to loans with one lead arranger. The dependent variable corresponds to the average share of the loan retained by the participants (but not by any lead arranger), and is defined between 0 and 1. UB is an indicator variable for whether at the time of the loan transaction any one of the (participating or lead) banks was a universal bank. After(1996) is an indicator variable for whether the loan was issued on or after August 1, 1996. Syndicate fixed effects for all participating and lead banks at the package level are included for all banks that were or eventually became universal banks, whereas all remaining commercial banks are grouped together in one category. Industry-year fixed effects are based on two-digit SIC codes of borrower firms. Robust standard errors (clustered at the package level) are in parentheses.
Table 32
IMPACT OF UNIVERSAL-BANK FINANCING ON LEAD SHARES – PACKAGE LEVEL,
COMPARATIVE STATICS

<table>
<thead>
<tr>
<th>Sample</th>
<th>Average lead share ∈ [0, 1]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Less stock-return volatility</td>
</tr>
<tr>
<td>UB</td>
<td>-0.303*** (-0.019)</td>
</tr>
<tr>
<td></td>
<td>-0.294*** (-0.018)</td>
</tr>
<tr>
<td>UB × After(1996)</td>
<td>-0.067** (0.032)</td>
</tr>
<tr>
<td></td>
<td>-0.084** (0.034)</td>
</tr>
<tr>
<td>Log of sales at close in 2010 $</td>
<td>-0.035*** (0.005)</td>
</tr>
<tr>
<td></td>
<td>-0.035*** (0.005)</td>
</tr>
<tr>
<td>Log of no. employees</td>
<td>0.005** (0.003)</td>
</tr>
<tr>
<td></td>
<td>0.006*** (0.003)</td>
</tr>
<tr>
<td>Syndicate FE</td>
<td>Y</td>
</tr>
<tr>
<td>Industry-year FE</td>
<td>Y</td>
</tr>
<tr>
<td>N</td>
<td>3,625</td>
</tr>
</tbody>
</table>

Notes: In general, the sample consists of all loans successfully issued by publicly listed firms. Observations are at the (aggregate) package/loan level. In the first and second column, we limit the sample to loans that are associated with six-year firm-level stock-return volatility (from \( t - 5 \) to \( t \)) in the bottom and top 50%, respectively. In the third and fourth column, we limit the sample to loans that are associated with six-year idiosyncratic volatility (from \( t - 5 \) to \( t \)) in the bottom and top 50%, respectively. The dependent variable corresponds to the (average) share of the loan retained by the lead arranger(s), and is defined between 0 and 1. UB is an indicator variable for whether at the time of the loan transaction any one of the (participating or lead) banks was a universal bank. After(1996) is an indicator variable for whether the loan was issued on or after August 1, 1996. Syndicate fixed effects for all participating and lead banks at the package level are included for all banks that were or eventually became universal banks, whereas all remaining commercial banks are grouped together in one category. Industry-year fixed effects are based on two-digit SIC codes of borrower firms. Robust standard errors (clustered at the package level) are in parentheses.
<table>
<thead>
<tr>
<th>Sample</th>
<th>Bankruptcy within ten years $\in {0, 1}$</th>
<th>All</th>
<th>All</th>
<th>All</th>
<th>One LA</th>
</tr>
</thead>
<tbody>
<tr>
<td>UB</td>
<td>-0.057*** -0.060*** -0.038** -0.041**</td>
<td>(0.016)</td>
<td>(0.017)</td>
<td>(0.017)</td>
<td>(0.018)</td>
</tr>
<tr>
<td>UB $\times$ After(1996)</td>
<td>-0.002 0.002 0.011 0.013</td>
<td>(0.026)</td>
<td>(0.029)</td>
<td>(0.028)</td>
<td>(0.029)</td>
</tr>
<tr>
<td>Log of sales at close in 2010 $$</td>
<td>-0.057*** -0.061***</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log of no. employees</td>
<td>0.012** 0.014**</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td></td>
<td></td>
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<tr>
<td>Syndicate FE</td>
<td>Y Y Y Y</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Industry-year FE</td>
<td>N Y Y Y</td>
<td></td>
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<tr>
<td>Year FE</td>
<td>Y N N N</td>
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<tr>
<td>N</td>
<td>7,171 7,171 7,171 6,722</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Notes: In general, the sample consists of all loans successfully issued by publicly listed firms. Observations are at the (aggregate) package/loan level. The sample in the fourth column is limited to loans with one lead arranger. The dependent variable is an indicator variable for whether the borrowing company was delisted for bankruptcy-related reasons in the ten years following the loan-issue year. Bankruptcy is identified using the following CRSP delisting codes: any type of liquidation (400-490); price fell below acceptable level; insufficient capital, surplus, and/or equity; insufficient (or non-compliance with rules of) float or assets; company request, liquidation; bankruptcy, declared insolvent; delinquent in filing; non-payment of fees; does not meet exchange’s financial guidelines for continued listing; protection of investors and the public interest; corporate governance violation; and delist required by Securities Exchange Commission (SEC). $UB$ is an indicator variable for whether at the time of the loan transaction any one of the (participating or lead) banks was a universal bank. $After(1996)$ is an indicator variable for whether the loan was issued on or after August 1, 1996. Syndicate fixed effects for all participating and lead banks at the package level are included for all banks that were or eventually became universal banks, whereas all remaining commercial banks are grouped together in one category. Industry-year fixed effects are based on two-digit SIC codes of borrower firms. Robust standard errors (clustered at the package level) are in parentheses.
C.2 Proofs

Proof of Proposition 18

Because \( c(\cdot) \) is strictly convex, borrowing costs are minimized by providing equal shares to all lenders. Since \( \xi_n^* > \frac{1}{N} \) to all banks, providing a loan share \( \frac{1}{N} \) is inconsistent with monitoring. Hence, the firm must provide a share greater than \( \frac{1}{N} \) to at least one bank to induce monitoring. Since the firm requires only one bank to monitor, it chooses the one with the lowest required share. This is bank \( n^* \). To minimize borrowing costs conditional on the choice of lead arranger, the firm then provides equal shares to all remaining banks.

Proof of Proposition 20

Here, we fully characterize the optimal contract under asymmetric information. Recall that the optimal contract is the solution to the following program:

\[
\begin{align*}
v &= \max_{\{w(\cdot), \kappa_1(\cdot)\}} \sum_z \Pr(z) \left[ Q^*(z) (X - w(\hat{z}^*)(z)) - \kappa_1(\hat{z}^*)(z) \right] \\
\text{s.t} \quad (i) & \quad \text{for every } (z, \hat{z}) \\
& \quad a^*(z, \hat{z}) = \arg\max_a Q(a, z, \hat{z}) w(\hat{z}) + \kappa_1(\hat{z}) - c(a, z) \\
& \quad (ii) \quad \text{for every } z \\
& \quad \hat{z}^*(z) = \arg\max_{z'} Q(a^*(z, z'), z, z') w(z') + \kappa_1(z') - c(a^*(z, z'), z) \\
& \quad (iii) \quad w(z) \geq 0 \quad \text{for every } z,
\end{align*}
\]

and \( v \) is the borrower’s pledgeable income. We solve this problem by first deriving the optimal contract within each contract class, and then characterize which contract class is optimal. Throughout, we sometimes ease notation by specializing (IC). In particular, we say that the pair \( \{w, \kappa\} \) provides incentives to implement the growth option if \( \kappa \geq k_1 \) and

\[ q^h w \geq pw + \kappa, \quad (IMP) \]

and that \( \{w, \kappa\} \) provides incentives to deter the gamble if

\[ pw \geq q^l w. \quad (DET) \]

To further simplify notation, we denote the optimal contract within each contract class by an asterisk throughout the Appendix. We also make use of the fact that it is never optimal to provide additional capital beyond the required \( k_1 \): in any optimal contract, we must have \( \kappa_1(z) \leq k_1 \) for all \( z \).

Optimal Implementation Contract

In an implementation contract, the bank provides incentives to implement the growth option, but does not provide incentives to deter the gamble. Since we want to implement the growth option, we have that \( \kappa_1(h) = k_1 \), and since we are considering an implementation contract, \( \{w(h), k_1\} \) satisfies (IMP) but not (DET), and \( \{w(l), \kappa_1(l)\} \) does not satisfy (DET).

First, suppose that \( \{w(l), \kappa_1(l)\} \) satisfies (IMP). Then it must be the case that \( \kappa_1(l) = k_1 \), since the growth option cannot be implemented otherwise. Since \( \{w(h), \kappa_1(h)\} \) and \( \{w(l), \kappa_1(l)\} \) both satisfy (IMP) but not (DET), the borrower always chooses the same action in every state. Since (REV) requires that the borrower’s report maximize the borrower’s payoff given its action, we must have \( q^h w(l) = q^h w(h) \) and \( q^l w(l) = q^l w(h) \). Otherwise, the firm would always prefer to report the state in which its expected wages are higher. Using the latter condition, program (P) can be specialized
We now characterize the optimal full-incentive contract. We proceed in two steps. First, we characterize the optimal full-incentive contract; that is, we consider the case in which the same contract; that is, we consider the case in which the same

\[ v = \max_{w(h)} \gamma \left( q^h(X - w(h)) - k_1 \right) + (1 - \gamma) \left( q'(X - w(h)) - k_1 \right) \quad (P') \]

\[ \text{s.t.} \quad q^h w(h) \geq pw(h) + k_1, \quad (29) \]

where (29) will be binding at the optimum. Let \( w^* \) denote the solution to this program. Since \( p_2 \geq q^h_2 > 0 \), it must be the case that \( w^*_2 = 0 \). We then ask whether the bank prefers to pay wages to the borrower in state 1 or in state 3. If the bank pays wages in state 1, providing \( \Delta \) units of incentives requires wages of \( \Delta \frac{q^h_1}{q^h_1 - p_2} \). The expected cost of providing \( \Delta \) units of incentives using wage payments in state 1 is thus \( \Delta \frac{q^h_1 + (1 - \gamma)q^h_1}{q^h_1 - p_2} \). By the analogous argument, the cost of providing \( \Delta \) units of incentives using wage payments in state 3 is \( \Delta \frac{q^h_3 + (1 - \gamma)q^h_3}{q^h_3 - p_3} \). As such, it is cheaper to provide incentives in state 3 than in state 1 if and only if

\[ \frac{1}{q^h_3 - p_3} < \frac{1}{q^h_1 - p_1}. \quad (30) \]

Since \( q^h_3 > p_3 \) and \( q^h_1 > p_1 \), by assumption, Assumptions 4 and 5 jointly imply that \( q^h_3 > q^h_3 \) and \( q^h_1 \leq q^h_1 \). In addition, we know from Assumption 5 that

\[ \frac{q^h_3}{q^h_3 - p_3} < \frac{q^h_1}{q^h_1 - p_1}. \]

Hence it follows that \( q^h_3 < q^h_3 \) and \( q^h_1 > q^h_1 \), and

\[ \frac{1}{q^h_3 - p_3} < \frac{1}{q^h_3 - p_3} < \frac{1}{q^h_1 - p_1} < \frac{1}{q^h_1 - p_1}. \]

Therefore, (30) is always satisfied given Assumption 5, so we have \( \{ w^*(l), \kappa^*_1(l) \} = \{ w^*(h), \kappa^*_1(h) \} = \{ \overline{w}(h), k_1 \} \).

Next, suppose that \( \{ w(l), \kappa_1(l) \} \) does not satisfy (IMP). The binding revelation constraint in state \( l \) is then given by

\[ q^l w(l) + \kappa_1(l) = q^l w(h) + k_1. \]

Since \( \{ w(h), k_1 \} \) satisfies (IMP), we can again specialize program (P) to (P'). Equation (31) implies that we again have \( \{ w^*(l), \kappa^*_1(l) \} = \{ w^*(h), \kappa^*_1(h) \} = \{ \overline{w}(h), k_1 \} \) whenever (30) is satisfied, which we have shown to be the case. Hence, the firm receives expected wages \( \overline{W}' = (1 - \gamma)k_1 + \overline{q} \frac{q^h}{q^h - p_3} = \overline{W} \), and pledgeable income is \( \overline{I} = \overline{q}X - \gamma k_1 - \overline{W}' \).

**Optimal Deterrence Contract**

In a deterrence contract, the bank provides incentives to deter the gamble, but does not provide incentives to implement the growth option. It is easy to verify that \( w = 0 \) provides incentives to deter the gamble. Hence, the contract \( \{ 0, 0, 0, 0 \} \) deters the gamble in every state of the world. By the limited-liability constraint \( w \geq 0 \), we also know that \( \{ w^*(l), \kappa^*_1(l) \} = \{ w^*(h), \kappa^*_1(h) \} = \{ 0, 0 \} \) is the deterrence contract that maximizes pledgeable income. The firm receives expected wages \( \overline{W}^D = 0 \), and pledgeable income is \( \overline{I}^D = pX \).

**Optimal Full-incentive Contract**

We now characterize the optimal full-incentive contract. We proceed in two steps. First, we characterize the optimal full-incentive pooling contract; that is, we consider the case in which the same
contract is offered in every state of the world, independently of the firm’s report. Second, we characterize the optimal full-incentive separating contract, in which the firm receives state-contingent contracts based on its report, subject to a truth-telling constraint. We then discuss whether a pooling or a separating full-incentive contract is preferred.

**Step 1: Optimal full-incentive pooling contract**

We look for a pooling contract in which \( \{w, \kappa_1\} \) is offered in every state of the world, and satisfies both (DET) and (IMP). Since this is a pooling contract, truth-telling constraints are irrelevant. Given that we want to implement the growth option in the high state, we must have \( \kappa_1 = k_1 \). The contracting problem can then be stated as:

\[
\begin{align*}
 v = \max_w & \quad \gamma \left( q^h(X - w) - k_1 \right) + (1 - \gamma) \left( p(X - w) - k_1 \right) \quad (P^*) \\
 \text{s.t.} & \quad q^h w \geq pw + k_1 \\
 & \quad pw \geq q^l w \\
 & \quad w \geq 0. 
\end{align*}
\]

As before, we let \( w^* \) denote the solution to this program.

**Lemma 7.** The implementation constraint (32) and the deterrence constraint (33) are binding.

**Proof.** Suppose that (32) is not binding, and that \( w_i > 0 \) for at least one \( i \). Then the bank can reduce expected wages by offering \( w = 0 \). But this violates (32). Hence, (32) must be binding. Next, suppose that (33) does not bind. By Assumption 5, the bank will satisfy (32) by offering wages only after \( X_3 \). But by Assumption 4, doing so violates (33), and hence (33) cannot be slack. It is easy to show that the bank will never offer wages in state 1. In particular, in our proof of the optimal implementation contract, we have shown that

\[
\frac{\gamma q^h_3 + (1 - \gamma)p_3}{q^h_3 - p_3} < \frac{\gamma q^h_1 + (1 - \gamma)p_1}{q^h_1 - p_1},
\]

Therefore, it is cheaper to satisfy (32) by offering wages in state 3 than in state 1. Since \( q^l_3 - p_3 < q^l_1 - p_1 \), paying any given wage in state 3 rather than state 1 also relaxes (33). To maximize pledgeable income, calibrate the optimal full-incentive pooling contract from \( w = 0 \), noting that (33) holds while (32) is violated at \( w = 0 \). Given that we must have \( w_1 = 0 \), we must increase \( w_3 \) to satisfy (32). But increasing \( w_3 \) while holding the remaining elements of \( w \) fixed violates (33). Hence, we must increase \( w_2 \) simultaneously. The cheapest way to do so is such that (33) holds exactly. Differentiating (33) yields the requirement:

\[
\frac{\partial w_2}{\partial w_3} = \xi
\]

with \( \xi \equiv \frac{q^l_2 - p_2}{q^h_2 - p_2} \). We then choose the change in \( w_3 \) such that (32) holds with equality. This requires a wage payment of \( \omega \equiv \frac{k_1}{(q^h_3 - p_3) - \xi(q^h_2 - p_2)} \) in state 3. Hence \( w^* = \{0, \omega, \omega\} \). The firm receives expected wages \( W^{FI}_{Pooling} = \hat{q}_2 \xi \omega + \hat{q}_3 \omega + (1 - \gamma)k_1 \), and pledgeable income is \( v^{FI}_{Pooling} = \hat{q}X - \gamma k_1 - W^{FI}_{Pooling} \). Given our parametric assumptions, it follows directly that \( W^{FI}_{Pooling} > W^I \).

**Step 2: Optimal full-incentive separating contract**

We now characterize the optimal full-incentive separating contract. To do so, we first define a particular class of wage schedules:

**Definition 11.** \( w \) is a pure-equity wage schedule if \( w = \alpha X \) for some \( \alpha \in [0, 1] \).

These wage schedules are useful for the following reason:

**Corollary 11.** Any pure-equity wage schedule satisfies (DET).

**Proof.** Follows from \( q^l X < pX \).
A full-incentive separating contract consists of a menu \( \{w(h), \kappa_1(h), w(l), \kappa_1(l)\} \) in which \( \{w(h), \kappa_1(h)\} \) satisfies (IMP) and \( \{w(l), \kappa_1(l)\} \) satisfies (DET). We begin by showing that a contract in which \( \{w(h), \kappa_1(h)\} \) also satisfies (DET) cannot improve upon a full-incentive pooling contract.

**Lemma 8** (Partial Payoff Equivalence of Pooling and Separating Contracts). Let \( \{w(h), \kappa_1(h)\} \) satisfy both (IMP) and (DET) under a full-incentive separating contract. Then the maximum attainable payoff is the same as under a full-incentive pooling contract.

*Proof.* Since \( \{w(h), \kappa_1(h)\} \) satisfies (DET), the revelation constraint in state \( l \) is given by

\[
 pw(l) \geq pw(h) + \kappa_1.
\]

Since this constraint must bind in equilibrium, we have that

\[
 pw(l) = pw(h) - \kappa_1.
\]

We know that there always exists a pure-equity \( w(l) \) that delivers this value and satisfies (DET). Next, we must pick \( w(h) \) to be the highest-value repayment schedule that satisfies (IMP) and (DET). From the previous step, we know that this is the optimal full-incentive pooling contract. Computing expected values under the restriction in (35) delivers the desired result.

Hence, full-incentive separating contracts cannot improve upon full-incentive pooling contracts whenever \( \{w(h), \kappa_1(h)\} \) satisfies both (IMP) and (DET). Since satisfying (DET) in isolation is costless, it is also never optimal to require \( \{w(l), \kappa_1(l)\} \) to satisfy (IMP). We therefore consider separating contracts where \( \{w(h), \kappa_1(h)\} \) satisfies (IMP) but not (DET), and \( \{w(l), \kappa_1(l)\} \) satisfies (DET) but not (IMP). We can, thus, restrict attention to contracts in which \( \kappa_1(h) = k_1 \) and \( \kappa_1(l) = 0 \).

Pledgeable income then is the solution to the program:

\[
 v = \max_{w(h), w(l)} \gamma (q^h(X - w(h)) - k_1) + (1 - \gamma)p(X - w(l)) \quad \text{s.t.} \quad \begin{align*}
 q^h w(h) &\geq pw(h) + k_1 \\
 pw(l) &\geq q^l w(l) \\
 pw(l) &\geq q^l w(h) + k_1 \\
 q^h w(h) &\geq pw(l) \\
 w(l) &\geq 0 \quad \text{and} \quad w(h) \geq 0,
\end{align*}
\]

where (38) and (39) denote the truth-telling constraints in states \( l \) and \( h \), respectively, while (36) and (37) denote the respective incentive constraints.

**Lemma 9.** The truth-telling constraint (38) is binding.

*Proof.* Since \( w(h) = 0 \) does not satisfy (36), we must have that \( w_i(h) > 0 \) for at least one \( i \). Suppose that (38) is slack. Then setting \( w(l) = 0 \) is optimal, because doing so does not violate (37) or tighten (39), and maximizes pledgeable income. But since \( w_i(h) > 0 \) for at least one \( i \), \( w(l) = 0 \) violates (38), a contradiction.

Since (38) is binding, use (38) in (39) to give

\[
 q^h w(h) \geq q^l w(h) + k_1.
\]

Combining (41) and (36) yields a combined incentive constraint on \( w(h) \) of the form

\[
 q^h w(h) \geq \max \{q^l w(h), pw(h)\} + k_1.
\]

By Assumption 5, the cheapest way to satisfy this equation is to pay wages in state 3 only. Since

\[
 X - w_1(h) - k_1 = 0.
\]
\( q_3^* > p_3 \), it follows that \( w^*(h) = \left\{ 0, 0, \frac{k_1}{q_3^* - q_1} \right\} \). Since (38) is binding, \( w^*(l) \) is the pure-equity wage schedule that satisfies

\[
p w^*(l) = q^* w^*(h) + k_1.
\]

Accordingly, the firm receives expected wages \( W_{FI_{\text{Separating}}} = \tilde{q}_3 \left( \frac{k_1}{q_3^* - q_1} \right) + (1 - \gamma)k_1 \), and pledgeable income is \( \tilde{v}_{FI_{\text{Separating}}} = \tilde{q}X - \gamma k_1 - W_{FI_{\text{Separating}}} \). It follows directly that \( W_{FI_{\text{Separating}}} > W_{FI} \).

Given these preliminaries, it is now straightforward to characterize the optimal full-incentive contract. In particular, assuming that a tie is split in favor of a separating contract, the optimal full-incentive contract is a separating contract if and only if \( W_{FI_{\text{Separating}}} \geq W_{FI_{\text{Pooling}}} \). In the optimal full-incentive contract, the firm receives expected wages \( W_{FI} = \min \{ W_{FI_{\text{Separating}}}, W_{FI_{\text{Pooling}}} \} \), and pledgeable income is \( \tilde{v}_{FI} = \tilde{q}X - \gamma k_1 - W_{FI} \).

Having characterized the optimal contract within each class of contracts, we can now determine the optimal contract class. In particular, the optimal contract class is the one that delivers the highest pledgeable income under asymmetric information. Assuming that ties are broken in favor of a full-incentive contract, a deterrence contract is optimal if and only if \( pX > \max \{ qX - \gamma k_1 - W_{FI}, \tilde{q}X - \gamma k_1 - \tilde{W} \} \). An implementation contract is optimal if and only if \( \tilde{q}X - \gamma k_1 - \tilde{W} > \max \{ qX - \gamma k_1 - W_{FI}, pX \} \). A full-incentive contract is optimal if and only if \( W_{FI} = \min \{ W_{FI_{\text{Separating}}}, W_{FI_{\text{Pooling}}} \} \).

Finally, since the optimal asymmetric-information contract is the one that delivers the highest pledgeable income across all contract classes, it must be the case that

\[
\tilde{v} = \max \left\{ \tilde{q}X - \gamma k_1 - W_{FI}, \tilde{q}X - \gamma k_1 - \tilde{W}, pX \right\}.
\]
Bibliography


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