ABSTRACT

Title of dissertation: ESSAYS ON MARKET FRICTIONS AND SECURITIZATION

An Wang, Doctor of Philosophy, 2016

Dissertation directed by: Professor Anton Korinek
Professor John Shea
Professor Albert Kyle
Department of Economics

This dissertation provides a novel theory of securitization based on intermediaries minimizing the moral hazard that insiders can misuse assets held on-balance sheet. The model predicts how intermediaries finance different assets. Under deposit funding, the moral hazard is greatest for low-risk assets that yield sizable returns in bad states of nature; under securitization, it is greatest for high-risk assets that require high guarantees and large reserves. Intermediaries thus securitize low-risk assets. In an extension, I identify a novel channel through which government bailouts exacerbate the moral hazard and reduce total investment irrespective of the funding mode. This adverse effect is stronger under deposit funding, implying that intermediaries finance more risky assets off-balance sheet. The dissertation discusses the implications of different forms of guarantees. With explicit guarantees, banks securitize assets with either low information-intensity or low risk. By contrast, with implicit guarantees, banks only securitize assets with high information-intensity and low risk.

Two extensions to the benchmark static and dynamic models are discussed. First, an extension to the static model studies the optimality of tranching versus securitization with guarantees. Tranching eliminates agency costs but worsens adverse selection, while securitization with guarantees does the opposite. When the quality of underlying assets in a certain security market is sufficiently heterogeneous, and when the highest quality assets are perceived to be sufficiently safe, securitization with guarantees dominates tranching. Second, in an extension to the dynamic setting, the moral hazard of misusing assets held on-balance sheet naturally gives rise to the moral hazard of weak ex-post monitoring in securitization. The use of guarantees reduces the dependence of banks' ex-post payoffs on monitoring efforts, thereby weakening monitoring incentives. The incentive to monitor under securitization with implicit guarantees is the weakest among all funding modes, as implicit guarantees allow banks to renege on their monitoring promises without being declared bankrupt and punished.

ESSAYS ON MARKET FRICTIONS AND SECURITIZATION

by

An Wang

Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
2016

Advisory Committee:
Professor Anton Korinek, Co-Chair
Professor John Shea, Co-Chair
Professor Albert Kyle
Professor Sebnem Kalemli-Ozcan
Professor Russell Wermers

Acknowledgments

I owe my gratitude to all the people who have made this thesis possible and because of whom my graduate experience has been one that I will cherish forever.

First and foremost, I would like to thank my main advisor, Professor Anton Korinek, for giving me the opportunity to work on a challenging topic from innovative perspectives over the past four years. He inspired me to start working on the topic, and his continuous encouragement walked me through good times and bad times in the past years. He gave me the freedom to pursue what I feel passionate about. Most importantly, he told me that I am who I am, and it is not changed by how other people think of me. I believe that realizing this is the key to happiness, and I am in debt to Professor Anton Korinek for this wisdom of life.

I would also like to thank my other two main advisors, Professor John Shea and Professor Albert Kyle. Professor John Shea has always made himself available for help and advice, and his attention to details exemplifies the spirit of true academia. Professor Albert Kyle has been a constant inspiration for me. His vast knowledge in nearly all areas of finance ignites many of the ideas in this dissertation, and his incredible intuition has uplifted me in so many ways.

I would like to thank two other committee members, Professor Sebnem Kalemli-Ozcan and Professor Russell Wermers, for agreeing to serve on my committee and for sparing their invaluable time reviewing the manuscript. I thank Prof. Russell Wermers in particular for his advice on career choices.

I thank Professor Felipe Saffie, Professor Mark Loewenstein, Professor Richmond Mathews, and Professor William Mullins for their valuable comments and suggestions. I am also grateful to seminar participants at the Georgetown Center for Economic Research Biennial Conference 2015, the Singapore Economic Review Conference 2015, the Finance Brown-bag Seminar at Robert H. Smith School of Business at the University of Maryland, the Macroeconomics Brown-bag Seminar at the University of Maryland, and the Midwest Macro Meeting 2016.

Thanks are also due to all administrative staff for they have made my life in the department so easy and smooth. My colleagues and friends in the department have enriched my graduate life in many ways and deserve a special mention.

I owe my deepest thanks to my family – my mother and father who have always stood by me and guided me through my life and career, and my cousins who have shouldered my family obligations as a son and a grandson. Words cannot express the gratitude I owe them. I would also like to thank Tianxi Yu, Haiqin Ge, Huazhu Ning, Ting Yang, and Yan Ma, who are like family members to me.

It is impossible to remember all, and I apologize to those I have inadvertently left out.

Lastly, thank you all and thank God!

Contents

List of Figures

List of Abbreviations

ABCP	Asset-Backed Commercial Paper
ABS	Asset-Backed Security
AMLF	ABCP MMMF Liquidity Facility
ARB	Accounting Research Bulletin
BHC	Bank Holding Company
CDO	Collateralized Debt Obligation
CMBS	Commercial Mortgage-Backed Security
CPFF	Commercial Paper Funding Facility
CRMP	Counter-party Risk Management Policy Group
FAS	Financial Accounting Standards
FASB	Financial Accounting Standards Board
FDIC	Federal Deposit Insurance Corporation
FHLMC	Federal Home Loan Mortgage Corporation
FNMA	Federal National Mortgage Association
GNMA	Government National Mortgage Association
GSE	Government-Sponsored Enterprise
IFRS	International Financial Reporting Standards
MBS	Mortgage-Backed Security
MMIFF	Money Market Investor Funding Facility
MMMF	Money Market Mutual Fund
QSPE	Qualifying Special Purpose Entities
RMBS	Residential Mortgage-Backed Security
SPV	Special Purpose Vehicle
US GAAP	United States Generally Accepted Accounting Principles
VIE	Variable Interest Entity

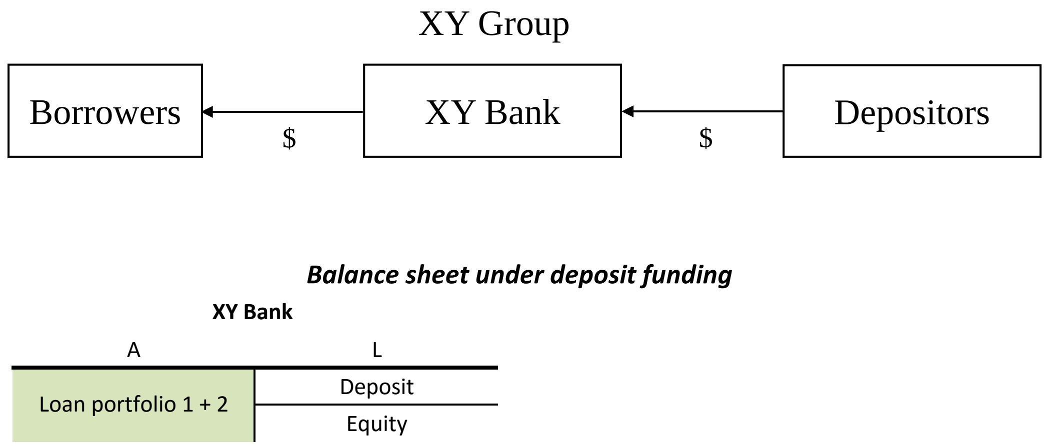
Chapter 1: Institutional Background on Securitization

1.1 Introduction

Securitization is a process and technology devised by financial intermediaries to finance assets off-balance sheet. The first step of securitization is financial intermediaries setting up legally segregated entities called special purpose vehicles (SPVs). These financial intermediaries are called sponsor banks, and the SPVs most commonly take the legal form of a trust. Financial intermediaries then pool assets and transfer them to their SPVs as "true sales" of assets. The claims to the cash flows of these assets are then sold by SPVs in the form of asset-backed securities (ABS) in the market, and the proceeds are used to finance the purchase of the assets from the sponsors.

The principal and interest payments of ABS depend on the cash flows of the underlying assets and the seniority of the securities. Securities with different seniority are called tranches. Securities with the highest seniority, i.e. the senior tranche, are backed by the safest component of the cash flows of the underlying pool of assets. By contrast, securities with the lowest seniority, i.e. the junior tranche, are backed by the most risky component of the cash flows and hence are also called the "equity tranche." Different tranches of securities are rated and sold in different markets.

Figure 1.1: Traditional On-Balance Sheet Intermediation



Traditionally, financial intermediaries use deposits to finance assets on-balance sheet until maturity, and this funding mode is called deposit funding or on-balance sheet financing. With securitization, loans can be financed not on the sponsor's balance sheet, but on the SPV's balance sheet, and hence securitization is commonly referred to as off-balance sheet financing.

To better understand the structure and function of securitization, I start with a comparison with traditional banking intermediation. Figure 1.1 is a depiction of traditional deposit funding and the corresponding stylized balance sheet. In this example, XY Bank is a bank entity of XY Group, which is a bank holding company (BHC). XY Bank raises external funds by issuing credits on checking or savings accounts to depositors. These funds are lent out to borrowers, and the loans are financed on the balance sheet until maturity.

By the nature of the liquidity transformation function, the traditional banking system is potentially subject to bank runs. The introduction of federal deposit insurance in the 1930s eliminated depositors' incentive to withdraw their funds when the solvency of a bank came into question and effectively ended bank runs. However deposit insurance creates an incentive for banks to shift risks to the public safety net. This second incentive is corrected by regulatory capital requirements, which mandate banks to keep sufficient amounts of capital as skin in the game. The combination of deposit insurance and regulatory capital requirements kept the U.S. banking system running smoothly after the Great Depression until the 2007-09 financial crisis.

The new player in the picture is the shadow banking system, a market-based intermediation system that runs a similar business to the traditional banking sector but is subject to much lighter regulations. The core of this system is securitization. Funds from outside investors, e.g. mutual funds, money market mutual funds, and pension funds, are channeled to finance various types of loans and assets, via issuing and selling securities backed by these loans and assets.

Securitization was first engineered in the United States by the Government National Mortgage Association (GNMA or "Ginnie Mae") in early 1970s as an innovative way to finance government-guaranteed residential mortgages. In the first three decades of its life, securitization was primarily confined to financing residential mortgages issued by government-sponsored enterprises (GSEs), e.g. the Federal National Mortgage Association (FNMA or "Fannie Mae") and the Federal Home Loan Mortgage Corporation (FHLMC or "Freddie Mac"). Securitizations carried out by non-government-sponsored financial institutions are called private-label securitizations, and they only started to pick up at the turn of the century, backed by both residential and non-residential mortgages and many other types of underlying assets.

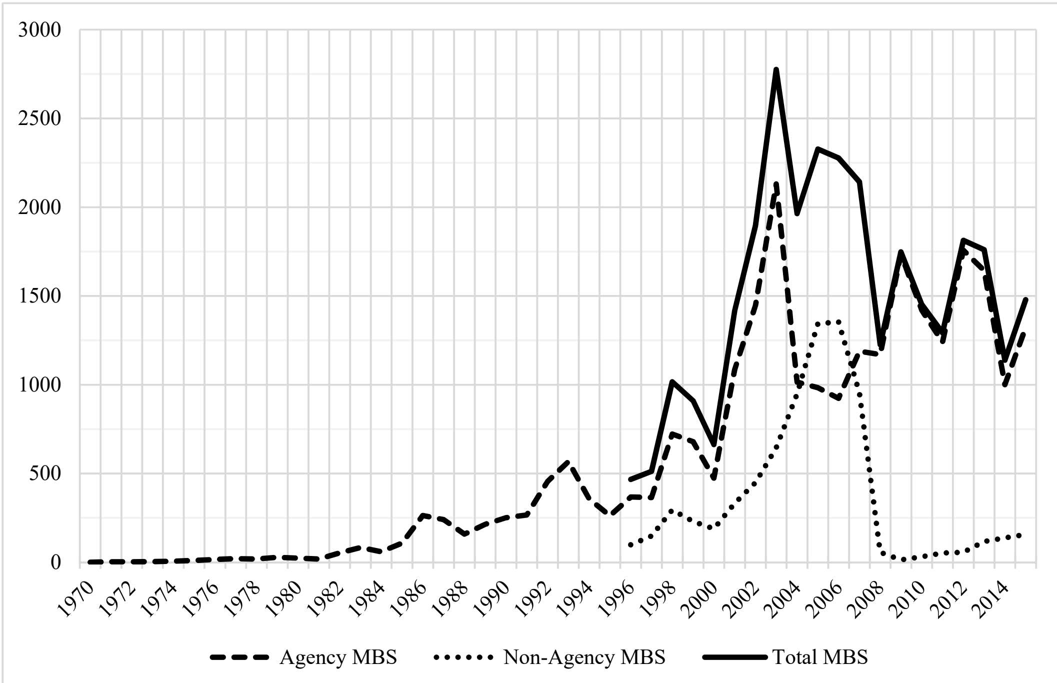
Since mortgage securitization was the oldest type of securitization and has always been a very prominent part of the securitization market, these securities merit their own name: mortgage-backed securities (MBS). Among MBS, there are residential mortgage-backed securities (RMBS) and non-residential mortgage-backed securities. The agencies mentioned above are only involved in RMBS, and the MBS issued by these agencies are called agency MBS. All other MBS issued by private financial institutions are called non-agency MBS, which include RMBS, commercial MBS (CMBS), and home equity securitization.

Figure 1.2 shows the annual issuance of both agency and non-agency MBS and the total. Agency MBS date back 1970, and non-agency MBS go back to the 1980s. However, the data on non-agency MBS issuance only goes back to 1996. The data on non-agency MBS *outstanding* starts from 1980, but the market was very small until the late 1980s and early 1990s.

From the figure, the share of non-agency MBS issuance in total issuance was around 20% until 2003. From 2003 to 2006, this number rose from slightly above 20% to almost 60%. The issuance of non-agency MBS exceeded that of agency MBS in 2005, peaked in 2006, and then crashed in 2007. The share of non-agency MBS issuance plummeted to less than 5% of total MBS issuance in 2008. After that, the issuance of non-agency MBS has been very small, reaching almost zero in 2009 and only slowly coming back. In 2015, non-agency MBS accounted for about 11% of total MBS issuance.

Outside the MBS market, the general name ABS applies, and private-label securitization dominates. The most prominent underlying assets of ABS include automobile loans, credit card debts, equipment loans, and student loans.

Figure 1.2: U.S. MBS Issuance, USD Billions

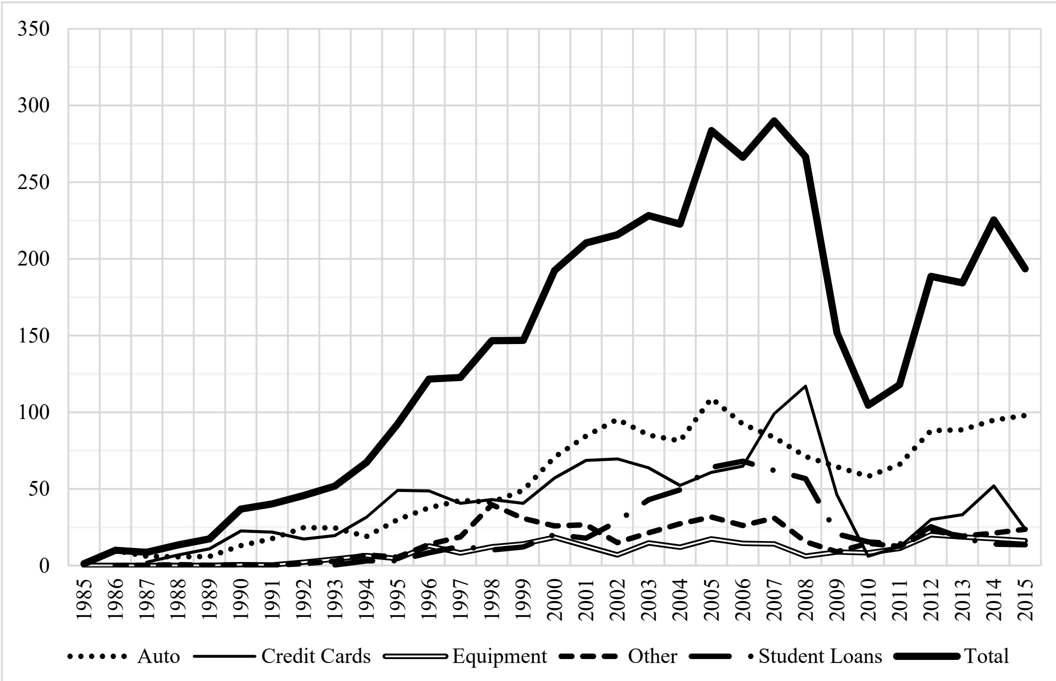


Data source: Securities Industry and Financial Markets Association

Figure 1.3 shows the annual issuance of different kinds of ABS and the total ABS issuance. The ABS market, and the data, goes back to 1985. Total issuance peaked in 2007 and then plummeted in 2008 to one third of its peak level. However, the market rebounded rapidly after 2010, driven mostly by securitization of automobile loans and credit card debts. In 2014, the issuance of ABS recouped over 75% of its all-time peak in 2007, despite the very stringent regulatory environment for securitization after the crisis.

One particular kind of ABS, asset-backed commercial paper (ABCP), is worth a separate mention. ABCPs are very short-term ABS, as indicated by the term "commercial paper" in the name. In its prime from 2006 to 2007, the average maturity of outstanding ABCP was about 30 days. ABCP was very popular before the

Figure 1.3: U.S. ABS Issuance, USD Billions



Data source: Securities Industry and Financial Markets Association

crisis: it was the most popular money market instrument, with an outstanding value of $1.22 trillion just before the financial crisis. As a reference, the outstanding value of Treasury Bills was $940 billion at that time. Note that the issuance of ABCP is not included in the ABS issuance data used to plot Figure 1.3. Because of the short maturity, there is no consolidated database on ABCP issuance. Fortunately, the data for ABCP *outstanding* can be easily found in the Federal Reserve Economic Database. Section 1.5 will discuss the ABCP market in more detail.

When the underlying assets are whole loans or legal rights to specific assets and cash flows, securitization is referred to as funding securitization. ABS, MBS, and asset-backed commercial paper (ABCP) are in this category. There is also non-funding securitization, in which the underlying assets are tranches of existing securities or derivatives. All kinds of collateralized debt obligations (CDOs) are in this category. This dissertation only focuses on funding securitization.

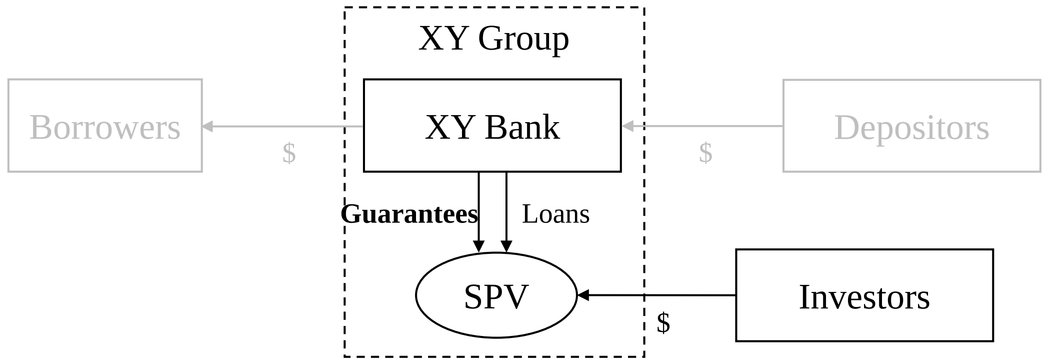
Abstracting from unnecessary details, the core intermediation relationship and the corresponding stylized balance sheet in securitization are depicted in Figure 1.4. In this example, the bank entity is XY Bank, which in reality can be any commercial bank or investment bank.

To securitize, the BHC (XY Group) sets up an SPV. XY Bank originates assets, i.e. issues loans to borrowers, and transfers them to the SPV. In this example, XY Bank sells loan portfolio 2 to its SPV. The SPV issues and sells ABS to investors and uses the proceeds to finance their purchase of loan portfolio 2 from XY Bank. In this case, XY Bank is called the sponsor bank, and ABS are claims to the cash flows of the pool of loans to borrowers (loan portfolio 2). The cash flows are passive in the sense that the underwriting decision has already been made prior to the point of securitization, and the SPV is merely a robot entity that follows pre-specified rules designed by their sponsors (Gorton and Metrick, 2012).

At the core, off-balance sheet financing performs the same functions as traditional banking, i.e. liquidity and maturity transformation, but under new names and with few regulations before the crisis. By nature, shadow banking is prone to runs if there is no insurance mechanism, and if there is public insurance, it is prone to risk-shifting in the absence of regulatory capital requirements.

One important feature in a lot of securitizations is the provision of guarantees by sponsors. In Figure 1.4, the sponsor bank, XY Bank, provides guarantees to its SPV. These guarantees can be either explicit or implicit, and both types provide

Figure 1.4: Off-Balance Sheet Intermediation



Balance sheets under securitization w/ guarantees

XY Bank

A	L
Loan portfolio 1	Deposit
SPV equity	Bank Equity
Reserves	Guarantees to SPV

Special Purpose Vehicle

A	L
Loan portfolio 2	Asset-Backed Securities
Guarantees from Bank	SPV Equity

recourse from the SPV to the sponsor bank's balance sheet. When the pool of loans (loan portfolio 2) is not performing and the SPV falls short of cash flows to pay off investors, XY Bank would have to honor these guarantees by buying back securities from investors at par.

In the corresponding balance sheet, potential guarantee payments to outside investors are a liability of XY Bank, and in order to stand ready for this obligation, XY Bank has to hold assets on its balance sheet as reserves for potential guarantee payments.

Implicit guarantees are verbal promises that sponsor banks make to buy back maturing securities at par from outside investors. Their use is evidenced in empirical studies on credit-card securitization. Explicit guarantees are contractual obligations of sponsor banks to buy back maturing securities at par, and are frequently used in the ABCP market. Acharya et al. (2013) document the prevalent use of explicit guarantees in the ABCP market. Section 1.5 presents more details on the ABCP market.

This dissertation emphasizes that the shadow banking system is not completely separated from the regulated banking system. A lot of sponsor banks are commercial banks or investment banks that are regulated and are oftentimes considered to be too-big-to-fail banks that have access to not only deposit insurance but also government bailouts. The use of guarantees links the shadow banking system to the regulated banking system.

Arguably, the collapse of ABS markets triggered the massive financial turmoil starting in 2007, and the severity of the crisis lay precisely in the fact that losses on bad assets were not all passed on to final investors (Covitz et al., 2009). Acharya et al. (2013) document that, due to the use of explicit guarantees, only 2.5% of ABCP outstanding as of July 2007 entered default from July 2007 to December 2008, a phenomenon the authors refer to as "securitization without risk transfer."

While this discussion omits significant details and heterogeneity across different markets, it does cover the general structures and features in securitization.[1]

The rest of the chapter proceeds as follows. Section 1.2 introduces the legal form and characteristics of SPVs. Section 1.3 summarizes the use of credit enhancement in securitization. Section 1.4 provides a comprehensive overview of the evolution of regulations and accounting standards relating to securitization. Section

[1]For a through exposition of various types of securitization structures and regulations, see Adrian and Ashcraft (2012), Gorton and Metrick (2012), and Pozsar et al. (2012).

1.5 describes the ABCP market as a leading example of securitization.

1.2 Special Purpose Vehicles

1.2.1 Legal Form of SPVs

Securitization SPVs are commonly in the legal form of a trust. According to the pre-crisis accounting rules, trusts were considered as qualifying special purpose entities (QSPEs), and hence transferring assets to a trust was considered a "true sale" of assets, which is important for the purpose of keeping assets off-balance sheet. Having witnessed the overheating of securitization markets, post-crisis accounting rules removed the concept of QSPE and eliminated all its references regarding the qualification of "true sale." Section 1.4 discusses the change in the regulatory environment in more detail.

SPVs are robot entities that have no physical location, no employees, and typically make no investment or management decisions. They only follow a pre-specified set of rules governing the acquisition and purchase of assets from their sponsors or other financial intermediaries, the pooling and tranching of the acquired pool of assets, and the issuing and selling of securities. From this perspective, once the rules are set at the moment of creating the SPV, the sponsor bank is a passive contributor to the SPV, and the SPV is a passive recipient of assets.

Due to the pre-specified rules, the discretion of the sponsor banks' managers over the transferred assets and their cash flows is significantly reduced relative to the case in which the assets are held on-balance sheet. This is called the "surrender of control."

In the very early days of securitization, a new SPV had to be set up each time a pool of loans was securitized. Later, financial intermediaries commonly used the legal form of a "Master Trust" for their SPVs, which allowed different vintages of loan pools to be sold to the same trust, and securities to be issued corresponding to each vintage (Gorton and Metrick, 2012). Master Trusts are particularly popular in the securitization of credit card loans, given the continuing nature of consumer credit card debts (Gorton and Metrick, 2012).

1.2.2 Bankruptcy Remote

An essential feature of SPVs is that they are "bankruptcy remote," which means that if the sponsor bank defaults and files bankruptcy, assets in the SPV are safe from being consolidated back onto the sponsor's balance sheet and being liquidated to pay the sponsor bank's creditors.

In terms of minimizing financing costs, bankruptcy remoteness is important not only because it is a pre-requisite for SPVs to receive off-balance sheet treatment, but also in that it separates the credit quality of the assets being securitized from that of the sponsor. In the cases where the sponsor bank has a lower credit rating than the pool of mortgages being securitized, bankruptcy remoteness helps the sponsor bank reduce financing costs, as investors can see the SPV and the sponsor as two separate entities with different risk levels.

In the early days of securitization, there was some confusion about the necessary accounting steps needed to ensure that a certain asset had in fact been sold to the SPV. To clarify this, Financial Accounting Standards Boards (FASB) required a two-step approach, in which sponsor banks set up two trusts, one for purchasing assets and one for issuing securities. Any residual interest that the sponsor holds in the SPV assets is held by the purchasing SPV, instead of the sponsor. Under this two-tiered structure, the transfer of assets constitutes a "true sale," which is the prerequisite for bankruptcy remoteness (Gorton and Souleles, 2007). Case law has to date upheld the bankruptcy remoteness of securitization SPVs (Gorton and Metrick, 2012).

When guarantees are used, they have to be structured in a certain way, such that, combined with this two-tiered structure, asset transfers are still considered "true sales."

1.3 Credit Enhancement and Guarantees

In securitization, credit enhancement takes a variety of forms, with the two most important being tranching and private guarantees.

In most securitizations, SPVs issue tranches of securities based on seniority. There are senior tranches, junior tranches, and intermediate mezzanine tranches, which are all horizontal slices of the underlying pool of assets. Under this tiered structure, the mezzanine and the junior tranches are subordinates of the senior tranche, meaning that the cash flows from the underlying pool of assets must be first allocated to make principal and interest payments of the senior tranche.

Private guarantees in the form of lines of credit and outright guarantees are frequently used in securitization to enhance the quality, liquidity, and eventually the rating of securities.[2]

As discussed before, securitization uses both explicit and implicit guarantees. The nature of these guarantees is that when the underlying pool does not generate enough cash flow to pay off security holders, the sponsor bank is obligated to pay off investors at par. However, to comply with being a "true sale," sponsor banks often use implicit guarantees. In the case where explicit guarantees are provided, they are most frequently structured as liquidity guarantees, rather than outright credit guarantees. The main difference between a liquidity guarantee and a credit guarantee is that in the former case the sponsor bank only needs to make payments to ABS holders when the underlying asset is claimed as solvent. Supposedly, a liquidity guarantee is a contingent provision of liquidity and not a full exposure to the credit risk of the underlying assets. Therefore, according to the pre-crisis accounting rules, using a liquidity guarantee did not invalidate a "true sale," and the underlying assets were still considered off-balance sheet and were subject to much lower capital requirements. Section 1.5.3 discusses the differences between various types of guarantees in more detail.

[2] A line of credit is an arrangement between a financial institution and a customer, in the case of securitization the sponsor bank and the SPV, that establishes a maximum loan balance that the sponsor bank will permit the SPV to maintain.

1.4 Regulatory Environment

One important motive for securitization before the financial crisis was to reduce cost of financing and evade capital requirements by moving assets off-balance sheet, i.e. regulatory arbitrage. To understand and assess this motive, two points are important regarding the regulatory environment pertaining to securitization: first, the rules governing recognition of assets as truly off-balance sheet, i.e. exemption from consolidation, and second, the treatment of capital requirements for the identified off-balance sheet assets. This section describes these two points and highlights changes in the regulatory environment over time.

1.4.1 Off-Balance Sheet Recognition

For an asset to be considered off balance sheet, the transfer from the sponsor to the SPV has to satisfy certain criteria set forth by the Financial Accounting Standards Boards (FASB) in the United States, and the International Financial Reporting Standards (IFRS) in more than 110 other countries.

The requirements in IFRS regarding consolidation have traditionally been stringent and robust and have withstood the financial crisis. As a result, there have not been any significant changes over time to IFRS rules. By contrast, the FASB issued two statements, Statements 166 and 167, in June 2009. These two statements, together with an additional rule published on January 2010 by Federal banking agencies drastically changed the standards for accounting consolidation in the U.S.[3] This section focuses on the evolution of standards for accounting consolidation in the U.S. that are relevant to securitization.

In the U.S., the FASB publishes and updates Generally Accepted Accounting Principles (US GAAP) that govern the standards and procedures that U.S. companies use to compile financial statements. Historically, there are various relevant accounting standards under US GAAP, some current and some obsolete, that determine whether an SPV shall be consolidated. The treatments for guarantees have also changed drastically over time. These rules are extraordinarily complex, and for clarification and better implementation, the FASB publishes interpretations to guide accounting professionals (Counter-party Risk Management Policy Group III [CRMP III], 2008).

Consolidation is defined as the process by which the financial statement of a parent is combined with those of its subsidiaries, as if they were a single economic entity (CRMP III, 2008). Consolidated financial statements are considered more useful for investors and creditors. Assets on a consolidated SPV are considered on-balance sheet and are subject to more stringent capital requirements.

SPVs can be structured as three types of entities, and there are three consolidation models, each based on the type of entity an SPV is structured as. The three types of entities are: (1) voting entities, (2) variable interest entities (VIEs), and (3) qualifying special purposes entities (QSPEs).

The consolidation rule for voting entities was codified in Accounting Research

[3]This rule was jointly issued by the Office of the Comptroller of the Currency, Board of Governors of the Federal Reserve System, Federal Deposit Insurance Corporation, and Office of Thrift Supervision.

Bulletin No. 51 (ARB 51), *Consolidated Financial Statements*, issued in August 1959. It requires an enterprise to consolidate an entity, e.g. an SPV, if the enterprise unilaterally controls the entity through majority voting interests.

In September 2000, the FASB created the concept of QSPE in Financial Accounting Standard No. 140 (FAS 140). FAS 140 specifies that, if an off-balance sheet entity can be deemed as a QSPE and the sponsor surrenders control, the entity can be exempted from consolidation and receive off-balance sheet treatment.

Under FAS 140, an SPV is a QSPE if it is (1) "demonstrably distinct" from the sponsor, (2) it is an automaton in the sense that there are no substantive decisions for it to make, and rules specified by the legal documents defining its existence must be strictly followed. The term "demonstrably distinct" means that at least 10% of the value of the SPV is held by unrelated third parties, and the sponsor cannot dissolve the SPV and liquidate the transferred assets unilaterally, i.e. the SPV must be bankruptcy remote (Gorton and Metrick, 2012). The term "surrender control" means that the sponsor cannot retain effective control of the transferred assets through an ability to dictate the use of the transferred assets or unilaterally ask the SPV to return assets.

To sum up, to be considered as off-balance sheet under the QSPE framework, the SPV must be a separate and distinct legal entity, with no substantial decisions to make, and must be bankruptcy remote. These criteria were easily met by the two-tiered structure mentioned above. As a result, securitization vehicles that held credit card receivables, automobile loans, residential mortgages, and commercial mortgages were commonly structured as QSPEs to receive off-balance sheet treatment.

Both the ARB 51 and the FAS 140 framework emphasize the legal form of the relationship between a sponsor and an entity and not the substance of the underlying transactions, and the former can be more easily manipulated (Gilliam, 2005). An infamous example of such accounting manipulation is the downfall of Enron in 2001, brought about in part by its use of off-balance sheet entities to deliberately understate its liabilities and overstate its profits. What Enron did was to set up entities in which it had no voting rights, while absorbing the entity's entire risks and rewards.

In response to the Enron scandal, the FASB issued an official interpretation, FASB Interpretation No. 46 (FIN 46) of ARB 51, in January 2003, and a revision of it, FIN 46R, in December 2003. FIN 46 and 46R introduced the concept of Variable Interest Entities (VIEs) and laid out a consolidation framework based on financial interest, determined by the benefits received or risk taken, rather than voting rights.

Under FIN 46R, an off-balance sheet entity should be consolidated if the sponsor bank has financial interest *and* voting rights. If not, the off-balance sheet entity is a VIE. In this case, the accountant looks to each stakeholder to determine who holds the majority of the entity's risks or rewards (or both), i.e. the primary beneficiary. The primary beneficiary must consolidate the VIE.

All types of guarantees, explicit and implicit, were considered a variable interest under FIN 46R, and hence many sponsor banks of SPVs and ABCP conduits met the primary beneficiary test and were required to consolidate (Deloitte & Touche LLP, 2007). However, if an SPV was deemed as a QSPE, the VIE rule did not apply.

In the year of 2003 to 2004, the growth of the ABCP market came to a complete halt, due to the uncertainty of the implementation of FIN 46R. In July 2004, Federal banking regulators issued a new rule for computing capital requirements of ABCP programs.[4] Under the new rule, ABCP programs consolidated under FIN 46R were excluded from capital ratio calculations, but guarantees had to be tested to determine their quality and were included in capital calculations. In particular, credit guarantees were treated as equivalent to on-balance sheet financing, and thus had a conversion factor of 100%. Long-term liquidity guarantees (greater than one year) were assigned a 50% conversion factor, and short-term liquidity guarantees, the most commonly used type, were assigned a 10% conversion factor (Gilliam, 2005).

Therefore, from 2004 to 2009, securitization SPVs were most commonly structured as QSPEs or ABCP conduits, both of which received off-balance sheet treatments with lower capital requirements, either under FAS 140 or the new rule for computing capital requirements even if the VIE rule applied.

After witnessing the financial turmoil in 2007-09, in June 2009, the FASB issued Statement No. 166, *Accounting for Transfers of Financial Assets* (FAS 166), and Statement No. 167, *Amendments to FASB Interpretation No. 46(R)* (FAS 167). FAS 166 revised FAS 140, by, among other things, eliminating the concept of QSPEs. Thus, the option to structure an SPV as a QSPE and not consolidate was no longer available. FAS 167 revised FIN 46R by changing the VIE rule. Under FAS 167, if a bank has the power to direct significant activities of the VIE, and has the obligation to absorb losses or the right to receive benefits that can be potentially

[4] This rule was jointly issued by the Office of the Comptroller of the Currency, Board of Governors of the Federal Reserve System, Federal Deposit Insurance Corporation, and Office of Thrift Supervision.

significant to the VIE, then the bank is deemed the primary beneficiary of, and hence must consolidate, the VIE. FAS 167 also requires auditors to conduct ongoing assessments of all financial linkages, including both implicit and explicit guarantees. Under this new rule, if a bank provides any guarantees to its SPV, the bank must consolidate the SPV.

In January 2010, Federal banking agencies published in the Federal Register a final rule amending their capital calculation guideline issued in 2004 (FAS 166/167 Rule).[5] This rule revoked the exemption previously granted to ABCP programs under the July 2004 rule. The reporting guidance for the transition to the capital requirements associated with FAS 166 and FAS 167 can be found in Federal Deposit Insurance Corporation (FDIC) (2010).

In this new regulatory environment, even though most SPVs continue to be bankruptcy remote, most of the transferred assets have been consolidated back onto the balance sheets of sponsors for financial reporting purposes.

1.4.2 Capital Requirements

Capital requirements for off-balance sheet items have also experienced drastic changes in the U.S.

Before the post-crisis regulatory reform, depending on the type of guarantees involved, qualifying off-balance sheet assets were mostly subject to much lower capital requirements than comparable on-balance sheet assets. According to Basel I,

[5] This rule was published jointly by the Office of the Comptroller of the Currency, Board of Governors of the Federal Reserve System, Federal Deposit Insurance Corporation, and Office of Thrift Supervision.

which was issued in 1988 and adopted by U.S. banks before the crisis, the risk weight was 50% for residential mortgages and 100% for private sector debt if held on-balance sheet. By contrast, the risk weight for securitized assets with no guarantees was 0%, while for securitized assets with liquidity guarantees, the risk weight was only 10% of what was required correspondingly if the assets were held on-balance sheet. Securitized assets with credit guarantees were treated equivalently to on-balance sheet assets. In addition to Basel capital requirements, U.S. banks also had to satisfy a leverage test, which also exempted securitized assets if they were qualified under US GAAP (Acharya et al. 2013).

U.S. banks started shifting from Basel I to Basel II, issued in 2004, in early 2008. Basel II assigns risk weights according to security ratings, with highly rated securities assigned lower risk weights. In Basel II, under the standardized approach, the capital requirements for securitized assets covered by liquidity guarantees increased from 10% to 20% relative to on-balance sheet financing. After the financial crisis, the Basel guidelines were superseded in the U.S. by the Federal FAS 166/167 Rule that requires banks to hold capital equivalent to on-balance sheet financing for conduit assets under liquidity guarantees.

1.4.3 Additional Regulatory Measures

To address the lack of appropriate due diligence on securitized assets prior to the crisis, the Basel framework now also requires banks to meet specific operational criteria in order to use the risk weights specified in Basel II. Failure to meet these criteria will result in assets being risk weighted at 1250%, which is equivalent to a deduction from the sponsor's capital.

Similar measures have also been taken by U.S. authorities. The Dodd-Frank Wall Street Reform and Consumer Protection Act (the Dodd-Frank Act) of 2010 requires sponsor banks to retain at least 5% of the credit risk of any asset being securitized.

Overall, the post-crisis regulatory environment for securitization is much more stringent than before the financial crisis.

Interestingly, the ABS market shrank significantly during the financial crisis but rebounded rapidly after 2010, despite the stringent new regulatory environment. The issuance of non-agency MBS has been steadily increasing since 2010, while the issuance of ABS has recouped 3/4 of its 2007 peak. In 2014, new issuance of ABS were at double their 2010 low, and the issuance of CMBS was up from just $5 billion in 2009 to more than $100 billion in 2015. Even in the ABCP market, where the regulatory arbitrage view drew evidence from, the outstanding value has stabilized at around $250 billion. Given that the average maturity of ABCP is around 30 days, this market rolls over $250 billion worth of debts on a monthly basis, which is hardly a small or inactive market. The rebound of securitization activities despite the strict post-crisis regulations suggests that regulatory arbitrage was not the sole explanation of securitization prior to 2008.

1.5 An Example: Asset-Backed Commercial Paper

An interesting example of securitization is asset-backed commercial paper (ABCP). ABCP is most commonly purchased by outside investors, with the majority of holders being money market mutual funds and pension funds. Thus, the ABCP market provides linkages between outside investors and the financial sector (Acharya et al., 2013). The majority of the underlying assets of ABCP are ABS and RMBS (Acharya et al., 2013). To some extent, one can think of ABS and MBS as analogous to intermediate goods, with ABCP being the final good sold to outside investors.

Acharya et al. (2013) document that there is practically no risk transfer between banks and outside investors in this market. This result contradicts the traditional understanding that banks securitize to transfer risks. In reality, risks are only transferred between banks, and when it comes the banking system as a whole versus outside investors, there is no substantial transfer of risk. From July 2007 to December 2008, only 2.5% of outstanding ABCPs entered default (Acharya et al., 2013). This section presents a detailed overview of the ABCP market.

In the ABCP market, SPVs are called ABCP conduits (or simply conduits). ABCP conduits are a form of SPV set up by banks to finance medium- to long-term assets with short-term liabilities in an off-balance sheet fashion. Before the financial crisis, more than half of ABCP daily issuances had maturities of 1 to 4 days, referred to as "overnight," and the average maturity of outstanding paper was about 30 days.

As in any securitization, sponsor banks originate or acquire assets and transfer them to their conduits. Conduits issue ABCPs and sells them to outside investors. To secure high ratings, sponsor banks frequently provide guarantees to their conduits.

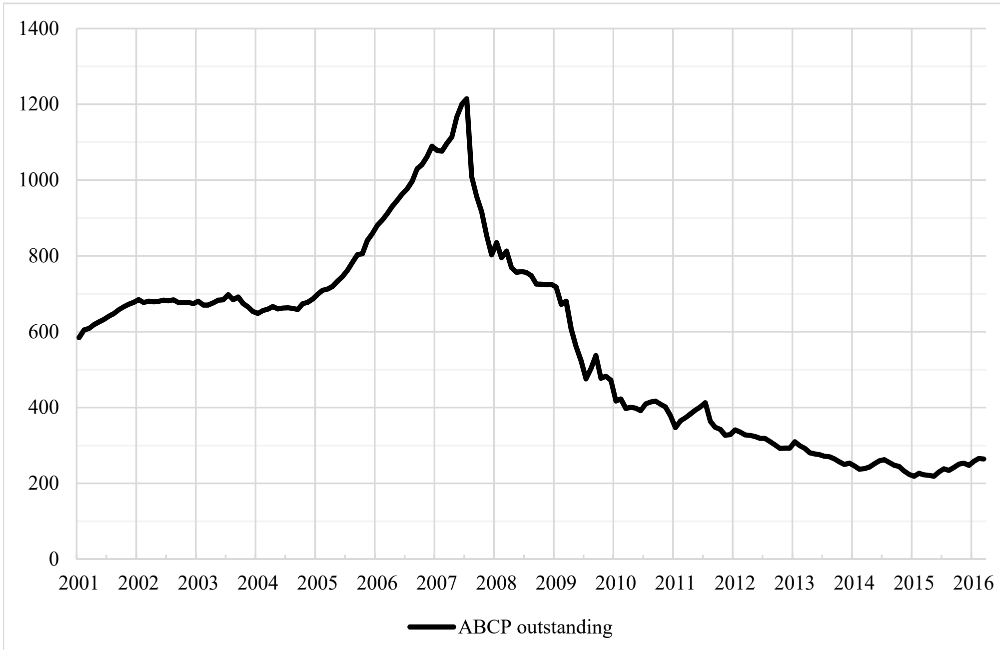
While the vast majority of conduits have credit ratings from major rating agencies, the specific assets held in the programs are not widely known. Some ABCP programs view their holdings to be *proprietary* investment strategies and deliberately do not disclose.

1.5.1 The History of ABCP

ABCP first appeared in the mid-1980s. Initially, ABCP conduits were primarily sponsored by major commercial banks to provide receivable financing to their corporate customers. In the past two decades, ABCP conduits have grown to serve a much wider range of purposes, such as asset-based financing for companies that cannot access the commercial paper market, warehousing assets prior to security issuance, providing leverage to mutual funds, and most importantly off-balance sheet funding of bank assets (Acharya et al., 2013).

In general, any asset class that has been funded in the ABS and MBS markets has also been funded by ABCP conduits, and there are a wide variety of assets that are unique to the conduit market, e.g. receivables from unsettled transactions. However, as of 2007, the majority of assets held by ABCP conduits were residential mortgages and RMBS (Acharya et al., 2013).

Figure 1.5: U.S. ABCP Outstanding, USD Billions



Data source: Federal Reserve Economic Data

Figure 1.5 depicts the seasonally adjusted monthly outstanding of ABCP from 2001 to 2016.[6] As of September 2001, there were approximately 280 active ABCP programs, with more than $650 billion outstanding (Acharya et al., 2013). From 2004 to 2007, ABCP saw a steady rise in market volume, fueled by the high demand for safe assets by institutional investors and a more relaxed regulatory environment.

In the years before the crisis, even the most conservative investors, like money market mutual funds and retirement funds, began to purchase ABCP. The outstanding value of ABCP reached its all-time peak of $1.22 trillion in July 2007. At that time, ABCP was the largest money market instrument in the U.S., followed by Treasury Bills with an outstanding value of $940 billion. This trend came to an abrupt end in August 2007.

[6] Data on U.S. ABCP issuance is not available.

Throughout 2007, negative news about U.S. residential mortgages spread, and subprime MBS started to lose value. Investors in ABCP conduits with exposures to subprime mortgages began to worry about the value of their paper and stopped rolling over their positions. At first, sponsor banks were able to pay off investors using their reserves and capital. As market confidence continued to deteriorate, flocks of investors turned their backs, and even the largest sponsor banks, e.g. Citibank and JP Morgan, began to experience difficulties (Acharya et al., 2013).

One of the defining moments of the crisis occurred in August 2007 when the French bank BNP Paribas suspended withdrawals from three of its funds invested in ABCP. Although defaults on mortgages had been rising since early 2007, the suspension triggered a panic in the ABCP market. The interest rate spread of overnight ABCP over the Federal Funds Rate spiked from 10 basis points to 150 basis points within one day of the BNP announcement (Covitz et al., 2013).

Subsequently, the ABCP market experienced a modern-day bank run (Covitz et al., 2013). Investors rushed out of the market, several ABCP conduits failed, and many sponsor banks bled to the point of needing government bailouts. By the end of December 2007, ABCP outstanding had dropped from \$1.22 trillion to \$774.5 billion. The market stabilized only after the federal government stepped in by announcing the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF) in September 2008, and the Commercial Paper Funding Facility (CPFF) and the Money Market Investor Funding Facility (MMIFF) in October 2008.

In the first half of 2009, the ABCP market experienced another sharp contraction, reduing the outstanding value to around \$400 billion. From January 2012 to

March 2016, the ABCP outstanding averaged at around $250 billion. In contrast to the quick recovery of the ABS market, ABCP outstanding only slightly rebounded in 2015 and 2016. One of the many reasons is the change in capital requirements for liquidity guarantees. Banks can no longer use liquidity guarantees to circumvent capital requirements and appeal to the demand for safe assets at the same time. Despite the slow recovery, the $250 billion market is hardly a small one, and it is still playing an important role in the money market.

1.5.2 Sponsors of ABCP

The structure of ABCP is similar to other securitizations as presented in Section 1.1. ABCP conduits are set up by sponsor banks that range from large commercial banks to non-bank financial institutions, like mortgage lenders and asset managers. Large U.S. banks have a history in sponsoring ABCP conduits, while smaller U.S. banks sponsor a very modest share.

Foreign banks sponsor a substantial share of ABCP, about 40 percent in 2007. Non-bank institutions, such as mortgage lenders, finance companies, or asset managers, also sponsor a considerable share of the market. Programs sponsored by non-bank institutions grew more dramatically than other programs and doubled their asset holdings from 2004 to 2007 (Covitz et al., 2013). The ten largest sponsors as of January 2007 were: Citigroup (U.S.), ABN AMRO (Netherlands), Bank of America (U.S.), HBOS Pls (U.K.), JP Morgan (U.S.), HSBC (U.K.), Deutsche Bank AG (Germany), Societe Generale (France), Barclays Plc (U.K.), and Rabobank (Netherlands).[7]

1.5.3 Guarantees

Contrary to our traditional understanding of securitization, sponsor banks effectively retain the risk of conduit assets by providing explicit guarantees. Ranked from the strongest to the weakest, the different types of guarantees offered are: full credit guarantee, full liquidity guarantee, extendible notes guarantee, and guarantee arranged via structured investment vehicles (SIVs).

Full credit guarantees provide the highest insurance to outside investors but expose sponsor banks to the same risks as holding assets on their balance sheets. Hence from a regulatory aspect, banks providing full credit guarantees are required to hold sufficient regulatory capital. In other words, assets covered by credit guarantees do not receive off-balance sheet treatment. From 2001 to 2009, 13% of ABCPs were covered by full credit guarantees (Acharya et al., 2013).

Full liquidity guarantees are similar to full credit guarantees with the main difference being that the sponsor only needs to pay off maturing papers if the underlying assets are not in default. In principle it is possible that full liquidity guarantees expire before the paper matures due to defaults of underlying assets. However, since conduit assets have much longer maturities than their ABCPs, it is very unlikely to happen that an ABCP vintage has not expired but the underlying asset is deemed insolvent. Hence full liquidity guarantees were viewed as almost equivalent to full credit guarantees from the ABCP investor's perspective. According to the pre-crisis

[7] For more details on ABCP sponsors, see Acharya et al. (2013).

regulation, full liquidity guarantees allowed banks to hold much less capital than full credit guarantees, 10% to be exact. From 2001 to 2009, about 61%, of ABCPs were covered by full liquidity guarantees (Acharya et al., 2013).

In extendible notes guarantee arrangements, banks have the discretion to extend maturing commercial papers for a limited period of time. Hence, they are considered weaker than full liquidity guarantees. From 2001 to 2009, they covered about 18% of outstanding ABCPs (Acharya et al., 2013).

SIV guarantees only cover a share of the conduit's liabilities, and are considered the weakest from investor's point of view. 7% of ABCPs were covered by SIV guarantees from 2001 to 2009 (Acharya et al., 2013).

Partial risk transfer as in the case of SIV guarantees conformed to the traditional view of securitization. In contrast, the majority of ABCP conduits, about 61% during the period from 2001 to 2009, were supported by full liquidity guarantees that ensured the highest credit rating so that they could be easily sold to even the most risk sensitive investors, and, at the same time, reduced regulatory capital requirements. This risk sharing structure provided ABCP conduits a recourse back to fully regulated financial intermediaries that were mostly large commercial banks with access to government bailouts.

Chapter 2: To Securitize or Not? An Agency Cost Perspective

2.1 Introduction

Securitization is a process in which financial intermediaries move assets off their balance sheets and finance them by issuing securities backed by the assets' cash flows, i.e. asset-backed securities (ABS). As a key step in off-balance sheet financing, securitization is crucial for the functioning of the shadow banking system that channels funds from investors to borrowers in an unregulated fashion.

In the years since the financial crisis, about 25% of U.S. consumer credit and 60% to 80% of mortgage credit has been financed through securitization and the shadow banking system. The significance of securitization and shadow banking for the well-being of the financial system was illustrated vividly and mercilessly during the recent financial crisis. The collapse of the mortgage-backed security (MBS) market and the sudden freeze of the asset-backed commercial paper (ABCP) market played a key role in triggering the financial crisis in 2007.[1]

Despite its importance, this system is largely unregulated. Prior to the crisis, off-balance sheet activities were often not subject to reporting duties to banking authorities, and off-balance sheet assets were not subject to as stringent capital

[1]The Financial Crisis Inquiry Report, Part IV.

requirements as on-balance sheet assets. From this perspective, the shadow banking system is largely self-disciplined, and as a consequence, principal-agent problems are fundamental issues in securitization.

This dissertation explores how market frictions, namely moral hazard, affect financial intermediaries' securitization decisions, including what to securitize, how to securitize, and how to monitor securitized assets. Understanding these decisions is important for forming a more comprehensive framework to think about securitization and to guide policy making around shadow banking.

According to the traditional *risk-transfer view*, financial intermediaries securitize to transfer risks from their balance sheets to outside investors. However, contrary to this view, the shadow banking system is a major provider of safe assets to outside investors. The empirical literature has documented that financial intermediaries frequently retain the risks of securitized assets by providing guarantees to their SPVs to secure outside investors' returns.[2] The severity of the crisis lay precisely in the fact that losses on bad assets were not all passed on to outside investors.[3] Acharya et al. (2013) interpret the existence of "securitization without risk transfer" as evidence that banks securitize to get around capital requirements. However, this *regulatory-arbitrage view* only applies to securitization by banks that are indeed subject to capital requirements.[4] In fact, in the subprime MBS market, among

[2]Implicit guarantees are commonplace in credit card securitization (Higgins and Mason, 2004; Gorton and Souleles, 2007). Explicit guarantees are extensively used in the asset-backed commercial paper (ABCP) market (Acharya et al., 2013).

[3]Acharya et al. (2013) document that only 2.5% of ABCP outstanding as of July 2007 entered default from July 2007 to December 2008, and hence term the phenomenon "securitization without risk transfer."

[4]See Gorton and Metrick (2010) for a survey on the literature of securitization, and Gorton and Metrick (2012) for a discussion of regulating shadow banking.

the top 10 originators (or sponsors) in 2005 and 2006, four were commercial banks and six were non-depository specialized mono-lined mortgage lenders (Ashcraft and Schuermann, 2008). Even in the ABCP market, as of January 2007, about 28% of the total value of ABCPs in the market were sponsored by non-bank institutions that were not subject to regulatory capital requirements, and therefore presumably had no regulatory arbitrage motive (Acharya et al., 2013).

This chapter develops a novel theory of securitization based on intermediaries minimizing moral hazard that does not suffer the shortcomings of the existing two views. The chapter focuses on the moral hazard that insiders and managers in financial institutions, who have discretion over how to use assets on-balance sheet, can misuse assets for their own benefit. This moral hazard can be generally interpreted as insiders' incentives to engage in ex-post activities that benefit themselves but can hurt outside investors. For example, insiders may have an incentive ex-post to misuse the cash flows of assets held on-balance sheet, or to take on higher risks. Insiders benefit from such activities, but outside investors are the ones bearing losses in bad states.

This chapter presents a benchmark static model and shows that securitization can reduce this moral hazard by increasing the remoteness of assets from managers in financial institutions. This idea is formulated in a banking model in which intermediaries choose between deposit funding and securitization in an environment with moral hazard. Even when intermediaries provide guarantees and the resulting risk-sharing structures are equivalent under securitization and deposit funding, insiders' incentive to divert assets, i.e. the magnitude of the moral hazard, is different under the two funding modes. The moral-hazard-reducing motive implies that securitization can be an appealing financial structure for low-risk assets.

The model economy consists of a bank holding company (BHC) that has a bank entity and an SPV, and a continuum of outside investors. Two features are important. First, the BHC is risk neutral, and outside investors are infinitely risk-averse. This assumption makes it desirable for the BHC to use guarantees in securitization to secure outside investors' returns. The infinite risk-aversion assumption imposed on outside investors greatly simplifies the analysis without losing generality, as results are robust to less-than-infinite risk-aversion. To stand ready for guarantee payments, the BHC needs to hold safe reserves on the bank entity's balance sheet. Second, as in Holmstrom and Tirole (1998), there is a moral hazard that insiders of the BHC can divert a portion of the assets held on the bank entity's balance sheet and let the BHC default. One possible interpretation of variation in the seizable portion is that it represents variation in the assets' information intensity. Assets with high information-intensity, e.g. small business loans, are harder for outside investors to value, and thus easier for insiders to divert.

Insiders' incentives to divert assets are greatest in bad states of nature. Under deposit funding, the BHC holds assets on the bank entity's balance sheet, and its incentive to divert is greatest for low-risk assets that yield sizable returns in bad states. By contrast, under securitization, the BHC holds reserves on the bank entity's balance sheet, and the moral hazard is most severe for high-risk assets that imply large draw-downs on reserves in bad states. To reduce the agency cost associated with the moral hazard, the BHC securitizes low-risk assets and holds high-risk assets on-balance sheet. I name this channel by which only safer assets are securitized the *agency cost mechanism*.

An extension of the static model discusses the optimal security structure in the presence of agency costs and adverse selection. This extension compares two commonly used structures in securitization: tranching and securitization with guarantees. Tranching eliminates agency costs but worsens adverse selection, while securitization with guarantees does the opposite. When asset quality in a certain market is sufficiently heterogeneous, and the highest quality ones are perceived to be sufficiently safe, securitization with guarantees dominates tranching.

The rest of this chapter proceeds as follows. Section 2.2 reviews related literature on securitization. Section 2.3 presents the benchmark static model. Section 2.4 studies the optimality of tranching versus securitization with guarantees. Section 2.5 concludes.

2.2 Related Literature

This chapter contributes to the literature by offering an economic rationale for securitization that can explain pre-crisis securitization without risk transfer by non-bank financial institutions that were not subject to regulatory arbitrage motives, and post- crisis securitization under the new stringent regulatory environment.

The traditional view on securitization assumes that outside investors have a higher risk-bearing capacity than financial institutions, and thus banks securitize to transfer risks to outside investors (Allen and Carletti, 2006; Wagner and Marsh, 2006). Consistent with this view, the literature on security design emphasizes the superiority of debt-like structures in terms of overcoming adverse selection and creating a liquid market (Gorton and Pennachi, 1990; DeMarzo and Duffie, 1999; DeMarzo, 2005; and Dang, Gorton, and Holmstrom, 2009). This liquid market allows banks to sell off loans to transfer risks to outside investors. Building on this view, Shin (2009) and Adrian and Shin (2009) emphasize that banks securitize to tap new funding sources. The resulting increase in the leverage of the financial sector as a whole drives down lending standards and makes the financial system more fragile.

However, Acharya et al. (2013) show that financial intermediaries frequently retain the risks of securitized assets by providing guarantees to security investors, and hence coin the term "securitization without risk transfer." Securitization without risk transfer is in clear contrast with the traditional risk-transfer view, and is interpreted by Acharya et al. (2013) as evidence supporting the regulatory-arbitrage view on securitization. Calomiris and Mason (2004) study credit card securitization and also find that regulatory arbitrage is an important motivation for securitization. This view is often combined with the idea of "too big to fail" and the resulting abuse of the public safety net. Acharya and Richardson (2009) suggest that banks provide guarantees and retain excessive risks because they are counting on a government bailout if things go bad.

Gornicka (2015) formalizes the regulatory-arbitrage view on securitization in a theoretical model. Her model predicts that, under implicit guarantees, banks may have higher incentives to monitor securitized assets, as the arbitrage motive implies higher profits from the high leverage on the SPV, making the cost of monitoring per unit of securitized assets lower than that of assets on-balance sheet. This prediction is inconsistent with the empirical finding that ex-ante similar assets have a higher default risk if securitized (Keys et al., 2010; Elul, 2015). This inconsistency suggests that regulatory arbitrage is not the sole explanation for securitization. Moreover, non-bank financial insitutions that are not subject to capital regulations constitute a significant portion of securitization markets (Ashcraft and Schuermann, 2008).

Contrary to the risk-transfer view, Gennaioli, Shleifer, and Vishny (2012, 2013) assume that banks have a higher risk capacity and a higher diversification capacity than outside investors. In their setting, banks securitize to facilitate pooling and diversification in order to synthesize risk-free securities demanded by risk-averse investors. Although the risk-sharing structure is consistent with securitization without risk transfer, banks do not achieve this outcome by retaining risks but by diversifying away risks. Their model abstracts from guarantees and does not explicitly model the distinction between on- and off-balance sheet financing.

This chapter provides a novel theory of securitization based on minimizing agency costs that does not suffer the shortcomings of the existing views. As in Gennaioli, Shleifer, and Vishny (2012, 2013), banks have a higher risk capacity than outside investors, but my model assumes that there is aggregate non-diversifiable risk and hence banks bear risks by providing guarantees instead of diversification. The agency cost perspective of this paper emphasizes the difference in the magnitudes of moral hazard under the two funding modes. The desire to reduce or overcome agency costs rationalizes securitization and carries important implications for how intermediaries finance different assets and monitor them ex-post.

The static setup is flexible enough to be easily extended to a dynamic setting to enable the study of both implicit guarantees and explicit guarantees, and the effect of government bailouts on intermediaries' securitization decisions, as I do in Chapter 3. This framework can also be extended to include other market frictions and study their interaction. Chapter 4 studies intermediaries' ex-post monitoring incentives in securitization.

The discussion of tranching versus securitization with guarantees in Section 2.4 is in line with Farhi and Tirole (2015), who argue that bundles are more liquid, as they encourage information-equalizing investment. This model generates a similar effect through the channel of agency costs and explores the optimality of tranching versus securitization with guarantees.

This study is also related to the literature on the benefits of financial innovation. Rajan (2005) argues that financial innovation has made the world better off by expanding opportunities but cautions that innovation without an adequate regulatory framework can make the financial system riskier. Yorulmazer (2013) develops a model of credit default swaps (CDS) and shows that banks only buy cheap CDS for regulatory arbitrage. Korinek (2012) uses a household-banker framework to study how banks can extract rents by creating new markets. My paper suggests a mixed effect of financial innovation. In the benchmark static model, securitization improves welfare by increasing investment and reducing output volatility. This result will be changed when probabilistic government bailouts become available to distressed financial intermediaries (Chapter 3) and when an additional moral hazard in monitoring is introduced (Chapter 4).

2.3 Securitization with Moral Hazard: Benchmark Static Model

2.3.1 Model Setup

Environment The economy lasts for two periods, $t = 0, 1$, and consists of a banking sector with a single good. There are three types of agents – a risk-neutral bank holding company (BHC), a risk-neutral equity investor, and a continuum of competitive and infinitely risk-averse outside investors. The BHC consists of a bank entity and a special purpose vehicle (SPV) if it decides to securitize assets. At $t = 0$, outside investors are endowed with wealth w for consumption and investment. At the same time, the equity investor receives an endowment A and gives it to the BHC as equity. At $t = 1$, the state of the economy is realized. With probability q, the high state is realized, and with probability $1 - q$, the low state is realized. All agents receive no endowments in the second period.

There are two types of assets in this economy – a safe asset available to both outside investors and the BHC, and a risky asset available only to the BHC. The safe asset yields a fixed rate of return $r_S = 1$ in the second period, while the rate of return of the risky asset, x, is stochastic. In the high state, the risky asset yields a rate of return $H > 1$ in the second period; while in the low state, it yields a rate of return $L < 1$. All returns are consumed in the second period.

Outside Investors Deep-pocketed outside investors receive a large amount of a perishable endowment w in period 0 for investment and consumption. As in Gennaioli, Shleifer, and Vishny (2013), investors are infinitely risk-averse in the sense that, ex-ante, they value stochastic consumption in the second period at the worst-case scenario. This assumption is consistent with the high degree of risk aversion seen in actual capital markets (Bernanke et al., 2011).

In the first period, outside investors invest by buying safe assets or financing the BHC either by providing deposits or by buying asset-backed securities (ABS). Outside investors' aggregate endowment is assumed to be large enough to meet all funding needs of the BHC.

The Bank Holding Company

Real Decisions The risk-neutral BHC receives capital A from the equity investor in period 0, and divides the capital between its bank entity and SPV. The BHC maximizes its expected profit by making real and financial decisions. Let X be the total units of investment in the risky asset, among which X_B units are kept on-balance sheet and X_S units are securitized up-front when the asset is originated. All profits generated by the BHC are consumed by the equity investor in the second period. To assure that the BHC has incentives to invest in the risky asset, I assume that the expected return of the risky asset is greater than the safe return:

Assumption 1. *The expected return of the risky asset is greater than 1, i.e.* $qH + (1-q)L > 1$.

Financial Decisions The BHC raises external funding from outside investors through deposit funding and/or securitization. The BHC finances X_B units of the risky asset on-balance sheet with deposits D and the bank entity's capital

A_B. Under securitization, the BHC sets up an SPV and moves X_S units of the risky asset to the SPV. There is no cost of setting up an SPV, and its only role is to sell claims on the risky asset originated by the bank entity. The SPV issues X_S units of ABS. Each ABS is backed by one unit of the risky asset and is sold at a market price p. The sales revenue pX_S and the SPV's capital A_S are used to invest in the risky asset X_S and in an amount RX_S of the safe asset, to hold as reserves to honor guarantees.

Guarantees The BHC can provide guarantees to outside investors. A guarantee is a promise that the BHC pays $\rho \in \mathbb{R}^+$ per unit of ABS to outside investors in the low state, e.g. an investor holding an ABS with a guarantee policy ρ gets $L + \rho$ in the low state and H in the high state. To make guarantees valuable to infinitely risk-averse investors, the BHC promises to stand ready for potential payouts in all states. This implies that the BHC must hold a certain amount of the safe asset as reserves. Reserves are kept on the bank entity's balance sheet.

Moral Hazard The moral hazard problem is modeled similarly to Holmstrom and Tirole (1998): the BHC can divert a portion of the assets held on the bank entity's balance sheet in the second period and default. This moral hazard can be generally interpreted as the incentive of insiders of the BHC to engage in ex-post activities that benefit themselves but hurt outside investors. For example, insiders of a bank may have an incentive ex-post to misuse the cash flows of assets held on-balance sheet, or to take on excessive risks. Insiders benefit from such activities, but outside investors are the ones bearing losses in bad states.

A possible interpretation of the portion that the BHC can divert is that it reflects the transparency of the bank entity's balance sheet. More transparent financial statements make it harder for insiders to misrepresent the level of risk taking or to misuse the cash flows of the assets. Another interpretation of this portion is that it reflects the degree of soft information on an asset that only the BHC possesses. Soft information is defined as information that cannot be reduced to a series of hard numbers (Petersen, 2004). An example of an information-intensive asset is a relationship-based small-business loan. Information intensive assets are difficult for outside investors to value, and thus are more easily diverted by insiders. For instance, if a bank defaults with a small business loan on its balance sheet, it is more likely that the bank can appropriate a large portion of the actual value of the asset, while outside investors bear sizable losses.

Let α_B denote the divertable portion of the risky asset, and α_S the divertable portion of the safe reserves. I make the following assumption:

Assumption 2. *Under deposit funding, the BHC can seize $\alpha_B \in (0, 1)$ of the risky asset held on-balance sheet. Under securitization, the BHC cannot seize the risky asset in the SPV, but can seize $\alpha_S \in (0, 1)$ of the safe reserves held on-balance sheet.*

Knowing this, outside investors and the BHC devise a contract with incentive payments to make the BHC indifferent in period two between defaulting and remaining solvent. As in Holmstrom and Tirole (1998), an efficient contract requires outside investors to grant a portion of the returns to the BHC.

Under deposit funding, the efficient contract features a payoff of $\alpha_B L$ per unit of investment to the BHC in the low state. This incentive payment makes the BHC indifferent between defaulting or not in the low state. Since outside investors are infinitely risk-averse, they must receive a payoff of $(L-\alpha_B L)$ per unit of investment in both states in equilibrium. As a result, the BHC gets the residual return $H-L+\alpha_B L$ in the high state. This high-state payoff ensures that the BHC will not default in the high state, as $H - L + \alpha_B L > \alpha_B H$. Under securitization, investors mandate that the BHC hold reserves in the amount of $R \geq \rho/(1-\alpha_S)$ per unit of investment. In the efficient contract under securitization, the BHC gets $\alpha_S R$ in the low state, and R in the high state. Efficient contracts ensure that no default happens in equilibrium. Table 2.1 tabulates the return allocation in period two between outside investors and the BHC under each funding mode. The "N/A" in the last row means that, under securitization, the BHC does not need to pay out anything to investors in the high state and is entitled to keep all the reserves.

Table 2.1: Return Allocation Per Unit of Investment

Funding modes	State	Divertable	Investors' return	Bank's return
Deposit funding	H	$\alpha_B H$	$L - \alpha_B L$	$H - L + \alpha_B L$
	L	$\alpha_B L$	$L - \alpha_B L$	$\alpha_B L$
Securitization	H	N/A	H	R
	L	$\alpha_S R$	$L + \rho$	$\alpha_S R$

2.3.2 BHC's Optimization Problem and Equilibrium

The BHC maximizes expected total profits from traditional deposit funding and from securitization plus any residual capital. In equilibrium, the BHC never leaves any capital unused.

Formally, the BHC's problem is the following:

$$\max_{A_B, A_S, X_B, X_S, r_D, \rho, p, R} \mathbb{E}\Pi^D + \mathbb{E}\Pi^S + A - A_B - A_S,$$

$$\begin{aligned} \text{subject to} \qquad r_D &\geq 1, && (2.1) \\ min\{L+\rho, H\}/p &\geq 1, && (2.2) \\ A_S + pX_S &\geq X_S + RX_S, && (2.3) \\ R &\geq \rho/(1-\alpha_S), && (2.4) \\ A &\geq A_B + A_S. && (2.5) \end{aligned}$$

The terms $\mathbb{E}\Pi^D$ and $\mathbb{E}\Pi^S$ represent the expected returns from the bank entity and the SPV respectively. Under the efficient contracts, they are given by:

$$\mathbb{E}\Pi^D = [q(H - L + \alpha_B L) + (1-q)\alpha_B L]\, X_B - A_B,$$

and

$$\mathbb{E}\Pi^S = [qR + (1-q)\alpha_S R]\, X_S - A_S.$$

(2.1) is the participation constraint for deposit investors, which says that the return on deposits, $r_D = (1 - \alpha_B)LX_B/(X_B - A_B)$ must be at least as high as the return on the safe asset, which is 1. (2.2) is the participation constraint for ABS investors, which says that the rate of return on ABS, $min\{L + \rho, H\}/p$, must be no less than 1. (2.3) is the period-one cash flow constraint of the BHC under securitization, where the total financing to the SPV, $A_S + pX_S$ (bank's equity plus ABS sales), is allocated between the risky project and safe reserves. (2.4) is the reserve constraint imposed by outside investors, requiring the BHC to hold a sufficient amount of reserves in order to stand ready for guarantee payments. (2.5) says that the BHC can use no more capital than what it receives from the equity investor.

Equilibrium *The equilibrium is defined as an efficient contract between outside investors and the BHC that specifies an allocation* $(A_B, A_S, X_B, X_S, \rho, R)$ *and a price system* (p, r_D) *where (i)* (X_B, X_S, ρ) *maximizes the profit of the BHC, given* (r_D, p)*; (ii) the no short-sale constraint is not violated, such that* $X_B, X_S \geq 0$ *; (iii) the price of the ABS* p *and the deposit rate* r_D *satisfy the individual participation constraints as in (2.1) and (2.2); and (iv) the cash flow and the reserve constraints of the SPV hold as in (2.3) and (2.4), while the capital constraint holds as in (2.5).*

From the BHC's problem, total investment X is bounded by the total capital A and the leverage per unit of capital allowed by investors' participation constraints. Consequently, for a given asset, the BHC chooses the one funding mode that delivers the highest profit. In other words, there will be no partial securitization in this model – if a risky asset suits securitization, its entirety would be moved to the SPV.

Therefore, without loss of generality, I proceed by splitting the problem into two, one under each funding mode. A novel result regarding the choice between deposit funding and securitization is derived at the end of the section: the BHC chooses the optimal funding mode by minimizing agency costs.

2.3.3 Deposit Funding

Under deposit funding, the BHC levers all its capital A for on-balance sheet investment. The BHC's problem is reduced to

$$\underset{X_B, r_D}{max}\ \mathbb{E}\Pi^D = [q(H - L + \alpha_B L) + (1-q)\alpha_B L]\, X_B - A,$$

$$\text{subject to} \qquad r_D \ \geq \ 1, \tag{2.6}$$

where $r_D = (1-\alpha_B)LX_B/(X_B - A)$.

Since outside investors are competitive, participation constraint (2.6) must bind. As a result, the level of investment under deposit funding is given by

$$X_B = \frac{A}{1 - L + \alpha_B L}. \tag{2.7}$$

The expected profit under deposit funding can be written as

$$\mathbb{E}\Pi^D = \frac{A}{1 - L + \underbrace{\alpha_B L}_{\text{agency cost under dep.}}} \left[\mathbb{E}(x) - 1\right], \tag{2.8}$$

where the agency cost under deposit funding is captured by $\alpha_B L$.

Without incentive payments, the bank would get nothing in the low state and $H - L$ in the high state. Hence, the bank has the highest incentive to default in the low state. For each unit of the risky asset, the return in the low state is L, and hence the incentive payment making the bank indifferent between defaulting and not, i.e. the agency rent, is $\alpha_B L$. Because of the moral hazard, the bank can only pledge $(1-\alpha_B)L$ to outside investors per unit of investment. Consequently, the bank needs $(1 - L + \alpha_B L)$ units of internal capital per unit of investment, resulting in the level of investment given by (2.7).

In other words, outside investors require the bank to hold more capital to protect themselves from the moral hazard, and since the bank only has a fixed amount of capital, a higher moral hazard implies a lower leverage and investment. In the absence of moral hazard ($\alpha_B = 0$), the agency cost is zero, and the pledgeable return is L. Therefore, the first-best level of investment is given by $X^{FB} = \frac{A}{1-L}$, where "FB" stands for "first-best."

2.3.4 Securitization with Explicit Guarantees

Under securitization, the BHC finances the risky asset by selling ABS through an off-balance sheet SPV. Sale proceeds of ABS are used to finance the risky asset and the safe asset held as reserves. The BHC chooses the levels of investment and guarantees. A higher level of guarantees increases the price of ABS but exposes the BHC to risks associated with the asset, thus reducing leverage. Since the BHC is risk neutral and outside investors are risk-averse, the optimal risk sharing structure is the BHC bearing all the risks through providing full guarantees. In this section, I show that there is a minimum level of guarantee that is necessary for an active ABS market to exist. In equilibrium, the BHC optimally synthesizes risk-free securities out of risky assets.

Under securitization, the BHC levers its capital A for off-balance sheet investment to maximize expected profits as follows:

$$\underset{X_S,\rho,\,p,\,R}{max} \mathbb{E}\Pi^S = [qR + (1-q)\alpha_S R]\, X_S - A,$$

$$\begin{aligned} \text{subject to} \qquad min\{L+\rho, H\}/p &\geq 1, & (2.9) \\ A + pX_S &\geq X_S + RX_S, & (2.10) \\ R &\geq \rho/(1-\alpha_S). & (2.11) \end{aligned}$$

Because outside investors are competitive, participation constraint (2.9) must bind, and hence the price of ABS will be given by $p = min\,\{L+\rho, H\}$. Investors' infinite risk-aversion narrows the range of ρ to $[0, H-L]$. When $\rho = H-L$, we say that the BHC is providing full guarantees to its ABS investors. Since $\mathbb{E}(x) > 1$, (2.10) and (2.11) must bind, and the level of SPV investment is given by $X_S = \frac{A}{1-L+\alpha_S\frac{\rho}{1-\alpha_S}}$. Using this, one can re-write $\mathbb{E}\Pi^S$ as $\mathbb{E}\Pi^S(X_S) = [(L+\rho) - ((1-q)\rho + 1)]\, X_S$. For a market to exist, the price of ABS, $L+\rho$, must exceed the issuance cost, $(1-q)\rho+1$, and hence the guarantees must reach a minimum level.

Lemma 1. ***(Threshold level of guarantee)*** *There is a unique threshold level of guarantee given by*

$$\hat{\rho} = \frac{1-L}{q}.$$

When $\rho \geq \hat{\rho}$, an active ABS market exists, and the BHC earns a positive unit profit $\pi = L + q\rho - 1$, which is increasing in ρ.

One can check that $\mathbb{E}\Pi^S$ is increasing in ρ, and hence in equilibrium the BHC provides full guarantees, i.e. $\rho = H - L$. Therefore, the BHC's expected profit under securitization is given by

$$\mathbb{E}\Pi^S = \frac{A}{1 - L + \underbrace{\alpha_S \frac{H-L}{1-\alpha_S}}_{\text{agency cost under sec.}}} \left[\mathbb{E}(x) - 1\right], \tag{2.12}$$

where the agency cost under securitization is captured by $\alpha_S \frac{H-L}{1-\alpha_S}$. Correspondingly, the price of the ABS is $p = H$, and the guaranteed ABS yields a rate of return equal to 1.

In the low state, guarantee payments are due, and the BHC has the highest incentive to default and seize α_S of the total amount of reserves $\frac{H-L}{1-\alpha_S}$. Therefore, the incentive payment making the BHC indifferent between defaulting and not, i.e. the agency rent, is $\alpha_S \frac{H-L}{1-\alpha_S}$. Again, moral hazard reduces leverage and investment, and in the absence of moral hazard ($\alpha_S = 0$), the BHC achieves the first-best level of investment $X^{FB} = \frac{A}{1-L}$ under securitization, and we are back in the Modigliani – Miller world.

2.3.5 Optimal Funding Mode and Agency Cost

Having separately derived the expected profits under deposit funding and securitization, the BHC chooses the funding mode that delivers the highest profit. For a given asset, this choice boils down to maximizing leverage, or, equivalently, minimizing agency costs, across funding modes. From equations (2.8) and (2.12), securitization is strictly preferred if the agency cost under securitization is smaller than that under deposit funding.

Proposition 1. *The BHC strictly prefers securitization if* $\alpha_S \frac{H-L}{1-\alpha_S} < \alpha_B L$.

This result implies three observations.

Agency Cost and Information Intensity The agency cost is the product of the *agency rate*, the level of information intensity, and the *agency base*, the unit value of the asset held on-balance sheet. Under deposit funding, the agency rate is α_B and the agency base is simply L. Hence, the agency cost under deposit funding is linear in α_B. Under securitization, the agency rate is α_S and the agency base is $\frac{H-L}{1-\alpha_S}$. Hence, the agency cost under securitization is quadratic in α_S. For assets with high information intensity, both the *agency rate* and *agency base* are high under securitization.

A reduction in the information intensity of the safe reserves increases the profitability of securitizing riskier assets. When $\alpha_S \ll \alpha_B$, securitization may be the most profitable funding mode, even for an asset with a high level of risk, i.e. high $H - L$, which implies a large agency base. This could be the case when reserves are standardized safe assets, e.g. U.S. Treasury securities.

Return Structure and the Agency Cost Mechanism To see how agency costs vary with the mean and the standard deviation of the binomial return distribution, I conduct two experiments. First, I increase the level of risk (standard deviation of the return) in a mean-preserving fashion. Second, I fix the level of risk but increase the mean return. To do this, I re-write $H = \mu + \sigma\sqrt{\frac{1-q}{q}}$ and $L = \mu - \sigma\sqrt{\frac{q}{1-q}}$, where $\mu = \mathbb{E}(x)$ and $\sigma = std(x)$. Using this formulation, the agency costs under the two funding modes are given by:

$$\begin{aligned}\text{Deposit funding agency cost} &= \alpha_B\left(\mu - \sigma\sqrt{\frac{q}{1-q}}\right),\\ \text{Securitization agency cost} &= \frac{\alpha_S}{1-\alpha_S}\left(\frac{\sigma}{\sqrt{q(1-q)}}\right).\end{aligned}$$

The deposit funding agency cost is increasing in μ and decreasing in σ. Under deposit funding, for a given risk level, a higher mean return implies a higher return in the low state, leading to a higher agency cost. For a given mean return, a higher risk implies a lower return in the low state, implying a lower agency cost. On the contrary, the agency cost under securitization is not affected by the mean return and is increasing in the risk level. Higher risks imply larger reserves in securitization, and hence higher agency costs. For a given information intensity, an asset's return structure determines its optimal funding mode: an asset with low risk and high mean return is most likely to be securitized. When there are multiple assets, the BHC ranks assets according to both expected return and agency cost. This is discussed in Section 2.3.7.

I use the term *agency cost mechanism* to refer to the channel by which safer assets are securitized and riskier ones are held on-balance sheet in the benchmark static model. High-risk assets generate low agency costs under deposit funding, but high agency costs under securitization.

Output and Welfare For a given asset, when only deposit funding is allowed, the level of investment is given by $\frac{A}{1-L+\alpha_B L}$; after the introduction of securitization, the level of investment is given by $max\left\{\frac{A}{1-L+\alpha_B L}, \frac{A}{1-L+\alpha_S \frac{H-L}{1-\alpha_S}}\right\}$. Therefore, securitization weakly increases total investment and the expected aggregate output. If investment in the risky asset is socially optimal, securitization also increases welfare.

2.3.6 Threshold Information Intensity

In the previous section, I discussed the case of $\alpha_S \ll \alpha_B$, in which it can be optimal to securitize risky assets due to the low information intensity of reserves. To emphasize the role of agency costs, I henceforth assume that the divertable portion of the risky asset and the reserves are identical, i.e. $\alpha_B = \alpha_S = \alpha$. This assumption also suits better the interpretation of the divertable portion as representing the transparency of financial statements. Since the deposit funding agency cost is linear in α and the securitization agency cost is quadratic in α, there is a unique threshold information intensity, below which securitization strictly dominates.

Corollary 1. *Assuming $\alpha_B = \alpha_S = \alpha$, there is a unique threshold information intensity $\alpha_0 = 2 - H/L$. For $\alpha \in [0, \alpha_0)$, securitization with guarantees strictly* *dominates deposit funding. For $\alpha \in (\alpha_0, 1]$, deposit funding strictly dominates. When $\alpha = \alpha_0$, the BHC is indifferent between deposit funding and securitization. The threshold α_0 is increasing in L and decreasing in H.*

To see how the risk level affects this threshold information intensity, I re-write α_0 in terms of the mean μ and the standard deviation σ of the binomial return distribution.

Corollary 2. *The threshold α_0 can be written as $\alpha_0 = 2 - \frac{\mu+\sigma\sqrt{\frac{1-q}{q}}}{\mu-\sigma\sqrt{\frac{q}{1-q}}}$, which is increasing in μ and decreasing in σ.*

From Corollary 2, riskier assets have a lower threshold level of information intensity and are less likely to be securitized. Again, this is the *agency cost mechanism* – the agency cost in risk taking is high under securitization but low under deposit funding.

What to Securitize? The predictions of the static model are in line with the observation that mortgage loans are much more likely to be securitized than small business loans. In the context of the model, the high-state return of a loan asset is the full payment with interest, while the low-state return is what banks get when borrowers default. In general, small business loans carry higher interest rates and are riskier than mortgage loans. With residential property as collateral, banks get the market value of the house if a mortgage borrower defaults. Although small business loans also have physical capital as collateral, the value of business capital depreciates considerably if the business fails. From the lens of this model, the high return volatility of small business loans elevates the securitization agency cost, making securitization undesirable. Also, α is presumably higher for small business loans than mortgages, increasing the agency costs associated with securitizing small business loans.

Prior to the recent crisis, the ABS market was particularly concentrated in mortgage assets (Gorton and Metrick, 2010). One explanation is the optimism regarding collateral values of real estate. In a booming housing market, banks believed that they could quickly sell these assets at minimal loss in the event of default. Optimism and low mortgage interest rates translate into a high L and low H, making securitization particularly profitable.

Another example of securitization with guarantees is credit card securitization. Individual credit card loans carry high interest rates and can be highly risky, but the associated risks are idiosyncratic and hence diversifiable.

2.3.7 Agency Costs and Asset Ranking

In an environment with multiple limited-supplied assets, the introduction of securitization alters the BHC's ranking of assets. From (2.8) and (2.12), the BHC computes scores of assets under deposit funding and securitization according to the following formulas:

$$\Upsilon^B = \frac{\mu - 1}{1 - (1-\alpha)\mu + (1-\alpha)\sqrt{\frac{q}{1-q}}\sigma},$$

$$\Upsilon^S = \frac{\mu - 1}{1 - \mu + \left[\frac{1}{(1-\alpha)}\sqrt{\frac{q}{1-q}} + \frac{\alpha}{1-\alpha}\sqrt{\frac{1-q}{q}}\right]\sigma}.$$

If securitization is not an option, the BHC ranks assets according to Υ^B. When both funding modes are available, assets are ranked according to $max\left\{\Upsilon^B, \Upsilon^S\right\}$. I conduct four experiments to illustrate how securitization affects the rank of assets. In the first three experiments, I vary only one of three parameters of the risky asset (α, μ, σ) and keep the other two unchanged. In the fourth experiment, I vary two parameters at the same time. Recall that μ and σ are the mean and the standard deviation of the binomial stochastic return x.

Panel A of Figure 2.1 plots the scores of assets with the same α and μ but different σ. Both scores are declining in the level of risk, with the securitization score higher at low risk levels. Similarly, panel B plots the scores of assets with the same α and σ but different μ. The effect of mean return on the optimal funding mode is very weak. In almost all parameterizations, the two scores do not cross for a wide range of μ. However, the advantage of a certain funding mode increases with μ. In the plotted parametrization, securitization dominates deposit funding because of the low σ, and the advantage of securitization over deposit funding is increasing in μ. For a higher σ, deposit funding would dominate, and its advantage would also increase in μ. Panel C plots the scores of assets with the same μ and σ but different α. Securitization dominates for assets with lower information intensity. In these three experiments, with both funding modes available, the ranking score is the upper contour of the two curves. Although for some assets the optimal funding mode is changed, the rank is preserved.

Figure 2.1: Scores of Assets

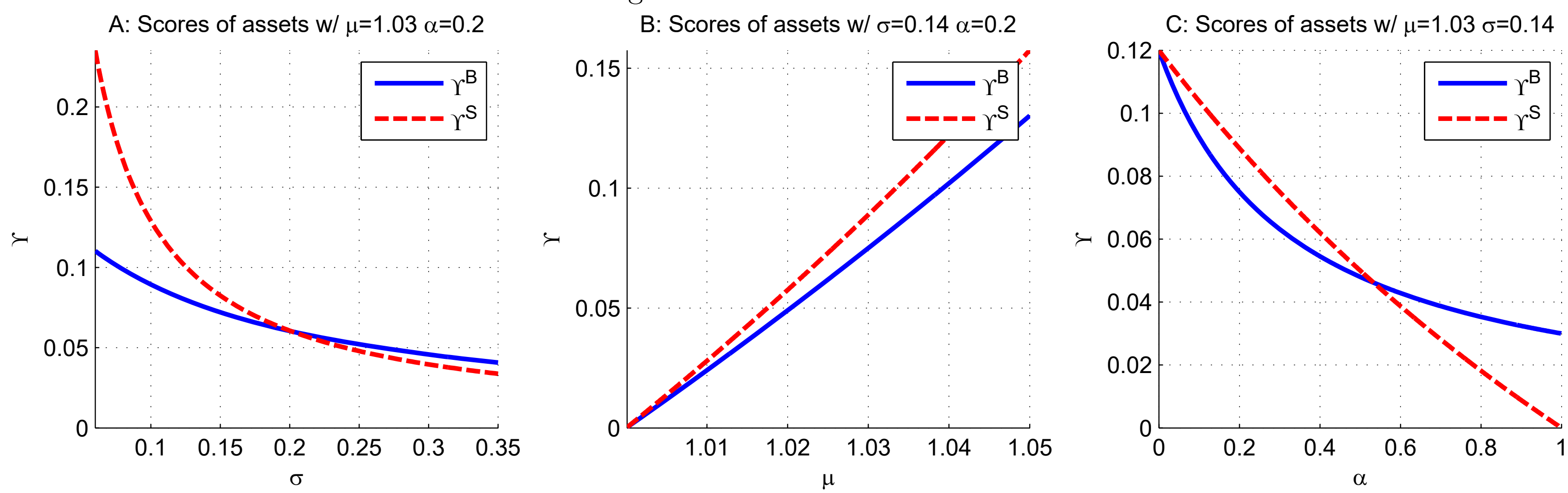
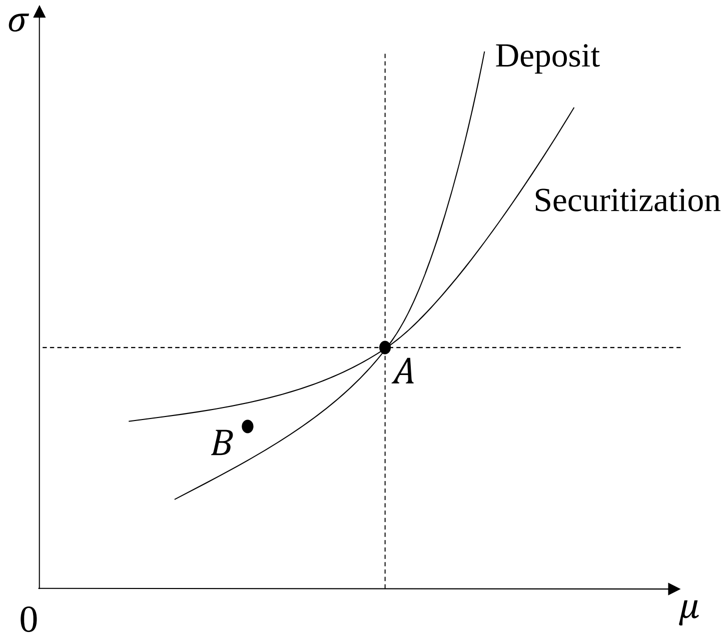


Figure 2.2: Rank of Assets



When assets differ in more than one dimension, the rank can be altered by the introduction of securitization. Figure 2.2 plots iso-profit curves under deposit funding and securitization for assets with a given α but different μ and σ. As the profit under securitization is more sensitive to the risk level, the iso-profit curve under securitization is flatter than that under deposit funding, and they cross at point A. To the north-east of A, deposit funding dominates, and to the south-west of A, securitization dominates. Imagine there are two assets, given by point A and B – an arbitrary point between the two indifference curves to the left of A. With only deposit funding available, A achieves higher profits. The bank would first invest in A using deposits and then move to B. With both funding modes available, the preference is reversed. In the region of B, securitization is the preferred funding mode, and according to the iso-profit curve under securitization, B is superior to

A. Therefore, the BHC would prioritize securitizing B and then securitize A. The introduction of securitization elevates the rank of assets with low risk and low mean return.

2.4 Optimal Security Structure with Moral Hazard

2.4.1 Overview

This section explores the optimality of two commonly used security designs in securitization, namely tranching and securitization with guarantees.

As discussed in the previous section, securitization with guarantees involves selling an entire asset to risk-averse outside investors. By providing full guarantees, banks synthesize risk-free securities out of risky assets to appeal to outside investors' demand for safe assets. To stand ready for potential guarantee payments, banks have to hold reserves on-balance sheet. Due to the moral hazard of insiders diverting assets, holding reserves on-balance sheet inflicts agency costs on banks using securitization with guarantees.

Another security structure that can be employed to meet the demand for safe assets is tranching. In tranching, the return of the risky asset is "tranched" into a safe component and a risky component, and the two components are sold separately. The safe component is called the senior tranche, while the risky one is referred to as the junior tranche or equity tranche. Facing demand for risk-free assets, banks sell the senior tranche and retain the equity tranche. In this way, banks do not have to hold reserves to satisfy outside investors, and as a result, the agency costs associated with reserves can be avoided.

Therefore, tranching can be superior to securitization with guarantees in that it avoids agency costs. However, when information on the underlying asset is asymmetric between banks and outside investors, tranching can suffer a higher degree of adverse selection than securitization with guarantees. Since only a piece of the underlying asset is being sold, it is harder for outside investors to identify the quality of the asset under asymmetric information. The optimal security structure therefore entails a trade-off between reducing agency costs and overcoming adverse selection.

This section shows that securitization with guarantees is the optimal structure when the assets being securitized are sufficiently heterogeneous in quality and the highest quality assets are perceived to be sufficiently safe. This prediction is consistent with the popularity of securitization with guarantees in the pre-crisis ABCP market, whose underlying assets were mostly residential mortgages and RMBS. In most cases, ABCP conduits only disclose rough compositions of the underlying pool of assets but never the asset-specific information of the portfolio to outside investors. The introduction of subprime mortgages and the many new types within subprime made the underlying assets of ABCPs more heterogeneous in quality, while the housing boom and the low interest rates caused prime mortgages be considered very safe prior to the crisis.

I extend the benchmark static model to allow for asymmetric information on asset quality. I assume that there are two types of asset (a good type and a "lemon" type), and the type is privately revealed to the BHC but not investors. Before meeting with outside investors, the BHC observes the asset type and the cost to signal. After observing these, the BHC decides whether or not to send a signal saying that the asset is a good one (henceforth a signal) and simultaneously chooses the security structure. Since the BHC chooses the security structure after observing its type and the signaling cost, the BHC can potentially use both the signal and security structure to indicate the quality of the asset.

Signaling incurs a fixed cost that is paid using the BHC's capital. This cost can be interpreted as the BHC's expenses on advertising and marketing, or the cost to obtain a good rating from rating agencies. While I assume that it is more costly for the BHC to signal for a lemon, the benefit of signaling may sometime exceed the cost, and as a result, pooling equilibria may arise.

As investors are infinitely risk-averse and signaling is costly, in a pooling equilibrium, the BHC never signals regardless of asset quality. When the cost to signal is sufficiently high for a lemon and sufficiently low for a good asset, a separating equilibrium arises, and investors can identify a bank's type according to the observed signal and security structure.

In this section, I first characterize the range of the signaling cost for a good asset and for a lemon respectively that can sustain a separating equilibrium under each security structure. In this part, I assume that the BHC takes security structure as given ex-ante.

With the advancement of information technology, the gap in the cost of signaling between lemons and good assets has arguably decreased over time. Assuming that signaling is sufficiently cheap for good assets under either security structure, the key question is then how costly signaling for a lemon has to be to induce a separating equilibrium under the two security structures. Therefore, the analysis focuses on the lower bound of the signaling cost for a lemon, above which a separating equilibrium exists.

I show that the minimum signaling cost for a lemon is lower when an asset is securitized whole-piece with guarantees, suggesting that whole-piece securitization has an advantage in overcoming adverse selection. This outcome is consistent with Farhi and Tirole (2015), who show that bundles encourage information-equalizing investments, and thereby facilitate trade.

Intuitively, signaling affects the BHC's expected profit by ameliorating adverse selection. In tranching, given the absence of agency costs, adverse selection is the only friction that parts the BHC from its first-best profit. As a result, signaling has a larger effect on profit under tranching, which increases the temptation for a bad bank to signal. By contrast, the agency costs in whole-piece securitization reduce the benefit of signaling, thereby increasing the credibility of low-cost signals.

Even though this result is the same outcome as Farhi and Tirole (2015), the mechanism is completely different. In Farhi and Tirole (2015), bundles, or whole-pieces, are harder to trade with asymmetric information, and therefore encourage information-equalizing investment. Here, the agency costs in whole-piece securitization reduce the effectiveness of signaling in boosting profits, and as a result, the incentive to send a fake positive signal is weaker.

After establishing the superiority of securitization with guarantees in overcoming adverse selection, I study the trade-off between securitization with guarantees and tranching when security structure is chosen *endogenously* while making signaling decisions.

The BHC internalizes the effect of security structure on the type of equilibrium that can be sustained. Three kinds of situations may arise. (I) On the one extreme, if the observed signaling cost for a lemon is sufficiently high, a separating equilibrium can arise under either security structure. Given that tranching helps the BHC avoid agency costs, the optimal security structure is tranching.

(II) On the other extreme, if the observed signaling cost for a lemon is sufficiently low, a separating equilibrium could never exist under either security structure. In this case, no one signals, and the optimal security structure is again tranching.

(III) With an intermediate signaling cost for a lemon, security structure affects equilibrium type. In this case, a separating equilibrium can be sustained under securitization with guarantees but not under tranching. Thus, with an intermediate signaling cost for a lemon, a good bank can potentially use both a signal and the security structure of securitization with guarantees to stand out.

The exact cutoff signaling cost for a lemon that differentiates cases (II) and (III) comes from the incentive compatibility constraint that ensures a bad bank using tranching would better off not signaling. This constraint yields the minimum signaling cost for a lemon that can sustain a separating equilibrium under *endogenous security structure*.

Finally, I characterize equilibrium outcomes for both good and bad banks at different levels of the signaling cost for a lemon. I present the condition under which tranching is dominated by securitization with guarantees: for a good bank, it is optimal to securitize with guarantees when adverse selection is severe and the underlying risky asset is relatively safe.

2.4.2 Setup

The BHC has access to one asset, and the quality of the asset is revealed only to the BHC before it meets with outside investors. A good asset yields $H > 1$ in the high state and $L < 1$ in the low state, while a "lemon" yields the same in the high state but $L - \delta$ in the low state. For simplicity, I label the BHC a "good bank" if the asset quality is revealed to be good and a "bad bank" otherwise.

After observing the quality of the asset, the BHC observes the cost to signal. Sending a positive signal incurs a fixed cost C_g if the asset is a good one, or C_b if the asset is a lemon. Both C_g and C_b are observable: the BHC observes its own signaling cost and the signaling cost of the other type, and outside investors observe the two costs as well. The signaling cost is paid by the BHC, using its own capital, A. After observing the asset quality and the signaling cost, the BHC decides whether or not to send a positive signal and announces a security structure. Throughout this section, to focus on the analysis of security structure, I assume that the only funding mode available is securitization. Or equivalently, the following analysis is conducted in the parameter space where securitization under either structure dominates deposit funding.

After observing the signal and security structure, investors form beliefs about the quality of the asset and provide funds to the BHC accordingly.

I assume that it is more costly to signal if the BHC is a bad bank. Formally, this assumption is given by:

$$C_g < C_b,$$

where the subscript "g" stands for good and "b" stands for bad.

To make the question interesting, I assume that banks have enough capital to signal regardless asset quality:

$$C_b < A.$$

Note that all results in this section are robust to whether the signaling cost is fixed or proportional. Appendix B presents the analysis in an alternative setting where the signaling cost is proportional to the level of investment. One caveat is that, when the cost of signaling is proportional, full pre-payment may not be possible. In the Appendix, I assume that the bank has a separate source of working capital to finance the cost of signaling and repays in full at the end of the second period before allocating returns to outside investors.

Under each security structure, two types of equilibria may arise in this signaling setting: a pooling equilibrium in which both types either always signal or do not signal; and a separating equilibrium in which only the good type signals.

Since investors are infinitely risk-averse and signaling is costly, from the BHC's perspective, there is no point to signal in a pooling equilibrium, as investors would always treat the asset as a lemon. Thus, the BHC only signals when a separating equilibrium can exist. Therefore, when a certain security structure is superior in terms of inducing a separating equilibrium, it is equivalent to conclude that this security structure encourages information-equalizing investment, using the terminology of Farhi and Tirole (2015).

In the following two subsections, I derive the threshold signaling costs that can sustain a separating equilibrium.

2.4.3 Signaling under Securitization with Guarantees

This section characterizes the sufficient set of conditions on the signaling cost under which a separating equilibrium arises under securitization with guarantees. In this section, I assume that the BHC takes as given that it can only offer whole-piece securitization with guarantees. Later, we will allow the BHC to choose either whole-piece securitization or tranching.

For a separating equilibrium to exist, two incentive compatibility constraints must be satisfied – one that ensures that a bad bank would not signal, and one that ensures that a good bank would signal. In other words, it must be (i) sufficiently cheap for a good bank to signal and (ii) sufficiently expensive for a bad bank not to signal. I start by characterizing the threshold signaling cost that satisfies incentive compatibility (i).

Let $\mu = qH + (1-q)L$ denote the expected return on a good asset. Recall that the low-state return of a "lemon" is $L - \delta$, and hence, with symmetric information, the agency cost per unit of asset for a lemon under securitization with guarantees is $\frac{\alpha}{1-\alpha}(H - L + \delta)$.

Conditional on a separating belief, when a good bank signals, investors believe that the low state return of the asset is L, and the agency cost per unit of asset is then $\frac{\alpha}{1-\alpha}(H-L)$. Therefore, the pledgeable return per unit of asset when a good bank signals is

$$L - \frac{\alpha}{1-\alpha}(H-L).$$

Since the BHC has to use some of its capital to signal, the residual capital available to lever up is $A - C$, and therefore a good bank that signals achieves a level of investment given by

$$X_{eq}^{g} = \frac{A-C}{1-L+\frac{\alpha}{1-\alpha}(H-L)},$$

where the superscript "g" stands for a good bank, and the subscript "eq" indicates that the BHC stays on the equilibrium path. It immediately follows that the equilibrium expected profit of a good bank is

$$\pi_{eq}^{g} = \frac{A-C}{1-L+\frac{\alpha}{1-\alpha}(H-L)}(\mu-1) - C.$$

Now consider the case where a good bank deviates from the equilibrium path and does not signal. In this case, investors do not observe the signal and believe that the low state return of the asset is $L-\delta$, and the agency cost per unit of asset is then $\frac{\alpha}{1-\alpha}(H-L+\delta)$. Conditional on this belief, the level of investment that the BHC can achieve is

$$X_{offeq}^{g} = \frac{A}{1-L+\delta+\frac{\alpha}{1-\alpha}(H-L+\delta)}.$$

In this case, the high state payoff per unit of asset to the BHC is the entire reserve $\frac{1}{1-\alpha}(H-L+\delta)$. Note that, in this case, the asset is good, but investors requires the BHC to hold more reserves than necessary as they believe the asset is a lemon based on the missing signal. As a result, if the low state is realized, the BHC does not need to pay out $H-L+\delta$, but just $H-L$ to make investors happy. Therefore, the low state payoff to the BHC per unit of asset is $\frac{1}{1-\alpha}(H-L+\delta)-(H-L)$, which are the residual reserves after paying out the necessary payments to make investors happy. The off-equilibrium expected profit is then given by:

$$\pi^g_{offeq} = X^g_{offeq}\left[q\frac{H-L+\delta}{1-\alpha} + (1-q)\left(\frac{H-L+\delta}{1-\alpha} - (H-L)\right)\right] - A. \tag{2.13}$$

One can easily show that (2.13) is equivalent to

$$\pi^g_{offeq} = \frac{A}{1-L+\delta+\frac{\alpha}{1-\alpha}(H-L+\delta)}\left(\mu-1\right).$$

To induce a good bank to stay on the equilibrium path and signal, the equilibrium profit must be not smaller than the off-equilibrium profit, i.e. $\pi^g_{eq} \geq \pi^g_{offeq}$. This condition gives rise to the maximum signaling cost for a good bank under whole-piece securitization with guarantees that can sustain a separating equilibrium:

$$C_g \leq \bar{C}^W_g,$$

where $\bar{C}_g^W$ satisfies the following equation:

$$\frac{A-\bar{C}_g^W}{1-L+\frac{\alpha}{1-\alpha}(H-L)}(\mu-1)-\bar{C}_g^W=\frac{A(\mu-1)}{1-L+\delta+\frac{\alpha}{1-\alpha}(H-L+\delta)}. \tag{2.14}$$

Intuitively, in a separating equilibrium, on the one hand, signaling has the benefit of increasing investment, captured by the two δs in the denominator on the right-hand side. But on the other hand, signaling subtracts from the BHC's capital, which is not only a fixed cost, as captured by the second term on the left-hand side, but also a restraint on the level of investment, as captured by the $\bar{C}_g^W$ in the numerator of the first term on the left-hand side. For a good bank to signal in equilibrium, the cost must be sufficiently small.

Now I turn to characterize the threshold signaling cost that satisfies incentive compatibility constraint (ii): it is sufficiently expensive to signal so that a bad bank would not signal.

Conditional on a separating belief, if a bad bank does not signal, investors believe that the low-state return is $L-\delta$, and the agency cost per unit of asset is $\frac{\alpha}{1-\alpha}(H-L+\delta)$. It is easy to see that the expected profit on the equilibrium path under securitization with guarantees is given by:

$$\pi_{eq}^b=\frac{A}{1-L+\delta+\frac{\alpha}{1-\alpha}(H-L+\delta)}\left[\mu-1-(1-q)\delta\right].$$

Now consider the case where a bad bank deviates and sends a signal. In this case, conditional on a separating belief, investors will think that the asset is good and the pleageable return per unit of asset is $L - \frac{\alpha}{1-\alpha}(H-L)$. Under this belief, the BHC raises funds enough to finance an investment of

$$X^b_{offeq} = \frac{A - C}{1 - L + \frac{\alpha}{1-\alpha}(H-L)}.$$

In this case, the high state payoff to the BHC per unit of asset is the entire reserve holding $\frac{1}{1-\alpha}(H-L)$. In the low state, the BHC will fall short of the reserves needed to pay off investors in full, and when this happens, the BHC defaults and diverts α of the reserve holding $\frac{1}{1-\alpha}(H-L)$. Therefore, the low state payoff to the BHC is $\frac{\alpha}{1-\alpha}(H-L)$. The off-equilibrium expected profit is given by:

$$\pi^b_{offeq} = \frac{A - C}{1 - L + \frac{\alpha}{1-\alpha}(H-L)} \left[q\frac{H-L}{1-\alpha} + (1-q)\alpha\frac{H-L}{1-\alpha} \right] - A. \tag{2.15}$$

Equation (2.15) can be easily simplified to:

$$\pi^b_{offeq} = \frac{A - C}{1 - L + \frac{\alpha}{1-\alpha}(H-L)} (\mu - 1) - C.$$

For a given C and conditional on a separating belief, the off-equilibrium expected profit of a bad bank is the same as the equilibrium expected profit of a good bank, π^g_{eq}.

The incentive compatibility constraint to ensure that a bad bank does not signal is $\pi^b_{eq} \geq \pi^b_{offeq}$, which yields the minimum signaling cost for a lemon needed to sustain a separating equilibrium as:

$$C_b \geq \underline{C}_b^W,$$

where $\underline{C}_b^W$ satisfies the following equation:

$$\frac{A\left[\mu - 1 - (1-q)\delta\right]}{1 - L + \delta + \frac{\alpha}{1-\alpha}(H - L + \delta)} = \frac{A - \underline{C}_b^W}{1 - L + \frac{\alpha}{1-\alpha}(H - L)}(\mu - 1) - \underline{C}_b^W. \tag{2.16}$$

Intuitively, the cost of signaling must be high enough to outweigh the benefit of signaling for a bad bank. In a separating equilibrium, signaling increases not only the level of investment, captured by the two δs in the denominator on the left-hand side, but also the unit profit, captured by the δ in the numerator on the left-hand side. This is because the BHC can always default in the low state and seize a fraction of the reserves, which makes a bad bank's payoff equal to a good bank's payoff in the low state. Again, the signaling cost is both a fixed cost and a restraint on the level of investment, as the BHC uses its own capital to pay for the signal.

This lower bound, $\underline{C}_b^W$, is of particular interest. Given the advancement of information technology, signaling has arguably become less costly, so it has become less likely that the upper bound on the signaling cost for a good bank is the binding constraint. Hence, the lower bound for a bad bank is increasingly crucial in determining the type of equilibrium that arises.

It is easy to check using (2.14) and (2.16) that $\underline{C}_b^W > \bar{C}_g^W$, which is intuitive, because for a separating equilibrium to arise, it is a necessary condition that the cost for a bad bank to signal is higher than that for a good bank. Otherwise, the BHC would always signal, and a separating equilibrium could never exist.

I summarize the above results in the following lemma:

Lemma 2. *Under securitization with guarantees (whole-piece securitization), the necessary and sufficient condition for a separating equilibrium to exist is:*

$$C_g \leq \bar{C}_g^W \text{ and } C_b \geq \underline{C}_b^W,$$

where $\bar{C}_g^W$ and $\underline{C}_b^W$ are the solutions to equation (2.14) and (2.16) respectively.

2.4.4 Signaling under Tranching

This section repeats the same exercise for the case in which the BHC must divide the asset's returns into two tranches. In tranching, the return of the asset is split into a safe part, i.e. the senior tranche, and a risky part, i.e the junior tranche, and the two parts are sold separately. Facing demand for risk-free assets from outside investors, the BHC sells the senior tranche and retains the junior tranche. In this way, the BHC is not holding reserves liable to outside investors, and thus the agency costs associated with holding reserves can be avoided.

For a good asset, the low state return is L, and hence the fair price of the senior tranche of one unit of the good asset is L. Therefore, the level of investment under symmetric information is $\frac{A}{1-L}$. For a lemon, the low state return is $L - \delta$, the fair price of the senior tranche is $L - \delta$, and thus the full-information level of investment is $\frac{A}{1-L+\delta}$. The payoff to the BHC is the residual return in the high state and low state. With symmetric information, the residual return to the junior tranche is 0 in the low state. In the high state, the residual return to the BHC is $H-L$ for a good asset and $H-L+\delta$ for a lemon.

Following the same logic in the previous section, the equilibrium payoff of a good bank that signals is given by:

$$\pi_{eq}^{g} = \frac{A-C}{1-L}\left(\mu-1\right) - C.$$

In the case where a good bank deviates from the equilibrium path and does not signal, its expected profit is:

$$\pi_{offeq}^{g} = \frac{A}{1-L+\delta}\left[q(H-L+\delta)+(1-q)\delta\right] - A.$$

This expression arises because, conditional on a separating belief, a missing signal reduces the level of investment to $\frac{A}{1-L+\delta}$, and investors expect to get $L-\delta$ per unit of the senior tranche in either state. In the high state where the asset yields H, the residual return is $H-L+\delta$. In the low state, investors only expect $L-\delta$, whereas the asset yields L, so the residual return to the BHC is δ. It is easy to see that

$$\pi_{offeq}^{g} = \frac{A}{1-L+\delta}\left(\mu-1\right).$$

In a separating equilibrium, the incentive constraint $\pi_{eq}^{g} \geq \pi_{offeq}^{g}$ must hold, from which the maximum signaling cost for a good bank to sustain a separating equilibrium is:

$$C_g \leq \bar{C}_g^T,$$

where $\bar{C}_g^T$ satisfies the following equation:

$$\frac{A - \bar{C}_g^T}{1 - L}(\mu - 1) - \bar{C}_g^T = \frac{A}{1 - L + \delta}(\mu - 1). \tag{2.17}$$

Similarly, the equilibrium expected profit of a bad bank is given by:

$$\pi_{eq}^b = \frac{A}{1 - L + \delta}\left[\mu - 1 - (1 - q)\delta\right].$$

In the case where a bad bank deviates from the equilibrium path and signals, the level of investment would be $\frac{A-C}{1-L}$, and investors would expect to get L in both states. In the high state, the asset yields H, and the BHC gets the residual $H - L$. However, in the low state, the asset yields $L - \delta$, which is less than what investors are expecting. In this case, the residual return to the BHC is 0, and investors would suffer a loss. Therefore, the off-equilibrium expected profit of a bad bank is given by:

$$\pi_{offeq}^b = \frac{A - C}{1 - L}\left[q(H - L) + (1 - q)0\right] - A,$$

which is equivalent to

$$\pi_{offeq}^b = \frac{A - C}{1 - L}(\mu - 1) - C.$$

In a separating equilibrium, the incentive constraint $\pi_{eq}^b \geq \pi_{offeq}^b$ must hold, from which the minimum signaling cost for a bad bank to sustain a separating equilibrium is:

$$C_b \geq \underline{C}_b^T,$$

where $\underline{C}_b^T$ satisfies the following equation:

$$\frac{A}{1-L+\delta}\left[\mu - 1 - (1-q)\delta\right] = \frac{A - \underline{C}_b^T}{1-L}\left(\mu - 1\right) - \underline{C}_b^T. \tag{2.18}$$

The two thresholds for the cost of signaling under tranching are summarized in the following lemma:

Lemma 3. *Under tranching, the necessary and sufficient condition for a separating equilibrium to exist is:*

$$C_g \leq \bar{C}_g^T \text{ and } C_b \geq \underline{C}_b^T,$$

where $\bar{C}_g^T$ and $\underline{C}_b^T$ are the solutions to equation (2.17) and (2.18) respectively.

Again, it is easy to check that $\underline{C}_b^T > \bar{C}_g^T$. The minimum signaling cost for a bad bank must be higher than that for a good bank to support a separating equilibrium.

2.4.5 Optimal Security Structure

Having characterized the range of signaling costs that can sustain a separating equilibrium under each given security structure, I now turn to the case in which the BHC can choose the security structure as well as whether or not to signal.

To lay a foundation for studying the case of an *endogenous* security structure, I first compare the range of signaling costs under the two structures that can sustain a separating equilibrium.

Comparing $\underline{C}_b^W$ defined in Lemma 2 and $\underline{C}_b^T$ defined in Lemma 3, one can get the following result. See Appendix A for proof.

Lemma 4. *When there is moral hazard, i.e.* $\alpha \in (0, 1)$*, the minimum signaling cost for a bad bank to sustain a separating equilibrium is higher under tranching than under securitization with guarantees:*

$$\underline{C}_b^T > \underline{C}_b^W.$$

This result suggests that securitization with guarantees has an advantage in overcoming adverse selection. If the cost of signaling is generally low due to advances in information technology, Lemma 4 implies that it is easier to sustain a separating equilibrium under securitization with guarantees than under tranching. Since the BHC only pays to signal if a separating equilibrium can arise, this implies that whole-piece securitization has an advantage in encouraging information-equalizing investment, using the language of Farhi and Tirole (2015).

Intuitively, when agency costs are absent, as in the case of tranching, adverse selection is the only friction that parts the BHC from its first-best profit. As a result, signaling has a larger effect on profit under tranching, which increases the temptation for a bad bank to signal. By contrast, the agency costs in whole-piece securitization reduce the impact of signaling on profit, thereby increasing the credibility of low-cost signals.

Even though this result is the same outcome as Farhi and Tirole (2015), the mechanism is completely different. In Farhi and Tirole (2015), bundles, or whole-pieces, are harder to trade with asymmetric information, and therefore encourage information-equalizing investment. Here, the agency costs in whole-piece securitization reduce the effectiveness of signaling in boosting profits, and as a result, the incentive to send a fake positive signal is weaker.

This result is very important in deriving the optimal security structure, as it shows that, in a certain *intermediate range* of signaling cost for a lemon, the security structure affects the type of equilibrium that can arise.

In what follows, I derive the minimum signaling cost for a lemon that defines the lower bound of this *intermediate range*. The upper bound is naturally the minimum signaling cost for a lemon under tranching. These two bounds divide the equilibrium outcomes into three cases. I characterize, in each case, outside investors' beliefs, the BHC's signaling decision, and the optimal security structure.

Note that, in the previous two sections, security structure was taken as exogenous when deriving the threshold signaling cost to sustain a separating equilibrium. In the following, I allow the BHC to choose security structure simultaneously with its choice of whether or not to signal, internalizing that whole-piece securitization has an advantage in overcoming adverse selection.

High Signaling Cost When $C_b \geq \underline{C}_b^T$, where $\underline{C}_b^T$ is the solution to (2.18), a separating equilibrium exists under either security design. Since tranching helps the BHC avoid agency costs, the BHC would always choose to tranche the asset, and therefore the condition in (2.18) still applies. Knowing that the signaling cost for a lemon is sufficiently high, outside investors believe that the asset is good whenever they see a signal, under both security structures. In this case, only a good bank signals.

Low Signaling Cost When $C_b < \underline{C}_b^T$, a separating equilibrium could never arise if the BHC used tranching. In this case, whole-piece securitization with guarantees can potentially play a role in helping a good bank overcome adverse selection.

In this region, there are two cases. First, imagine that the signaling cost for a bad bank is lower than a certain threshold, say $\hat{C}_b^W$. In this case, a separating equilibrium could never arise even when the BHC uses securitization with guarantees. With no hope of arriving at a separating equilibrium, the BHC would never signal, and since there is no benefit from using securitization with guarantees, it would always use tranching to avoid agency costs.

When the signaling cost for a bad bank increases to a level higher than $\hat{C}_b^W$ but lower than $\underline{C}_b^T$, a good bank would signal under securitization with guarantees, but not under tranching. In this region, a separating equilibrium can be sustained under securitization with guarantees. To ensure that a separating equilibrium can indeed exist, we just need to make sure that a bad bank would be better off not signaling. In Section 2.4.3, I evaluated the off-equilibrium expected profit of a bad bank that signals under *securitization with guarantees*, where security structure was given exogenously. Here, the BHC can choose its security structure, and since tranching avoids agency costs, the expected profit of a bad bank in a separating equilibrium should be evaluated under the security structure of *tranching*.

Therefore, to ensure that a bad bank would indeed better off not signaling, the following condition must hold:

$$\frac{A\left[\mu-1-(1-q)\delta\right]}{1-L+\delta} \geq \frac{A-C}{1-L+\frac{\alpha}{1-\alpha}(H-L)}(\mu-1)-C.$$

The left hand side is the expected profit of a bad bank when it does not signal and it tranches. The right hand side is the expected profit if a bad bank signals and chooses whole-piece securitization in order to pool with the good bank.

This condition yields the minimum signaling cost for a bad bank under endogenous security structure to sustain a separating equilibrium, $\hat{C}_b^W$, which is the solution to the following equation:

$$\frac{A\left[\mu-1-(1-q)\delta\right]}{1-L+\delta} = \frac{A-\hat{C}_b^W}{1-L+\frac{\alpha}{1-\alpha}(H-L)}(\mu-1)-\hat{C}_b^W. \tag{2.19}$$

Comparing equation (2.16) and (2.19), one can easily see that the minimum signaling cost for a lemon under endogenous security structure is lower than that under exogenous security structure, i.e. $\hat{C}_b^W < \underline{C}_b^W$. Intuitively, giving a bad bank the flexibility of choosing security structure increases its equilibrium expected profit, making it less tempting to send a fake signal.

It follows that, when $C_b \leq \hat{C}_b^W$, signaling for a lemon is too cheap, and thus a separating equilibrium could never exist under either security structure. In a pooling equilibrium, outside investors' beliefs are that there is always a non-zero chance that a signaling bank is a bad bank. Therefore, out of infinite risk-aversion, they provide the bad-bank level of funding, regardless of the signal and the security structure that the BHC uses. Since signaling is costly, and there is no hope for a separating equilibrium, the BHC would never signal and would always tranche to avoid agency costs.

Intermediate Signaling Cost Now suppose that $C_b \in (\hat{C}_b^W, \underline{C}_b^T)$. In this region, a separating equilibrium could not exist under tranching, but it could arise under securitization with guarantees. This means that a good bank, after observing a signaling cost in this range, can use security structure as an additional signal to stand out from bad banks. In other words, signals are more credible under securitization with guarantees when the signaling cost falls in this range.

If C_b is in this range, an outside investor who observes that the bank signals and chooses to securitize with guarantees can be sure that this bank is a good bank. By contrast, if the signaling bank tranches, outside investors recognize that, under tranching, sending fake signals is more tempting, and hence they would regard the signal as a fake one. In other words, with an intermediate signaling cost, a good bank can never overcome the adverse selection by signaling if it chooses to tranche.

The BHC chooses its ex-ante optimal security structure internalizing outside investors' beliefs.

I first study the optimal security design for a *good bank*. In this region, a *good bank* faces the following trade-off. If it securitizes with guarantees, it suffers agency costs but can signal effectively and overcome the adverse selection. The resulting expected profit is given by:

$$\Pi^W = \frac{A - C_g}{1 - L + \frac{\alpha}{1-\alpha}(H - L)}(\mu - 1) - C_g. \tag{2.20}$$

If a good bank tranches the asset, it would not be able to overcome the adverse selection, since a separating equilibrium does not exist in this case. Therefore, it would simply not signal, the level of investment is $\frac{A}{1-L+\delta}$, and the resulting expected profit is given by:

$$\Pi^T = \frac{A}{1 - L + \delta}(\mu - 1). \tag{2.21}$$

Using (2.20) and (2.21), for a good bank, tranching is optimal if

$$\frac{A}{1 - L + \delta}(\mu - 1) > \frac{A - C_g}{1 - L + \frac{\alpha}{1-\alpha}(H - L)}(\mu - 1) - C_g. \tag{2.22}$$

When the signaling cost for a good bank approaches zero, i.e. $C_g \to 0$, condition (2.22) converges to:

$$\frac{A}{1 - L + \delta}(\mu - 1) > \frac{A}{1 - L + \frac{\alpha}{1-\alpha}(H - L)}(\mu - 1).$$

The above condition boils down to a comparison between δ and $\frac{\alpha}{1-\alpha}(H - L)$. This result suggests that, with an intermediate level of signaling cost, tranching is the optimal security structure for a good bank when assets are similar but risky, meaning that δ is low but $(H - L)$ is high. Intuitively, when assets are more heterogeneous, the cost of not being able to credibly signal one's type is high, and therefore tranching is dominated by whole-piece securitization, which is more efficient in overcoming adverse selection. Conversely, when assets are highly risky, the high agency costs imposed by the use of guarantees render whole-piece securitization relatively unprofitable.

Lastly, I characterize the optimal security design for a *bad bank*. In this region, a bad bank would not signal under securitization with guarantees, because it is too costly. It would also not signal under tranching, because there is no hope for a separating equilibrium. Therefore, with an intermediate signaling cost, a *bad bank* would never signal and would always choose tranching.

Summarizing the above analysis, the BHC's optimal signaling decision and security structure is given by the following proposition.

Proposition 2. ***(Optimal security structure)*** *Assuming* $C_g \leq min\left\{\bar{C}_g^W, \bar{C}_g^T\right\}$*, in equilibrium, the BHC's signaling decision and the optimal security structure follow the rules below:*

1. *A* ***bad bank*** *never signals and its optimal security structure is tranching;*
2. *If* $C_b \geq \underline{C}_b^T$*, a* ***good bank*** *signals and its optimal security structure is tranching, where* $\underline{C}_b^T$ *satisfies (2.18);*
3. *If* $C_b \leq \hat{C}_b^W$*, a* ***good bank*** *never signals and its optimal security structure is tranching, where* $\hat{C}_b^W$ *satisfies (2.19);*
4. *If* $C_b \in (\hat{C}_b^W, \underline{C}_b^T)$*, a* ***good bank*** *does not signal and its optimal security structure is tranching if condition (2.22) holds; otherwise, a* ***good bank*** *signals*

and its optimal security structure is whole-piece securitization with guarantees.

Relating this result to the ABCP market prior to the recent financial crisis, I interpret the good asset and the "lemon" as various types of the underlying assets of ABCPs. The return differential δ captures the heterogeneity in the quality of assets backing ABCPs. The high- and low-state returns, H and L, represent the average range of returns of good underlying assets. From the lens of this simple model, the perception prior to the crisis that mortgage assets in general were low risk and the introduction of subprime mortgages can explain the use of guarantees in securitization in the ABCP market.

In most cases, ABCP conduits disclose rough compositions of the underlying pool of assets but never the asset-specific information of the portfolio to outside investors. Some ABCP conduits treat their holdings as proprietary and deliberately do not disclose. While the majority of assets backing ABCPs are mortgage assets and MBS, the introduction of subprime mortgages and the many types within subprime enlarged δ, making the quality of assets backing ABCPs more heterogeneous. On top of that, the booming housing market and the credit expansion made the return variability $(H - L)$ of prime mortgage assets very small. These two developments led to condition (2.22) being violated, resulting in a preference for securitization with guarantees over tranching for good assets.

In practice, both securitization with guarantees and tranching exist in the shadow banking system. However, prior to the crisis, very few assets were completely tranched, especially the so-called equity tranches. These risky tranches were commonly insured to obtain an investment grade in order to be sold. Among all outstanding ABCPs, over 70% were covered by credit and liquidity guarantees (Acharya et al., 2013). This simple extension of the static model explains why securitization with guarantees was so prevalent prior to the crisis.

Two empirically testable implications are: (1) ABCPs covered by credit or liquidity guarantees are backed by high-quality assets; (2) the percentage of assets being securitized whole-piece should increase during periods of rapid growth of subprime mortgage lending, as in the mid- to late 1990s. So far, there is no existing empirical evidence on these two points. Due to data limitation, I cannot test these two implications, but these results point to a direction for empirical exercises that can assess the importance of this channel.

2.5 Conclusion

This chapter develops a theory of securitization based on intermediaries minimizing the moral hazard that insiders can misuse assets held on-balance sheet. This theory provides an novel economic rationale for "securitization without risk transfer."

In an environment with the moral hazard of insiders diverting assets, intermediaries securitize to increase the distance between assets and insiders, e.g. managers, and thus ameliorate the moral hazard. Although the risk-sharing structures are equivalent under deposit funding and securitization with guarantees, intermediaries' incentive to renege on their promises, i.e. the magnitude of moral hazard, is different under the two funding modes.

Under deposit funding, intermediaries hold assets on-balance sheet, and the moral hazard is greatest for low-risk assets that yield sizable returns in bad states. By contrast, under securitization, the moral hazard is most severe for high-risk assets that require large reserve holdings for guarantees. The moral-hazard-reducing motive implies that banks securitize low-risk assets and hold high-risk assets on-balance sheet.

This agency cost perspective and the existing theories are not mutually exclusive, and all are likely to have played a role in the crisis. The agency cost perspective is able to explain some securitization behaviors that other theories cannot. More importantly, in the post-crisis era where regulatory loopholes have been, to a large extent, closed down, the agency cost perspective may very much be a relevant theory of securitization. The paper shows that, besides risk transfer and regulatory arbitrage, moral hazard also plays an important role in affecting securitization decisions. The static framework presented in this chapter can be easily extended to a dynamic apparatus that enables the study of both explicit and implicit guarantees, as well as the role of government bailouts in securitization, as I show in the following chapters.

The discussion of tranching versus securitization with guarantees explains the prevalence of securitization with guarantees prior to the crisis. When mortgage assets are sufficiently heterogeneous (the introduction of subprime mortgages), and the prime ones are perceived to be sufficiently safe (booming housing market and low interest rate), securitization with guarantees dominates tranching.

Chapter 3: Explicit Guarantees, Implicit Guarantees, and Government Bailouts

3.1 Introduction

This chapter develops a dynamic model to study both explicit and implicit guarantees, by embedding the static model of securitization with moral hazard in an infinite-period setup. The dynamic model unveils an important linkage between securitization and government bailouts.

As in the Folk Theorem of repeated games, the BHC can use its franchise value as a commitment device to overcome the moral hazard of diverting assets and default.[1] But as the moral hazard gets stronger, the strength of franchise value as a commitment device gets weaker. When risky assets are securitized, a large amount of reserves are held on-balance sheet. As a result, the magnitude of the moral hazard is high, and very few risky assets can overcome the moral hazard. Thus, the *agency cost mechanism* identified in Chapter 2 carries over into the dynamic framework,

[1] "The original Folk Theorem concerned the payoffs of all the Nash equilibria of an infinitely repeated game. This result was called the Folk Theorem because it was widely known among game theorists in the 1950s, even though no one had published it. Friedman's (1971) Theorem concerns the payoffs of certain subgame-perfect Nash equilibria of an infinitely repeated game, and so strengthens the original Folk Theorem by using a stronger equilibrium concept – subgame-perfect Nash equilibrium rather than Nash equilibrium. The earlier name has stuck, however: Friedman's Theorem (and later results) are sometimes called Folk Theorems, even though they were not widely known among game theorists before they were published" (Gibbons, 1992, p. 89).

and only low-risk assets are securitized.

A new mechanism, the *franchise value mechanism*, arises in the dynamic setting. High-return assets generate high franchise values, thereby making it easier for the bank entity to commit not to default under deposit funding. This makes securitization less valuable as a method to reduce and/or overcome the moral hazard. Thus, the *franchise value mechanism* promotes deposit funding for high-return assets.

In an extension to the dynamic model, this chapter unveils a novel channel through which the possibility of government bailouts exacerbate the moral hazard and reduce total investment irrespective of the funding mode. This adverse effect is stronger for riskier assets under deposit funding, implying that intermediaries finance a larger portion of riskier assets off-balance sheet. Government bailouts thus have the effect of promoting securitization of risky assets.

Specifically, when the BHC defaults, there is a chance that it will be bailed out, where the probability of a bailout conditional on default is strictly less than one. After a bailout, the BHC continues to operate, but it can no longer overcome moral hazard via commitment and hence lives with a post-bailout profit that is lower than the one before default. The probabilistic nature of bailouts induces a misalignment of incentives: the risk-neutral BHC values the possibility of bailouts, but infinitely risk-averse outside investors do not value it at all, as the probability of bailouts is strictly less than one. The misalignment exacerbates the moral hazard, and thus reduces total investment irrespective of the funding mode.[2]

[2] If the misalignment was not present, government bailouts would not exacerbate the moral

This misalignment is larger for riskier assets if they are financed on-balance sheet. Outside investors do not value bailouts, but the bank entity values them very much. For riskier assets, the post-bailout profit under deposit funding is still high, as the agency costs in this case is small. To reduce misalignment, the BHC optimally securitizes these assets. When the probability of getting a bailout is sufficiently high, the effect of government bailouts dominates the *agency cost mechanism*, and the BHC finances a larger portion of risker assets via securitization.

This chapter also discusses the implications of different forms of guarantees. Explicit guarantees are contracted insurance to outside investors, while implicit guarantees are only verbal promises. With explicit guarantees, agency costs under securitization increase in both the risk level and information intensity of the underlying asset. Therefore, intermediaries securitize assets with either low information intensity or low risk. Implicit guarantees are non-contractual promises sustained by bank reputation. Hence, intermediaries only securitize information-intensive assets for which bank reputation is highly valued.

The dynamic model can explain several important empirical regularities about the shadow banking system. The use of guarantees and the prioritization of securitizing safer assets induce an increase in reserve holdings that may dominate the reduction of riskier assets on-balance sheet. This is consistent with the regularity that banks sponsoring off-balance-sheet conduits tend to have high bank leverage in comparison to non-sponsor banks (Altunbas et al., 2009; Kalemli-Ozcan et al.,

hazard. For example, when government bailouts occur with probability one conditional on default, financial intermediaries and outside investors will collectively increase risk taking and shift the risks to the public sector.

2012; Kohler, 2015)(empirical fact I). When probabilistic government bailouts are available, the misalignment between banks' and investors' perceptions of the value of bailouts increases with the likelihood of a bailout, thereby explaining the extensive participation and risk-taking of larger banks in shadow banking (Kalemli-Ozcan et al., 2012; Acharya and Schnabl, 2010; Acharya et al., 2013) (empirical fact II). The resulting increase in the securitization of risky assets is consistent with the empirical finding that banks securitize risky assets but keep safe assets on their balance sheets (Mian and Sufi, 2009; Demyanyk and Van Hemert, 2011)(empirical fact III).

The rest of this chapter proceeds as follows. Section 3.2 reviews the related literature. Section 3.3 presents the benchmark dynamic model and studies securitization with explicit and implicit guarantees respectively. Finally, Section 3.4 extends the benchmark dynamic model to study the role of government bailouts in inducing risk-taking in securitization. Section 3.5 concludes.

3.2 Related Literature

The first contribution of this chapter is that it builds on the static framework in Chapter 2 and develops a dynamic apparatus that can be easily extended in different directions.

The dynamic framework is closest to the reputational model in Gorton and Souleles (2007) that is used to understand implicit guarantees. They show that banks provide implicit guarantees to overcome adverse selection, and these guarantees are sustained by bank reputation. While their study focuses on why banks provide guarantees to outside investors, this chapter emphasizes the implications of honoring guarantees ex-post for the ex-ante securitization decision.

Ordonez (2014) also develops a reputational model and argues that the reputational benefit of honoring implicit guarantees is lower under adverse economic circumstances. By contrast, Segura (2013) emphasizes the signaling role of honoring guarantees and shows that a pooling equilibrium, in which both good and bad banks signal, is more likely to arise in bad states. These studies all abstract from the questions of whether and which assets to securitize, which are the focal point of this dissertation.

This chapter also contributes to the literature by differentiating explicit and implicit guarantees and discussing the different effects of them on intermediaries' securitization decisions. The chapter compares the set of assets that would be securitized under the two forms of guarantees, and the very different securitization decisions predicted by the model offer testable implications that can be explored empirically.

Last but not least, the chapter unveils a novel perspective that the possibility of government bailouts may worsen moral hazard and make financial intermediaries worse off ex-ante. This adverse effect arises when bailouts are ex-ante probabilistic and investors are more risk-averse than intermediaries. The exacerbated moral hazard reduces investment regardless of the funding mode, but more severely when riskier assets are financed on-balance sheet. Thus, when there is a high chance of government bailouts in the event of default, securitization will be geared toward riskier assets, increasing output volatility. To the best of my knowledge, this is the first paper that relates government bailouts to shadow banking and explores how bailouts affect the choice of assets for securitization.

3.3 Securitization with Moral Hazard: Benchmark Dynamic Model

In the static model, the BHC cannot commit not to default unless it receives incentive payments, and hence only the *agency cost mechanism* is at play. In a dynamic framework, the BHC may also use its franchise value to commit not to default, giving rise to a *franchise value mechanism*, through which high-expected-return assets are more likely to be held on-balance sheet, as opposed to being securitized in the static model. The ability to overcome moral hazard depends on both the franchise value and the magnitude of moral hazard. Hence, the *agency cost mechanism* is still at play in the dynamic model.

3.3.1 Securitization with Explicit Guarantees

3.3.1.1 Model Setup

Everything is the same as in the static benchmark, except that now the economy has an infinite horizon, $t = 0, 1, ..., \infty$. The three types of agents – a risk-neutral BHC, a risk-neutral equity investor, and infinitely risk-averse outside investors – are infinitely-lived with a common time preference $\beta \in (0, 1)$. The BHC invests in the risky asset at the beginning of each period, and returns are realized and consumed at the end of each period.

Bankruptcy In a dynamic setting, it is important to specify the consequence of default. Default happens either when the bank entity fails to pay depositors in full, or when the SPV fails to honor guarantees to ABS investors. After a default, the BHC declares bankruptcy and loses its ability to raise external funding forever, i.e. its franchise value. In this section, I assume that there are no government bailouts after default.

3.3.1.2 BHC's Optimization Problem

Similar to Acharya (2003), all profits generated by the BHC in a period are consumed by the equity investor at the end of each period. As the equity investor cannot commit to any dynamic investment strategy, the BHC's problem can be expressed as a stationary dynamic program as follows:

$$V_t = \max_{A_B, A_S, X_B, X_S, \rho, p, R} \mathbb{E}\Pi^D + \mathbb{E}\Pi^S + \mathbb{I}_{\{\text{no default}\}}\beta V_{t+1},$$

$$\begin{aligned} \text{subject to} \qquad \tilde{L}X_B &\geq X_B - A_B, && (3.1) \\ min\{L+\rho, H\}/p &\geq 1, \\ A_S + pX_S &\geq X_S + RX_S, \\ R &\geq \tilde{\rho}, && (3.2) \\ A &\geq A_B + A_S. \end{aligned}$$

The expected per-period returns $\mathbb{E}\Pi^D$ and $\mathbb{E}\Pi^S$ are given by

$$
\begin{aligned}
\mathbb{E}\Pi^D &= \left[q(H-\tilde{L}) + (1-q)\left(L-\tilde{L}\right)\right] X_B - A_B, \\
\mathbb{E}\Pi^S &= \left[qR + (1-q)(R-\rho)\right] X_S - A_S,
\end{aligned}
$$

where $\tilde{L}$ is the pledgeable return per unit of the risky asset under deposit funding. βV_{t+1} is the discounted continuation value of the bank. $\mathbb{I}_{\{no\,default\}}$ is an index function that equals 1 when the BHC does not default, and 0 otherwise.

In the dynamic setting, rather than relying on incentive payments, the BHC can use its franchise value to commit not to default. All the constraints are the same as in the static model, except that in (3.1) the pledgeable return $\tilde{L}$ depends on whether or not the bank entity can commit not to default, as discussed further below. Similarly, in (3.2), the minimum required reserves per ABS, $\tilde{\rho}$, depend on whether or not the SPV can commit not to default.

Deposit Funding Without incentive payments, the BHC potentially has incentives to default in both states. In the absence of franchise value considerations, the bank always has an incentive to default in the low state. However, if the following condition holds:

$$H - L \leq \alpha H, \tag{3.3}$$

the bank also has an incentive to default in the high state. Since $\alpha L < \alpha H$, the sufficient ex-post incentive compatibility constraint (ICC) to ensure that the bank does not default in either state when $H - L \leq \alpha H$ is

$$\alpha H X^{FB} \leq \beta V^{FB}, \quad \text{(ICCH)}$$

where $X^{FB} = \frac{A}{1-L}$ is the first-best level of investment of a credible bank, and $V^{FB} = \frac{1}{1-\beta} \cdot X^{FB} \left[\mathbb{E}(x) - 1\right]$ is the first-best franchise value. Conversely, if (3.3) does not hold, the bank would only default in the low state absent franchise value considerations, and the sufficient ex-post ICC is

$$\alpha L X^{FB} \leq \beta V^{FB}. \quad \text{(ICCL)}$$

ICCH and ICCL ensure that the bank entity's commitment is credible. In other words, even if the bank has an incentive to default absent franchise value considerations, it will not do so, as losing franchise value is too much compared to the one-time gain. Having specified the relevant ICCs, the pledgeable return $\tilde{L}$ is given by

$$\tilde{L} = \begin{cases} L & \text{if } H - L \leq \alpha H \text{ and ICCH holds, or if } H - L > \alpha H \text{ and ICCL holds,} \\ (1-\alpha)L & \text{otherwise.} \end{cases}$$

If the relevant ICC holds, rational investors know that the bank will not default ex-post, and they will finance $X_B = X^{FB}$ ex-ante. Otherwise, they only finance

$X_B = X_d^B = \frac{A}{1-L+\alpha L} < X^{FB}$. Note that ICCH and ICCL can be simplified to

$$\alpha H \leq \frac{\beta}{1-\beta} \cdot [\mathbb{E}(x) - 1], \tag{3.4}$$

$$\alpha L \leq \frac{\beta}{1-\beta} \cdot [\mathbb{E}(x) - 1]. \tag{3.5}$$

Securitization Under securitization, the BHC only has an incentive to seize reserves and default in the low state, in the absence of franchise value considerations. Therefore, the required reserves per ABS, $\tilde{\rho}$, are given by

$$\tilde{\rho} = \begin{cases} \rho & \text{if } \alpha\rho X^{FB} \leq \beta V^{FB}, \quad \text{(ICCS)} \\ \rho/(1-\alpha) & \text{if } \alpha\rho X^{FB} > \beta V^{FB}, \end{cases}$$

where ICCS is the incentive compatibility constraint under securitization that ensures that the SPV's commitment is credible. In other words, if ICCS holds, the cost of default (losing franchise value) is too high compared to the one-time gain from seizing reserves.

If ICCS is satisfied, ABS investors will finance $X_S = X^{FB}$. Otherwise, they only finance $X_S = X_d^S = \frac{A}{1-L+\frac{\alpha}{1-\alpha}(H-L)} < X^{FB}$. ICCS can be simplified to

$$\alpha(H-L) \leq \frac{\beta}{1-\beta} \cdot [\mathbb{E}(x) - 1]. \tag{3.6}$$

As in the static model, I proceed, without loss of generality, by splitting the BHC's problem into two, one under each funding mode.

3.3.1.3 Threshold α under Deposit Funding

Conditions (3.3), (3.4), and (3.5) generate three thresholds, α_1^{DH}, α_1^H, and α_1^L, respectively. The superscript "DH" stands for "default in high state", and "H" and "L" stand for "high state" and "low state" respectively. The three thresholds together generate a unique threshold information intensity, below which the bank entity can achieve X^{FB}.

Lemma 5. ***(Threshold information intensity under deposit funding)*** *Assuming $\alpha_B = \alpha_S = \alpha$, under deposit funding, there is a unique threshold level of information intensity*

$$\alpha_1 = min\left\{max\{\alpha_1^{DH}, \alpha_1^H\}, \alpha_1^L\right\},$$

where

$$\begin{aligned}
\alpha_1^{DH} &= 1 - \frac{L}{H}, \\
\alpha_1^H &= \frac{\beta}{1-\beta}\left[\mathbb{E}(x) - 1\right]\frac{1}{H}, \\
\alpha_1^L &= \frac{\beta}{1-\beta}\left[\mathbb{E}(x) - 1\right]\frac{1}{L}.
\end{aligned}$$

For $\alpha \in [0, \alpha_1]$, depositors agree to finance $X = X^{FB} = \frac{A}{1-L}$. Otherwise, depositors only finance $X = X_d^B = \frac{A}{1-L+\alpha L}$. α_1^{DH} is increasing in H and decreasing in L. α_1^H is increasing in L and decreasing in H. α_1^L is increasing in H and decreasing in L.

When $\alpha \leq \alpha_1$, the one-time gain of default is too small compared to the forfeited franchise value. Therefore, default is less tempting, and the bank entity's commitment is credible.

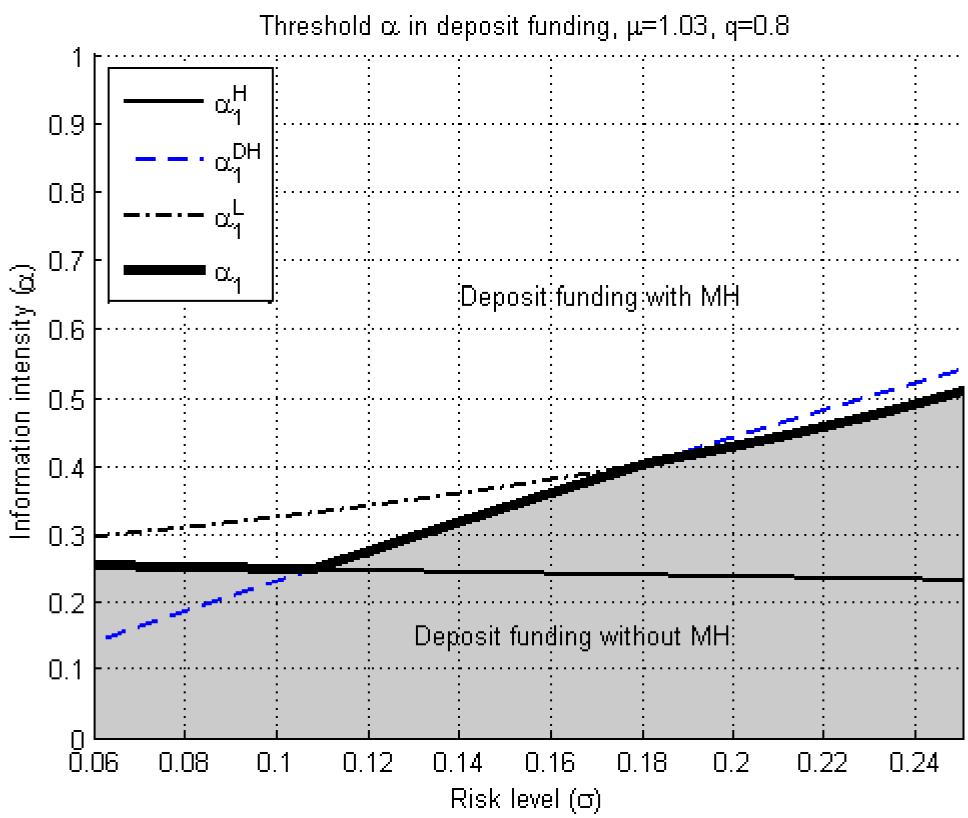
I conduct the same experiments as in the static model: (1) increasing risk in a mean-preserving fashion, and (2) fixing the risk level and increasing the mean return. To do this, I re-write the above thresholds in terms of the mean and standard deviation of the binomial return as:

$$\begin{aligned}
\alpha_1^{DH} &= 1 - \frac{\mu - \sigma\sqrt{\frac{q}{1-q}}}{\mu + \sigma\sqrt{\frac{1-q}{q}}}, \\
\alpha_1^{H} &= \frac{\beta}{1-\beta} \cdot \frac{\mu - 1}{\mu + \sigma\sqrt{\frac{1-q}{q}}}, \\
\alpha_1^{L} &= \frac{\beta}{1-\beta} \cdot \frac{\mu - 1}{\mu - \sigma\sqrt{\frac{q}{1-q}}}.
\end{aligned}$$

For a given μ, α_1^{DH} is increasing in σ: high-risk assets enlarge the non-default payoff in the high state, $H - L$, making default in the high state less tempting. For a given σ, α_1^{DH} is decreasing in μ, since a higher μ means a higher high-state return, making default in the high state more tempting. Threshold α_1^{L} is increasing in σ, since high-risk assets yield less in the low state and diminish the one-time gain of default. On the contrary, α_1^{H} is decreasing in σ, as high-risk assets yield more in the high state, making default in the high state more tempting. Both α_1^{H} and α_1^{L} are increasing in μ, as higher franchise values strengthen incentives to repay and maintain reputation – the *franchise value mechanism*.

Figure 3.1 depicts the threshold information intensity under deposit funding for different levels of risk and a fixed mean return. The shaded region under the

Figure 3.1: Threshold α under Deposit Funding



thick solid line shows values of α and σ for which the bank entity can achieve the first-best level of investment through credible commitment. The vertical width of the shaded region is generally increasing in the level of risk, especially for medium- to high-risk assets. This is because of the *agency cost mechanism* – under deposit funding, high-risk assets yield less in the low state, reducing the benefit of default and and making it easier for the bank entity to commit.

3.3.1.4 Threshold α under Securitization with Explicit Guarantees

Condition (3.6) defines a threshold information intensity α_2, below which the SPV can achieve X^{FB} under securitization.

Lemma 6. ***(Threshold information intensity under securitization)*** *Assuming $\alpha_B = \alpha_S = \alpha$, under securitization, there is a unique threshold level of information intensity*

$$\alpha_2 = \frac{\beta}{1-\beta}\left[\mathbb{E}(x) - 1\right]\frac{1}{H-L}.$$

For $\alpha \in (0, \alpha_2]$, ABS investors agree to finance $X = X^{FB} = \frac{A}{1-L}$. Otherwise, ABS investors only finance $X = X_d^S = \frac{A}{1-L+\alpha\frac{H-L}{1-\alpha}}$. The threshold α_2 is increasing in both H and L.

When α is smaller than α_2, the one-time gain of default is too small relative to the cost of default. When securitizing assets with $\alpha \in (0, \alpha_2]$, the bank has no incentive to default ex-post, and ex-ante investors will finance X^{FB}. For assets with $\alpha \in (\alpha_2, 1]$, the SPV cannot credibly commit not to default, and hence the level of investment is given by X_d^S. Re-writing α_2 as

$$\alpha_2 = \frac{\beta}{1-\beta} \cdot \frac{\mu - 1}{\left(\sqrt{\frac{q}{1-q}} + \sqrt{\frac{1-q}{q}}\right)\sigma},$$

it is obvious that α_2 is increasing in μ and decreasing in σ. A higher mean return gives the SPV more incentives to repay and maintain reputation, while a higher risk implies larger reserve holdings that worsen the incentive to repay. This is again the *agency cost mechanism.*

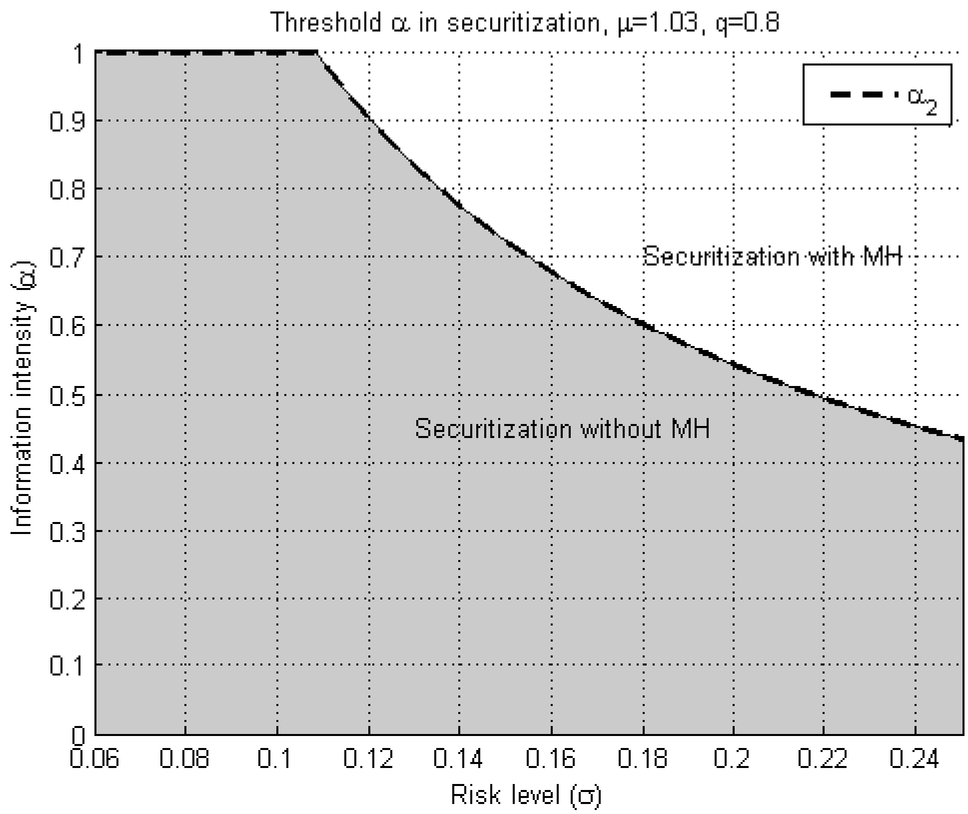
Figure 3.2 depicts the threshold information intensity under securitization for a fixed mean return and different risk levels. The shaded region shows parameter combinations for which the SPV can achieve the first-best level of investment through credible commitment.

3.3.1.5 Range of Securitization with Explicit Guarantees

Lemma 5 and Lemma 6 describe the set of assets for which the first-best level of investment can be achieved under deposit funding and securitization. Once α is sufficiently high that the BHC cannot commit, we are back in the static model, as far as comparing deposit funding versus securitization. Combining Corollary 1 and Lemma 5 and 6, a full description of optimal funding modes is derived.

Proposition 3. ***(Optimal funding modes)*** *Assume both deposit funding and securitization with explicit guarantees are allowed, and $\alpha_B = \alpha_S = \alpha$. For assets with $\alpha \in [0, min\{\alpha_1, \alpha_2\})$, the BHC is indifferent between deposit funding and securitization, with the level of investment given by $X = X^{FB} = \frac{A}{1-L}$. If $\alpha_1 \geq \alpha_2$, the*

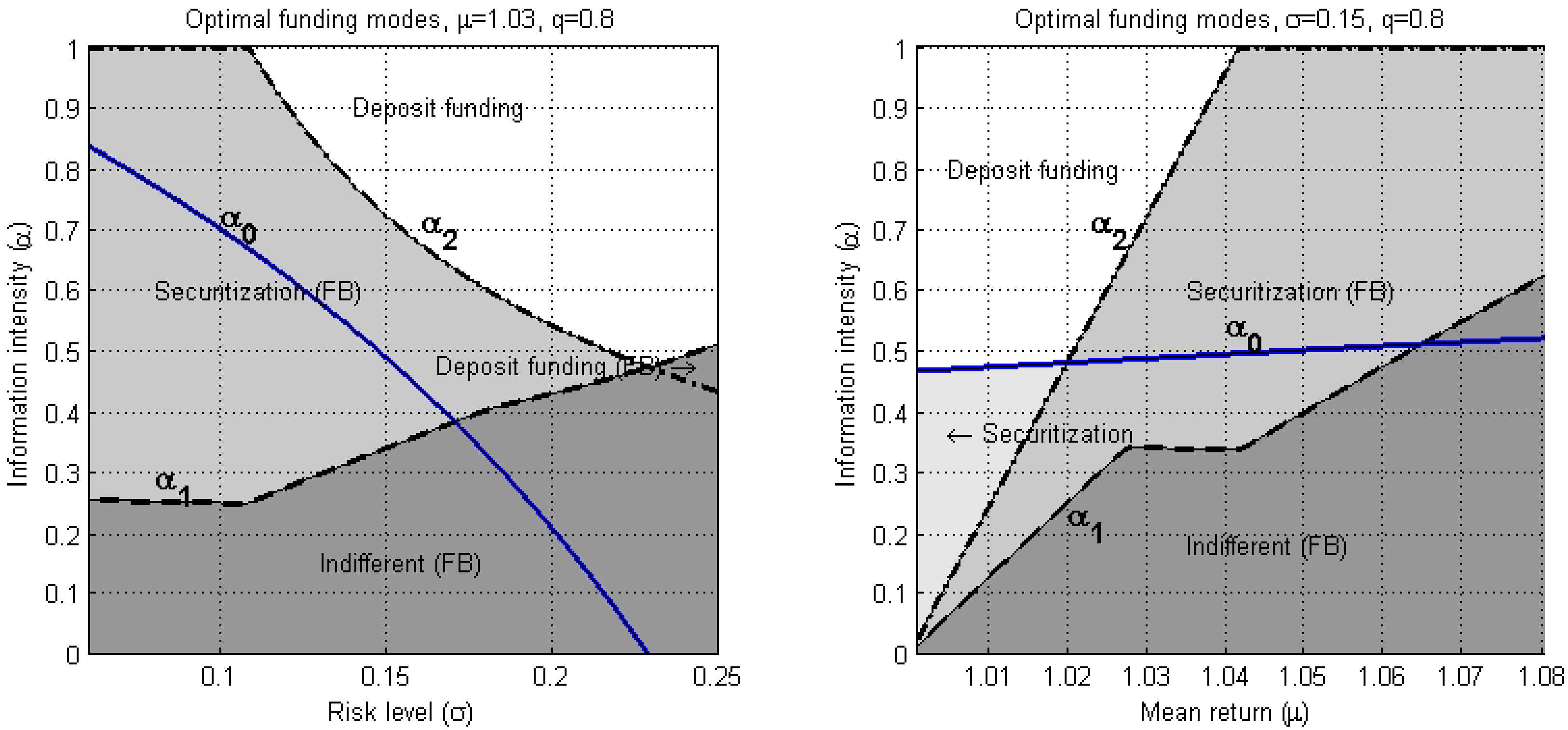
Figure 3.2: Threshold α under Securitization



BHC strictly prefers deposit funding for assets with $\alpha \in [\alpha_2, \alpha_1]$, *with* $X = X^{FB}$. *If* $\alpha_2 \geq \alpha_1$, *the BHC strictly prefers to securitize assets with* $\alpha \in [\alpha_1, \alpha_2]$, *with* $X = X^{FB}$. *When* $\alpha_0 = 2 - \frac{H}{L} \geq max\{\alpha_1, \alpha_2\}$, *the BHC strictly prefers to securitize assets with* $\alpha \in (max\{\alpha_1, \alpha_2\}, \alpha_0]$, *with* $X = X_d^S = \frac{A}{1-L+\alpha\frac{H-L}{1-\alpha}}$. *For assets with* $\alpha \in (max\{\alpha_1, \alpha_2, \alpha_0\}, 1]$, *the BHC strictly prefers on-balance sheet financing, with* $X = X_d^B = \frac{A}{1-L+\alpha L}$.

The left panel of Figure 3.3 is a map of optimal funding modes for assets with the same μ and different σ. The optimal funding mode in each region is labeled and shaded. The range of α for which securitization is strictly preferred is generally decreasing in the level of risk (except the very left end with very small σ). Assets with both high information-intensity and high risk are less likely to be securitized, as they are too obscure to be accepted by outside investors, and the associated reserves create agency costs that are too large under securitization. This reflects the *agency cost mechanism* in the dynamic setting. Among the safest assets, banks strictly prefer to securitize assets with high information intensity. As the agency base under securitization is very small given the low risk, the bank can afford to securitize information-intensive assets.

Figure 3.3: Map of Optimal Funding Modes with Explicit Guarantees



The right panel of Figure 3.3 depicts optimal funding modes for a fixed σ and varying μ. For a wide range of α (0% to almost 50%), securitization strictly dominates deposit funding for low-return assets, while the bank is indifferent between the two funding modes for high-return assets. This is the effect of the *franchise value mechanism*. High-return assets have high franchise values, and hence the associated cost of default is large. In other words, high franchise values make default less tempting, and thus make the bank entity's commitment more credible. For high-return assets, the increased ability to achieve the first-best level of investment under deposit funding reduces the region where securitization is strictly preferred.

3.3.2 Securitization with Implicit Guarantees

In some markets, regulation forbids the use of explicit guarantees, and financial intermediaries resort to implicit guarantees.[3] The difference between an explicit and an implicit guarantee lies in the legal consequence of reneging on the guarantee promise ex-post. Explicit guarantees are contractual, and failing to honor them constitutes a default that forfeits the bank's franchise value. Meanwhile, implicit guarantees are non-contractual, and the bank is not legally obligated to repay anything. I assume that if a bank "defaults" on its implicit guarantees, it loses credibility in the ABS market and subsequently continues as a discredited bank that can use

[3] The existence of implicit guarantees is well documented in credit-card securitization (Higgins and Mason, 2004; Gorton and Souleles, 2007). The maturities of ABS backed by credit card debts are much longer than ABCPs, thus deeming liquidity guarantees invalid as a way to provide guarantees without being treated as equivalent to on-balance sheet financing. However, sponsor banks have the discretion to designate losses from credit card debts as due to fraud. The rules of credit card securitizations require fraud losses to be absorbed by sponsors, while pure credit losses fall on investors of ABS (Gorton and Metrick, 2012).

only deposit funding subject to moral hazard.

3.3.2.1 Range of Securitization with Implicit Guarantees

In the previous section, since the bank can only seize a portion of the assets held on-balance sheet in the event of default, I assumed $\alpha_B = \alpha_S = \alpha < 1$. Under implicit guarantees, the bank can potentially seize all of the reserves and still not be held liable in court. Therefore, I assume $\alpha_B < \alpha_S = 1$ in this section. Recall that in the static model, as $\alpha_S \to 1$, the agency cost of securitization goes to infinity, making securitization unsustainable. In the dynamic framework, implicit guarantees can be supported by the BHC's reputation. Once reputation is lost, the BHC becomes a discredited bank entity in all future periods and is identical to the deposit funding case of the static model.

With implicit guarantees, the ex-post incentive compatibility constraint under securitization is given by

$$(H - L)X^{FB} \leq \beta \left(V^{FB} - V_d^B\right),$$

where the left hand side is what the BHC gets from reneging in the low state – the entire reserve holding. The right hand side is the cost of reneging – the discounted reduction in the BHC's continuation value, where $V_d^B = \frac{1}{1-\beta} \cdot \frac{A}{1-L+\alpha L} [\mathbb{E}(x) - 1]$ is the franchise value of a discredited bank entity with $X_d^B = \frac{A}{1-L+\alpha L}$. The cost of not honoring guarantees, $\beta \left(V^{FB} - V_d^B\right)$, is the discounted reduction in the franchise value caused by losing credibility. A discredited bank entity suffers agency costs, and hence the cost of not honoring guarantees is large when agency costs are high absent reputation. As a result, the BHC is less tempted to renege on guarantees if assets are subject to high agency costs under deposit funding without reputation. This condition gives rise to a minimum on-balance sheet information intensity for securitization.

Proposition 4. ***(Region of securitization with implicit guarantees)*** *When both deposit funding and securitization with implicit guarantees are allowed, the BHC strictly prefers deposit funding for assets with $\alpha_B \in [0, min\{\alpha_1, \alpha_{IM}\}]$, with investment given by $X = X^{FB} = \frac{A}{1-L}$. If $\alpha_{IM} < \alpha_1$, the BHC is indifferent between deposit funding and securitization for assets with $\alpha_B \in (\alpha_{IM}, \alpha_1)$, with $X = X^{FB}$. If $\alpha_{IM} \geq \alpha_1$, the BHC strictly prefers deposit funding for assets with $\alpha_B \in (\alpha_1, \alpha_{IM})$, with $X = X_d^B = \frac{A}{1-L+\alpha L}$. For assets with $\alpha_B \geq max\{\alpha_1, \alpha_{IM}\}$, the BHC strictly prefers securitization, with $X = X^{FB}$. The threshold α_{IM} is given by $\alpha_{IM} = \varphi_S / L$, where*

$$\varphi_S \quad = \quad \frac{H-L}{\frac{\beta}{1-\beta}\cdot\frac{\mathbb{E}(x)-1}{1-L} - \frac{H-L}{1-L}} = \frac{R(1-L)}{\beta V^{FB} - R}, \tag{3.7}$$

and where $\partial\alpha_{IM}/\partial H \geq 0$ while $\partial\alpha_{IM}/\partial L \leq 0$.

The commitment device in securitization with implicit guarantees is the BHC's reputation, the value of which depends in part on whether agency costs are high without reputation. Therefore, the BHC only securitizes highly information-intensive assets with implicit guarantees. The denominator in (3.7), $\left(\beta V^{FB} - R\right)$, is the net benefit from honoring implicit guarantees if failing to do so constitutes a legal default. Note that if $\beta V^{FB} \leq R$, the SPV would default even when facing the strongest penalty. This threshold is decreasing in $\beta V^{FB} - R$, as a higher net benefit from repayment constitutes a stronger commitment device, and is increasing in R, as more reserves provide stronger incentives to "default."

The left panel of Figure 3.4 plots optimal funding modes with $\mu = 1.03$ and varying σ. The securitization region lies where information intensity under deposit funding is relatively high and the risk level is relatively low. As assets get riskier, the securitization region vanishes due to the increase in reserve holdings associated with high-risk assets, making default more tempting – the *agency cost mechanism.*

The right panel of Figure 3.4 plots optimal funding modes with $\sigma = 0.15$ and a range of μ. The securitization region lies where the mean return is relatively high, as high mean returns increase the net benefit of honoring implicit guarantees – the *franchise value mechanism.*

3.3.3 Explicit vs. Implicit Guarantees

In this section, I superimpose the plots from the previous two sections to evaluate the optimal funding mode when deposit funding and securitization with both kinds of guarantees are available.

The left panel of Figure 3.5 shows the optimal funding modes under securitization with implicit and explicit guarantees for a fixed μ. The right panel of Figure 3.5 does the same thing, but for a fixed σ. The region for securitization with implicit guarantees is a subset of that with explicit guarantees. Since implicit guarantees provide the BHC a form of insurance, in the sense that the bank can continue to operate following a "default," the bank has greater incentive to renege on its promise. Therefore, under implicit guarantees, rational investors are only willing to finance the first-best level of investment for a more selected set of assets. This result can be generalized as long as outside investors are more risk-averse than the BHC. The plot suggests that medium-risk assets with medium information intensities should only be securitized with explicit guarantees – a potentially testable implication for empirical work.

Figure 3.4: Map of Optimal Funding Modes with Implicit Guarantees

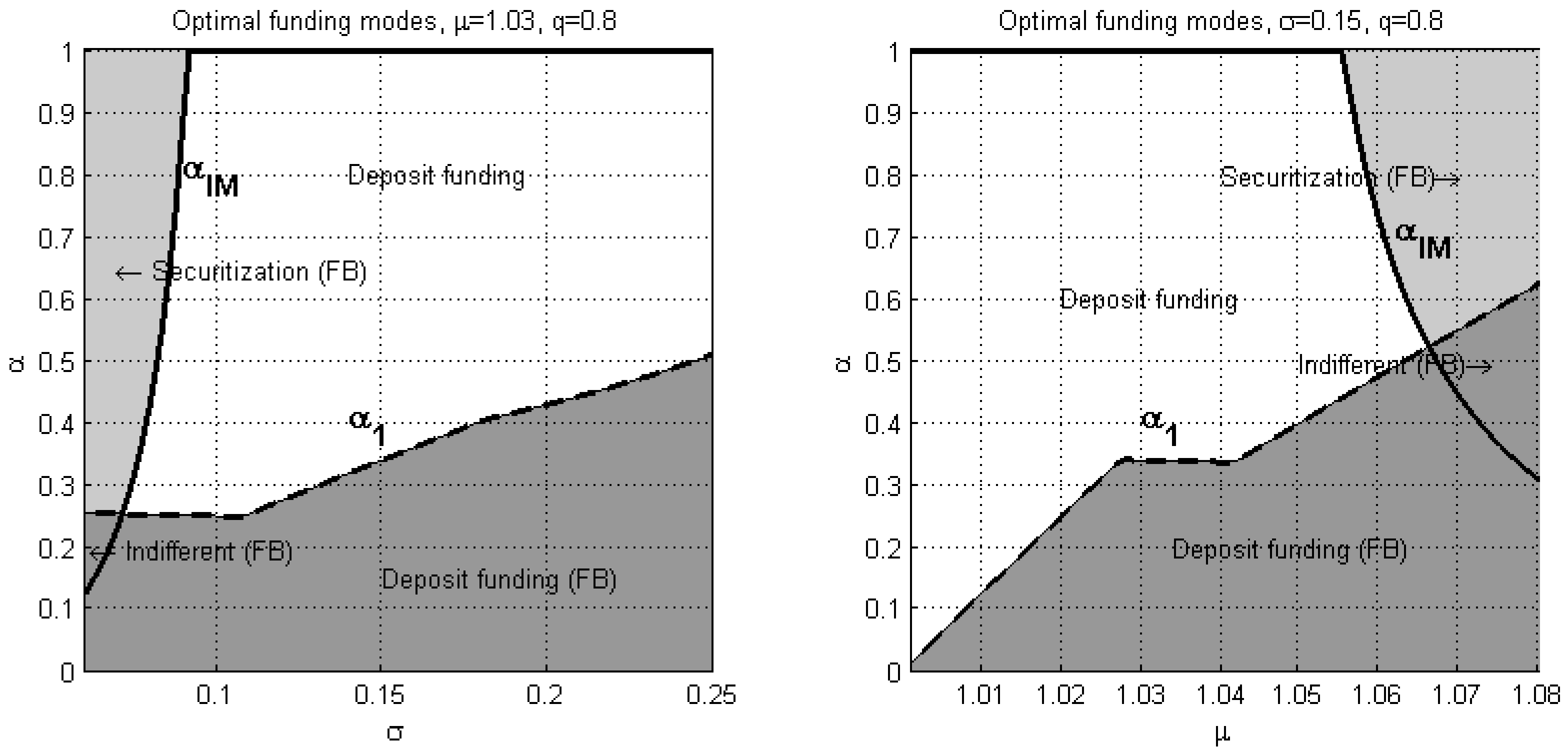
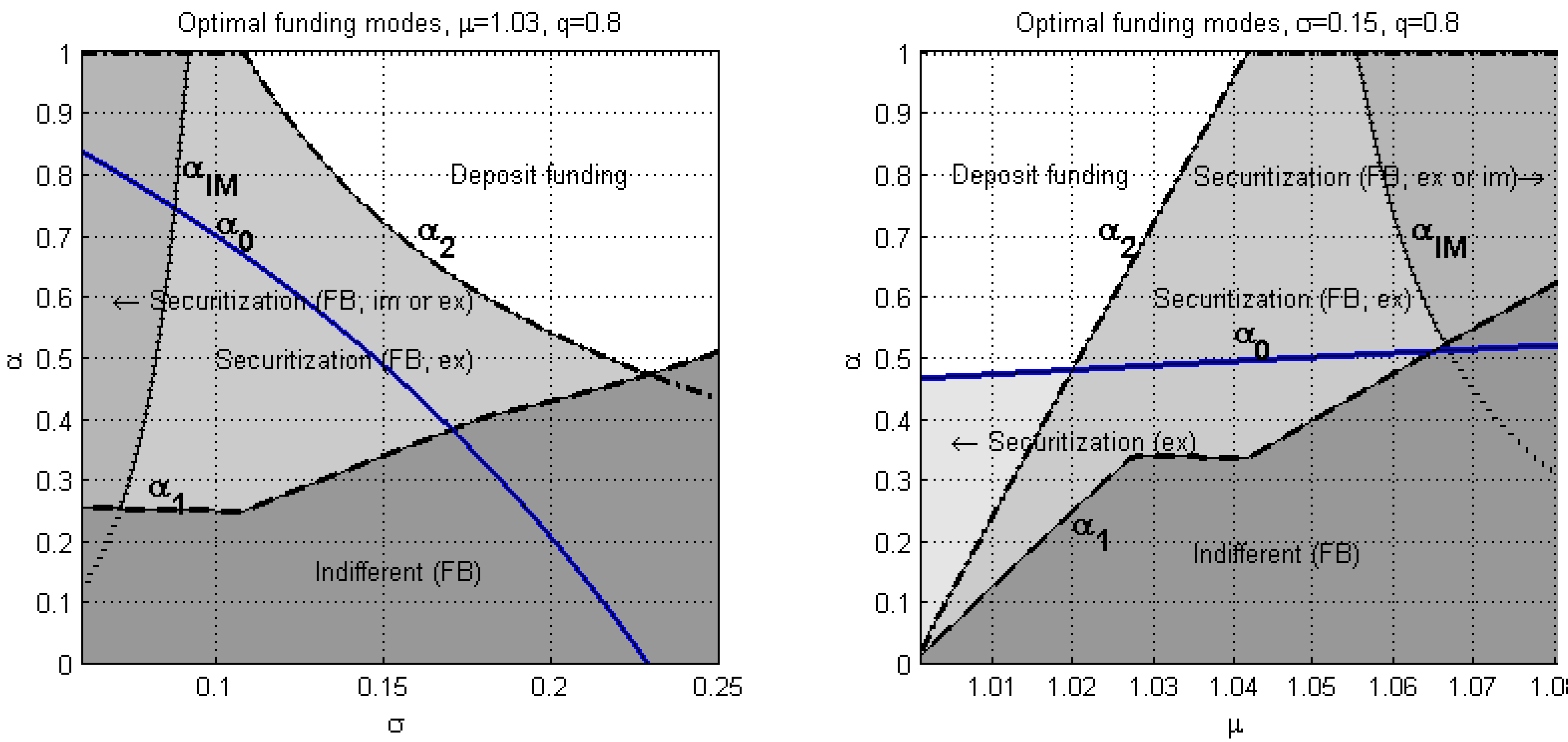


Figure 3.5: Explicit versus Implicit Guarantees



3.3.4 Securitization, Asset Ranking, and the BHC's Portfolio

Introducing securitization changes the size and composition of the bank entity's portfolio. To see this, imagine that all the assets have the same information intensity, $\alpha = 0.3$, and the same mean return, $\mu = 1.03$, but different levels of risk. Each asset is in limited supply, and all the assets can be thought of as lying on the horizontal blue line at $\alpha = 0.3$ in Figure 3.6.

Before the introduction of securitization, the BHC invests according to the left panel of Figure 3.6. In a static setting or a dynamic setting in which the BHC cannot commit not to default, safer assets with higher pledgeable returns achieve higher levels of investment, and hence are prioritized by the bank entity. In terms of Figure 3.6, the bank entity has an incentive to invest from the left.

However, when the BHC can commit not to default using franchise value, the bank may prioritize riskier assets to overcome moral hazard. Note that α_1 is the upper bound of α that the BHC can commit not to default in deposit funding. Since α_1 is upward sloping, there is a range of α (including $\alpha = 0.3$ in the figure), in which a safer asset may lie above α_1, while a riskier asset lies below it. This implies that, for some safer assets, the BHC cannot overcome moral hazard, while for some riskier ones, the BHC can, due to the low returns in the bad state. This gives the BHC an incentive to start investing from riskier assets.

To trade-off these two incentives, for each given level of α, the bank computes a cutoff risk level $\hat{\sigma}(\alpha)$ such that the asset with $\hat{\sigma}(\alpha)$ generates the same profit as the asset with $\sigma_0 = 0.06$ (the lowest risk level in the left panel of Figure 3.6). For assets with $\sigma > \hat{\sigma}(\alpha)$, even the first-best profit, $\frac{A}{1-L(\sigma)}(\mu - 1)$, is lower than the profit from the safest asset, $\frac{A}{1-L(\sigma_0)+\alpha L(\sigma_0)}(\mu - 1)$. It is easy to see that

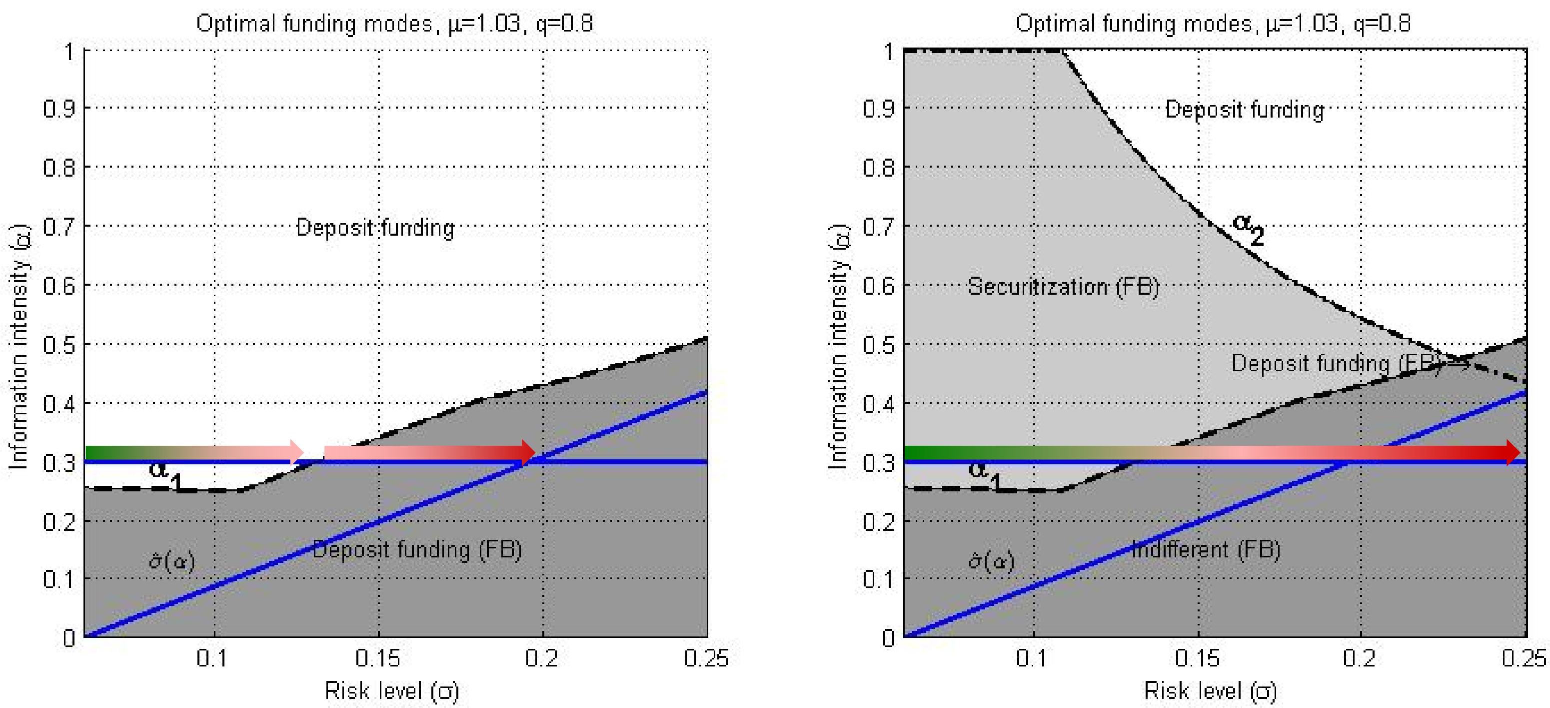
$$\hat{\sigma}(\alpha) = \sigma_0 + \left(\frac{\mu}{\sqrt{q/(1-q)}} - \sigma_0 \right) \alpha.$$

For $\alpha = 0.3$, under deposit funding, the bank entity starts investing from the asset with $\sigma = 0.132$ (the first one in the shaded region in the left panel), and moving right along the horizontal blue line (as indicated by the arrow on the right), until it uses up all of its capital or reaches $\hat{\sigma}(0.3) = 0.197$. If the bank entity still has capital left after reaching $\hat{\sigma}(0.3)$, it goes to the asset with σ_0 and moves right again (as indicated by the arrow on the left).

After the introduction of securitization with explicit guarantees, the BHC invests according to the right panel of Figure 3.6. In this map, with the help of securitization, safer assets can also achieve the first-best level of investment. Therefore, the BHC starts by investing in very safe assets, prioritizing them for securitization and de-prioritizing high-risk assets for deposit funding (as indicated by the long arrow).

If the distribution of assets across σ has high densities for low values of σ, the associated increase in reserve holdings on-balance sheet may dominate the reduction in risky investments on-balance sheet, so that securitization may result in a higher total leverage of a sponsoring bank entity (empirical fact I).

Figure 3.6: Change in Asset Ranking



3.3.5 Output Analysis

This section analyzes the output consequences of introducing securitization with explicit guarantees to banks that otherwise rely only on deposit funding in the dynamic model. This is carried out numerically using the results in the previous two sections.

I discretize $\sigma \in [0.06, 0.25]$ into 96 points, and assume that there is 1 unit of asset available at each level of risk. All assets have a mean return of 1.03. The probability of the high state is 0.8, and the discount factor is 0.9. The endowed capital is $A = 1$. The information intensity α is varied across experiments.

Table 3.1 shows the mean and standard deviation of aggregate period-two output before and after the introduction of securitization with explicit guarantees in the dynamic model. At all levels of α, securitization weakly increases mean output and reduces volatility. When both funding modes are available, the BHC prioritizes securitizing low-risk assets and de-prioritizes deposit-funding high-risk assets. As a result, the number of risky assets falls. The mean and volatility of output after the introduction of securitization is constant across α, since, under the given parameterization, the BHC always uses up its capital before going out of the region where the first-best level of investment is achievable.

3.4 Securitization, Moral Hazard, and Government Bailouts

In the benchmark dynamic model, the penalty to the BHC for reneging on its promises is losing external funding forever. In reality, banks have access to the

Table 3.1: Output changes from securitization

α	Mean of output			Vol. of output		
	before	after	change (%)	before	after	change (%)
0.1	9.65	9.65	0	0.207	0.207	0
0.2	9.65	9.65	0	0.207	0.207	0
0.3	4.29	9.65	125%	0.271	0.207	-23.8%
0.4	3.08	9.65	213%	0.315	0.207	-34.3%
0.5	2.22	9.65	335%	0.351	0.207	-41.2%

public safety net – government bailouts that allow banks to continue operation after default. In this section, I incorporate this realistic assumption into the dynamic framework.

I define a bailout as help from the government to repay outside investors in full, along with permission to continue operation after default rather than going out of business. I assume that default of either the bank entity or the SPV triggers a potential bailout with probability $\phi \in [0, 1)$.

In this section, I focus on deposit funding and securitization with explicit guarantees. This is because allowing for government bailouts only affects the equilibria under deposit funding and securitization with explicit guarantees – these are the cases where seizing assets constitutes a default. With implicit guarantees, the bank is never legally obligated to repay, and thus failing to honor implicit guarantees does not trigger a default.

After receiving a government bailout, the BHC continues to operate, but only as a discredited bank entity or SPV, as in the static model, in all future periods.

The cost of default is losing reputation and having to suffer agency costs thereafter. The probabilistic nature of the bailout is crucial, as it induces misalignment between outside investors' and the BHC's perceptions of the cost of default. The misalignment exacerbates moral hazard and hence makes the BHC worse off irrespective of the funding mode. Moreover, for riskier assets, the misalignment is larger under deposit funding: infinitely risk-averse outside investors value probabilistic bailouts at 0, while the bank entity values them highly as the bank entity can continue operating with low agency costs. This misalignment reduces total investment irrespective of the funding mode and works in the opposite direction of the *agency cost mechanism*, promoting risk taking in securitization.

3.4.1 Threshold Information Intensity under Deposit Funding

With probability ϕ, the bank entity will be bailed out following a default and continue as a discredited bank. Therefore, the incentive compatibility constraints (ICCs) under deposit funding are now written as

$$\alpha H X^{FB} \leq \beta \left[V^{FB} - \phi V_d^B \right], \quad \text{(ICCH)}$$

$$\alpha L X^{FB} \leq \beta \left[V^{FB} - \phi V_d^B \right], \quad \text{(ICCL)}$$

respectively for assets satisfying the condition $H - L < \alpha H$ and not. $V_d^B = \frac{1}{1-\beta} \cdot \frac{A}{1-L+\alpha L} \left[\mathbb{E}(x) - 1 \right]$ is the franchise value of a discredited bank with $X_d^B = \frac{A}{1-L+\alpha L}$. The cost of default is the expected reduction of franchise value caused by the resurrection of agency costs as a discredited bank, $V^{FB} - \phi V_d^B$. When agency costs are low, the franchise value of a discredited bank entity, V_d^B, is high, making default more tempting and commitments less credible. Recall that, without reputation, riskier assets create lower agency costs under deposit funding, and hence they make the bank entity worse off ex-ante by weakening its ability to commit.

Note that the above formulations of ICCH and ICCL critically hinge on the assumption that the bailout probability is strictly smaller than 1. Specifically, the continuation values, V^{FB} and V_d^B, are only finite and different from each other when $\phi < 1$. If $\phi = 1$, outside investors know that their deposits are always safe and will disregard the moral hazard of diverting assets. In this case, $X = \infty$ and $V^{FB} = V_d^B = \infty$, and hence the above formulations would be invalid. The same reasoning applies to the case of securitization as well.

As in the benchmark, conditions $H - L < \alpha H$, ICCH, and ICCL together create a maximum information intensity given by the following lemma.

Lemma 7. ***(Threshold information intensity under deposit funding)*** *Under deposit funding, there is a unique threshold level of information intensity*

$$\alpha_1^B = min\left\{max\{\alpha_1^{DH}, \alpha_1^H\}, \alpha_1^L\right\},$$

where

$$\begin{aligned}
\alpha_1^{DH} &= 1 - \frac{L}{H}, \\
\alpha_1^H &= \phi\left[\frac{\beta}{1-\beta}\left[\mathbb{E}(x) - 1\right]\frac{1}{H} - \left(\frac{1}{L} - 1\right)\right] + (1-\phi)\frac{\beta}{1-\beta}\left[\mathbb{E}(x) - 1\right]\frac{1}{H}, \\
\alpha_1^L &= \phi\left[\frac{\beta}{1-\beta}\left[\mathbb{E}(x) - 1\right]\frac{1}{L} - \left(\frac{1}{L} - 1\right)\right] + (1-\phi)\frac{\beta}{1-\beta}\left[\mathbb{E}(x) - 1\right]\frac{1}{L}.
\end{aligned}$$

For $\alpha \in [0, \alpha_1^B]$, investors agree to finance $X = X^{FB} = \frac{A}{1-L}$. Otherwise, investors only finance $X = X_d^B = \frac{A}{1-L+\alpha L}$.

In the above equations, the terms multiplying $(1-\phi)$ represent the threshold information intensity in the benchmark with a zero probability of bailouts. The terms multiplying ϕ represent the threshold information intensity if the bailout probability approaches 1. The first terms in the square brackets correspond to the threshold levels of information intensity when the bailout probability is zero in that , i.e. they are the same as the terms multiplying $(1-\phi)$. The identical second terms in the square brackets, $\left(\frac{1}{L} - 1\right)$, capture the effect of bailouts. When the BHC receives a bailout, its cost of default is the re-emerged agency costs that are associated with the low-state return of the asset. The lower the low-state return, the lower the agency costs under deposit funding, and hence the lower the cost of default, and thus the lower the threshold information intensity.

3.4.2 Threshold Information Intensity under Securitization

After being bailed out following a default, the SPV has two options: continuing as a discredited SPV or as a discredited bank entity. Note that the first-best franchise value, V^{FB}, is always higher than the franchise value of a discredited SPV or a discredited bank entity. The drop in the franchise value from losing reputation constitutes the long-run cost of default and provides the credibility of commitment.

Therefore, the ICC is given by:

$$\alpha(H-L)X^{FB} \leq \beta\left(V^{FB} - \phi max\{V_d^S, V_d^B\}\right) \quad \text{(ICCS).}$$

Again, the cost of default is the expected cost of losing reputation, $V^{FB} - \phi max\{V_d^S, V_d^B\}$. When agency costs are high, the franchise value of a discredited BHC, $max\{V_d^S, V_d^B\}$, is low, making default less tempting and commitments more credible. Recall that, in the absence of reputation, riskier assets create higher agency costs under securitization, and hence they make the BHC better off under securitization by strengthening its commitment.

This condition generates a threshold information intensity under securitization:

Lemma 8. ***(Threshold information intensity under securitization)*** *Under securitization, there is a unique threshold level of information intensity*

$$\alpha_2^B = \phi min\left\{\alpha_2^S, \alpha_2^D\right\} + (1-\phi)\frac{\beta}{1-\beta}\left[\mathbb{E}(x) - 1\right]\frac{1}{H-L},$$

where

$$\begin{aligned} \alpha_2^S &= \frac{\frac{\beta}{1-\beta}\left[\mathbb{E}(x)-1\right] - (1-L)}{H-1}, \\ \alpha_2^D &= \frac{\frac{\beta}{1-\beta}\left[\mathbb{E}(x)-1\right]\frac{L}{H-L} - (1-L)}{L}. \end{aligned}$$

For $\alpha \in [0, \alpha_2^B]$, investors agree to finance $X = X^{FB} = \frac{A}{1-L}$ in the SPV. Otherwise, investors only finance $X_d^S = \frac{A}{1-L+\alpha\frac{H-L}{1-\alpha}}$ in the SPV.

3.4.3 Range of Securitization

As in the benchmark, I combine Corollary 1 with Lemma 7 and Lemma 8 to get the full range of securitization.

Proposition 5. ***(Region of securitization with government bailouts)*** *Assume that both deposit funding and securitization with explicit guarantees are allowed; that the BHC is bailed out by the government after a default with probability* $\phi \in [0, 1)$*; and that* $\alpha_B = \alpha_S = \alpha$*. The BHC is indifferent between deposit funding and securitization for assets with* $\alpha \in [0, \alpha_1^B)$*, with* $X = X^{FB} = \frac{A}{1-L}$*. If* $\alpha_2^B \geq \alpha_1^B$*, the BHC strictly prefers securitizing assets with* $\alpha \in [\alpha_1^B, \alpha_2^B]$*, with* $X^{FB} = \frac{A}{1-L}$*. If* $\alpha_0 \geq \alpha_2^B$*, the BHC strictly prefers securitizing assets with* $\alpha \in (\alpha_2^B, \alpha_0]$*, with* $X_d^S = \frac{A}{1-L+\alpha\frac{H-L}{1-\alpha}}$*. For asses with* $\alpha \in (max\{\alpha_2^B, \alpha_0\}, 1]$*, the BHC strictly prefers on-balance sheet financing with* $X_d^B = \frac{A}{1-L+\alpha L}$*.*

Figure 3.7 plots the optimal funding modes when the probability of government bailouts is set to $\phi = 0.99$. In drastic contrast with the benchmark map, a larger portion of riskier assets are now financed off-balance sheet. In the benchmark dynamic model with no bailouts, the deposit funding threshold α_1 is increasing in σ; while with a high probability of a government bailout, the deposit funding threshold α_1^B is decreasing in σ.

The effect of a government bailout is twofold. First, bailout expectations reduce the cost of default – instead of losing its entire franchise value, the BHC only faces a reduction of its franchise value commensurate with the magnitude of the agency costs in the absence of reputation. This adverse effect uniformly limits the set of assets for which a bank entity or an SPV can commit to repay, therefore reducing total investment irrespective of the funding mode.

Second, in either funding mode, the BHC is less tempted to default when facing a large drop in its franchise value after a default – the *franchise value mechanism*. Recall that the reduction of franchise value is commensurate with the resurrected agency costs after default. Also, without reputation, the BHC chooses deposit funding for the most risky assets and chooses securitization for all the safer ones. Therefore, for medium-risk assets, the post-default SPV continues as a discredited SPV. Thus, from the *agency cost mechanism*, without reputation, medium-risk assets inflict high agency costs under securitization but low agency costs under deposit funding. Therefore, when securitizing medium-risk assets, the SPV values its reputation more than the bank entity does, making it easier to commit under securitization. The *franchise value mechanism* here increases the chance that banks will fund riskier assets through securitization rather than deposit funding.

The pattern of the optimal funding modes is consistent with industry practice and empirical regularities. In practice, small business loans are rarely securitized. From the lens of this paper, they correspond to assets in the upper-right corner in the left panel of Figure 3.7 and are not suitable for securitization due to their high information intensities and high risks. Their risk levels are so high that even securitization cannot help the BHC overcome moral hazard, and their information intensities are so high that they can only be financed on-balance sheet.

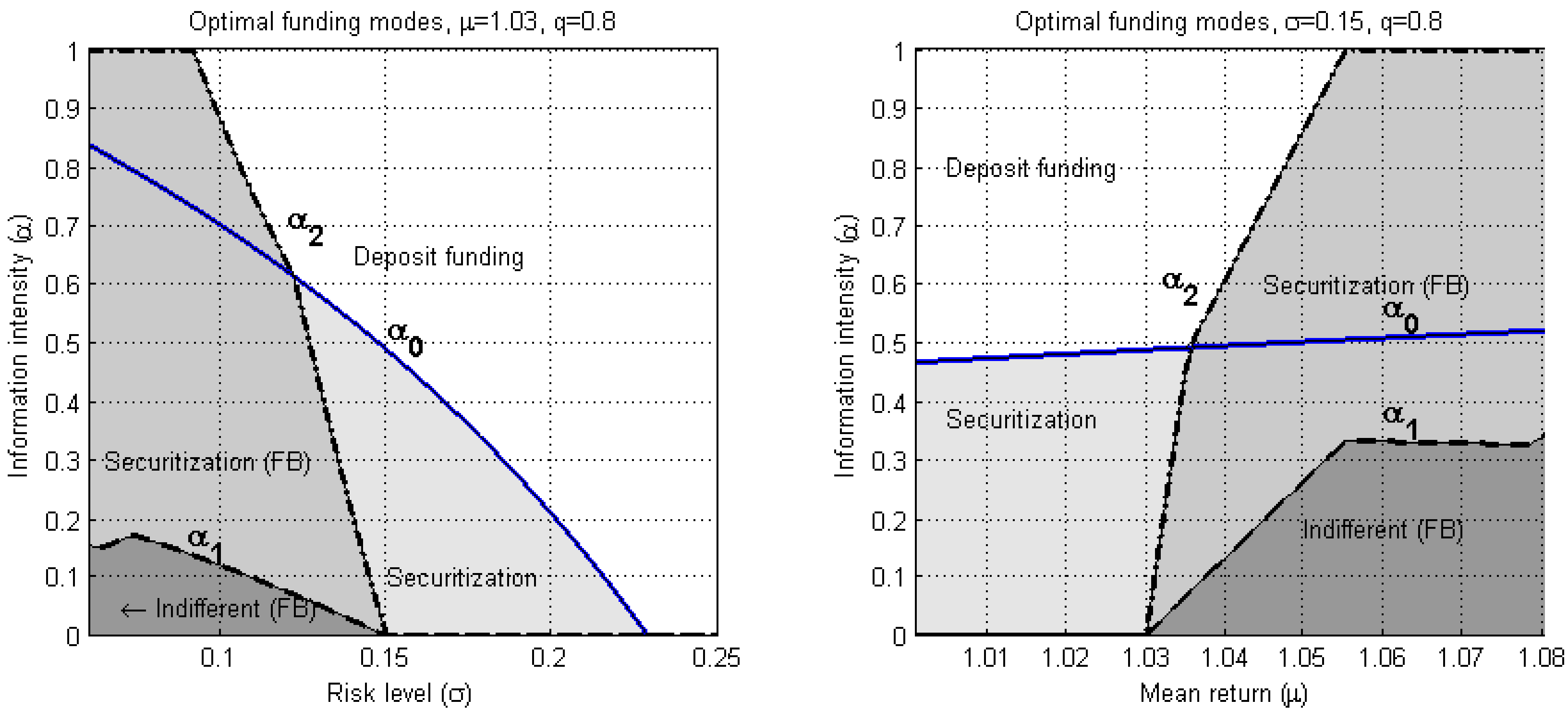
Assets in the securitization region in the left panel of Figure 3.7 could represent sub-prime mortgages and other riskier assets that are not as high-risk and opaque as small business loans. Given the high probability of government bailouts, these assets create high misalignments if financed on-balance sheet and are optimally securitized.

Assets in the indifference region in the left panel of Figure 3.7 could represent prime mortgages and other very safe and standardized assets. Prime mortgages are more standardized than subprime mortgages and small business loans, and their risk levels are in general very low.

In determining risk taking in securitization, the *franchise value mechanism* works in the opposite direction of the *agency cost mechanism*, and the force of the former is increasing in the likelihood of bailouts. This result implies that larger banks that have higher access to government bailouts engage in securitization more extensively, which is consistent with empirical fact II.

The outcome that, with a high probability of government bailouts, the BHC finances a larger share of riskier assets via securitization is driven by the negative slope of most parts of the deposit funding threshold α_1^B. The downward sloping part of α_1^B is α_1^L, as defined in Lemma 7. Therefore, to study the effect of government bailouts, I look at the slope of α_1^L with respect to σ. Corollary 3 decomposes the slope of α_1^L into two parts and derives the threshold level of the bailout probability above which risk taking occurs in the shadow banking system.

Figure 3.7: Map of Optimal Funding Modes with Probabilistic Government Bailouts



Corollary 3. ***(Threshold bailout probability)*** *When $\phi \in [0,1)$, the partial derivative of α_1^L with respect to σ depends on the bailout probability as follows:*

$$\frac{\partial \alpha_1^L}{\partial \sigma} = \underbrace{\phi \cdot \frac{-\sqrt{\frac{q}{1-q}}}{\left(\mu - \sigma\sqrt{\frac{q}{1-q}}\right)^2}}_{(-)\,\textit{franchise value mechanism}} + \underbrace{\frac{\beta}{1-\beta} \frac{[\mu - 1]\sqrt{\frac{q}{1-q}}}{\left(\mu - \sigma\sqrt{\frac{q}{1-q}}\right)^2}}_{(+)\,\textit{agency cost mechanism}}.$$

Therefore, α_1^L is decreasing in σ when $\phi > \frac{\beta}{1-\beta}(\mu - 1)$, i.e. when the franchise value mechanism dominates the agency cost mechanism.

In the benchmark model with no bailouts ($\phi = 0$), α_1^L is increasing in σ. When ϕ is sufficiently high, the *franchise value mechanism* dominates the *agency cost mechanism*, and α_1^L becomes decreasing in σ. A declining α_1^L in σ implies that banks are more likely to securitize riskier assets.

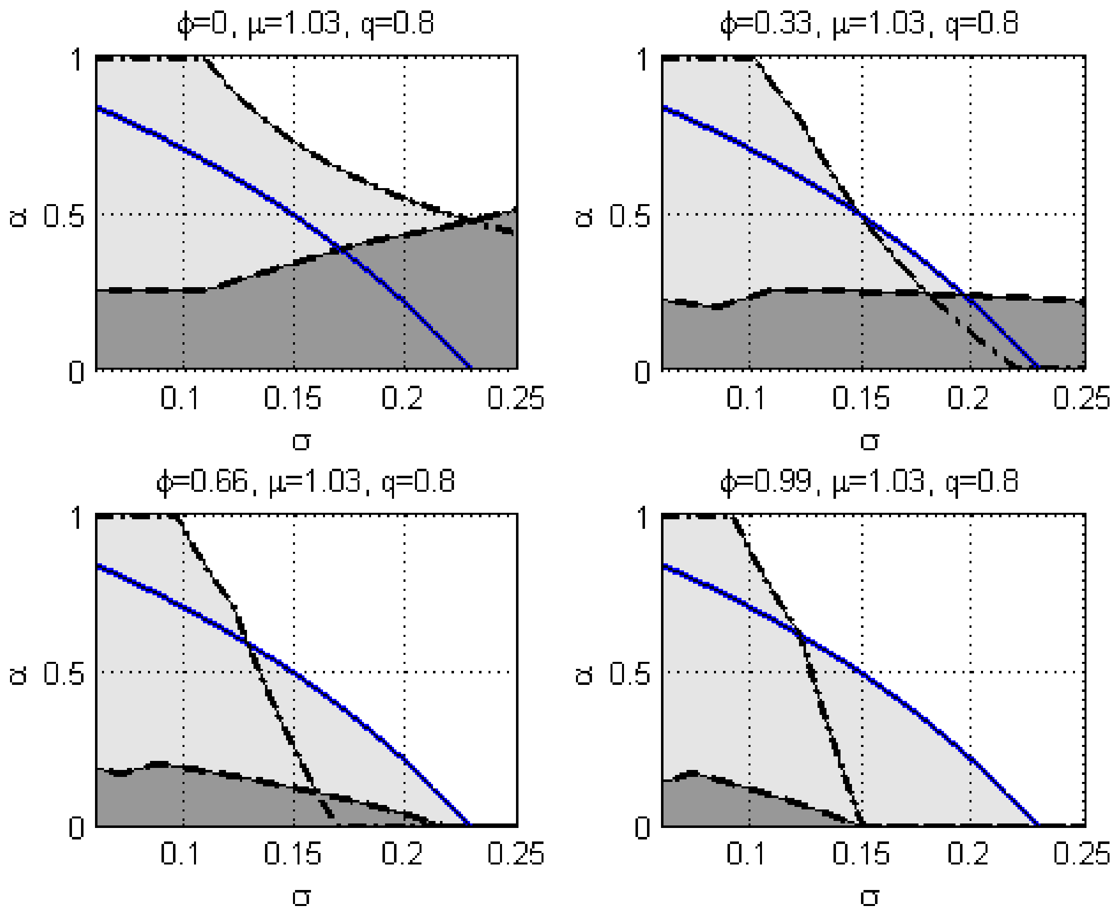
Contrary to the conventional wisdom that government bailouts induce risk shifting from the banking sector to the public sector, this model unveils a novel mechanism. The existence of bailouts weakens banks' ability to overcome agency problems. The probabilistic nature of the bailout plays a key role in inducing misalignment between the BHC's and outside investors' perceptions of the cost of default in traditional banking. As discussed earlier, if the probability of receiving government bailouts equals to 1, the level of investment and the franchise value would be infinity in either funding mode, and the formulations of all the incentive compatibility constraints would be invalid. In this case, risk-averse outside investors and the BHC would collectively invest to infinity and shift the risk to the public safety net.

When the probability of receiving government bailouts is strictly less than one, the risk-neutral bank values the expected bailout, but investors do not value it at all (since they are infinitely risk-averse). Because of this misalignment, government bailouts exacerbate the moral hazard, and thus reduce total investment irrespective of the funding mode. Moreover, for riskier assets, this misalignment is larger under deposit funding. Infinitely risk-averse outside investors value probabilistic bailouts at 0, while the bank entity values it very much as the bank entity can continue operating with low agency costs. This effect encourages intermediaries to finance a larger portion of riskier assets via shadow banking. If the misalignment is not present, government bailouts would not exacerbate the moral hazard, as both outside investors and the BHC value the bailout equally.

The conventional view on government bailouts predicts excessive risk-taking by bank entities. However, prior to the recent financial crisis, risky assets were concentrated in the shadow banking sector (empirical fact III), consistent with the prediction of this novel channel.

Figure 3.8 illustrates how the region of securitization changes with ϕ, the probability of getting a government bailout conditional on a default. The dark gray region is where the BHC is indifferent between deposit funding and securitization. The light gray region is where securitization is strictly preferred. The white region is where deposit funding is strictly preferred. As the probability of getting a government bailout increases, the lower bound of the region where securitization is strictly preferred becomes downward sloping.

Figure 3.8: Map of Optimal Funding Modes and the Probability of Bailouts



3.4.4 Output Analysis

This section conducts the same output analysis as in Section 3.3.5, but assuming a bailout probability $\phi = 0.99$ after a default. Table 3.2 shows the mean and standard deviation of period-two output before and after the introduction of securitization.

Securitization still increases expected output, as investment is boosted by overcoming agency costs. However, the increase in expected output comes with an increase in volatility. On the one hand, the increase in investment itself increases volatility, since all assets are risky. More importantly, the reduction of agency costs increases the capital utilization efficiency defined as the maximum level of investment per unit of capital, thus allowing the BHC to invest in riskier assets down the rank that otherwise wouldn't be exploited.

Table 3.2: Output changes from securitization w/ bailout

α	Mean of output			Vol. of output		
	before	after	change (%)	before	after	change (%)
0.1	9.65	9.65	0	0.207	0.207	0
0.2	3.73	9.65	159%	0.115	0.207	79.7%
0.3	2.82	9.65	242%	0.098	0.207	110%
0.4	2.26	9.65	327%	0.087	0.207	137%
0.5	1.89	9.65	411%	0.079	0.207	161%

3.4.5 Policy Implications

There is empirical evidence that underscores the marked variation in the performance of different classes of securitized assets during and after the financial crisis (Segoviano et al., 2013). This model points to the role of government bailouts in affecting risk preferences under securitization. Systemically important intermediaries have a higher chance of receiving government bailouts than small intermediaries. The variation in the possibility of bailouts may contribute to the variation in the performance of securitized assets across different origination intermediaries. This outcome is consistent with empirical facts. Kalemli-Ozcan et al. (2012), Acharya and Schnabl (2010), and Acharya et al. (2013) show that, before the financial crisis, larger banks securitized riskier assets.

The positive contribution of the paper is to point out that, besides risk transfer and regulatory arbitrage, there is also moral hazard involved in securitization, and the moral hazard has important implications for bank behavior. Moreover, the paper provides a new understanding of how government bailouts affect shadow banking. These new perspectives should be considered by regulators to ensure sound policy making.

The model completely abstracts from regulatory arbitrage, yet it can still generate the result that, when securitization becomes available, banks finance more risky assets off-balance sheet, as long as there is a possibility of a government bailout. Therefore, the model suggests that, even if regulatory arbitrage can be cleaned up, banks may still securitize risky assets, especially too-big-to-fail banks. In the model, risk taking in securitization is an efficient equilibrium outcome that is inherently neither good nor bad per se, but the stability of the system critically hinges on the sufficiency of reserves held on-balance sheet to honor guarantees. From the perspective of the delegation theory of regulation, regulators should monitor on behalf of investors to ensure that banks hold adequate reserves for the guarantees they provide.

3.5 Conclusion

This chapter embeds the static model of securitization with moral hazard in an infinite-period setup and develops a dynamic apparatus to study both explicit and implicit guarantees.

In a dynamic setting, the BHC can use their franchise value as a commitment device to overcome the moral hazard of diverting assets and default. But as the moral hazard gets stronger, the strength of franchise value of a commitment device gets weaker. When risky assets are securitized, a large amount of reserves are held on-balance sheet. As a result, the magnitude of the moral hazard is high, and very few risky assets can overcome the moral hazard. Thus, the *agency cost mechanism* identified in Chapter 2 carries over into the dynamic framework, and only low-risk assets are securitized.

A new mechanism, the *franchise value mechanism*, arises in the dynamic setting. High-return assets generate high franchise values, thereby making it easier for the bank entity to commit not to default under deposit funding. This makes securitization less valuable as a method to reduce and/or overcome the moral hazard. Thus, the *franchise value mechanism* promotes deposit funding for high-return assets.

Introducing probabilistic government bailouts unveils a novel channel through which bailout expectations exacerbate the moral hazard and reduce total investment by creating misalignment of incentives between outside investors and banks. This misalignment is larger for riskier assets if they are financed on-balance sheet. To reduce misalignment, banks securitize riskier assets and hold safer ones on-balance sheet. Government bailouts thus have the effect of inducing banks to securitize risky assets. The linkage between government bailouts and securitization decisions is a novel result of the dissertation.

This chapter discusses the implications of different forms of guarantees. With explicit guarantees, banks securitize assets with either low information intensity or low risk. By contrast, with implicit guarantees, banks only securitize assets with high information intensity and low risk. The very different securitization decisions under the two types of guarantees predicted by the model offer testable implications that can be explored empirically.

Chapter 4: Securitization and Monitoring

4.1 Introduction

In the aftermath of the recent financial crisis, a lot of academic and regulatory concerns circle around the consensus that higher securitization activity is associated with a reduction in loan quality.

Regarding the connection between securitization and loan quality, the empirical literature has shown two major regularities. First, the credit expansion before the crisis, and in particular to subprime borrowers, was closely related to the increase in securitization (Berndt and Gupta, 2009; Mian and Sufi, 2009; Pernanandam, 2011; Dell'Ariccia et al., 2012; Elul, 2015). This is consistent with the results in Chapter 3, where large banks that have access to government bailouts expand leverage through securitization, and the majority of the securitized assets are relatively high-risk assets.

The second, and more interesting, empirical finding is that securitization may lead to diminished bank monitoring (Berndt and Gupta, 2009; and Keys et al., 2010). In particular, Keys et al. (2010) exploit an industry rule of thumb, i.e. a cutoff credit score of 620, and find that delinquency rates of securitized mortgages are higher than those of similar loans kept on-balance sheet. Ex-ante, borrowers with credit scores of 621 and 620 were very similar, but mortgages with score 621 were much easier to be sold and hence were more frequently securitized. They show that the average delinquency rate jumps up at this ad-hoc rule of thumb cutoff score. This result suggests that securitization adversely affects the screening and/or monitoring incentives of financial intermediaries.

This chapter discusses the linkage between securitization and ex-post monitoring and attempts to explain the latter regularity. To focus on how the choice of funding modes affects ex-post monitoring decisions, I compare monitoring incentives when different funding modes are employed exogenously. I argue that the moral hazard of diverting assets, i.e. the benchmark moral hazard, naturally gives rise to a lower incentive to screen borrowers and monitor assets after fund raising via securitization. In other words, under securitization, the benchmark moral hazard induces a new moral hazard of weak monitoring. Intuitively, while securitization reduces the moral hazard of managers diverting assets, it at the same time increases the distance between managers and the assets. This enlarged distance inevitably reduces managers' incentives to exert effort after fund raising.

As in earlier chapters, this paper studies the optimal contract between rational outside investors and financial intermediaries. The new element added to the benchmark model is ex-post monitoring. Ex-post monitoring increases the expected return of risky assets, but is costly. One can interpret ex-post monitoring as any costly effort that is exerted after an intermediary has raised its funds. For example, after fund raising, banks screen borrowers to decide who to lend out. Knowing that loans originated down the road will be securitized, banks may act sloppy in the screening process. Another example is due diligence. When loans are to be securitized, banks may have less incentive to perform due diligence, e.g. call borrowers when they are late for payments.

The key sequence of moves is that outside investors provide funds to intermediaries first, and then intermediaries decide whether or not to exert effort. This ordering creates a time-inconsistency problem that is at its core a moral hazard problem in which intermediaries' monitoring effort is not contractible. Rational investors observe an intermediary's monitoring cost and comprehend the consequence of its potential default and thus form beliefs about its ex-post monitoring effort. Funding is provided ex-ante according to these beliefs. In a rational expectation equilibrium, outside investors' ex-ante beliefs are consistent with the intermediary's ex-post monitoring action.

In an environment with moral hazard of diverting assets, the BHC's equilibrium payoffs are determined by what can be diverted off-equilibrium. Under securitization, assets are moved to off-balance sheet vehicles, and only reserves are held on-balance sheet. Thus, the BHC's payoff is determined solely by the amount of reserves set aside ex-ante. The incentive to monitor depends on the contingency of the BHC's payoff on the monitoring action, and since neither the amount nor the return of reserves depend on ex-post monitoring, the BHC has less incentive to monitor securitized assets.

This chapter also studies monitoring incentives under different guarantee structures. Under securitization, the incentive to monitor is the weakest when guarantees are implicit, as these guarantees allow banks to renege on their monitoring promises without being declared bankrupt and punished.

The rest of the chapter is structured as follows. Section 4.2 summarizes the related literature. Section 4.3 describes the setup of the model with monitoring. Section 4.4 studies a static model with monitoring, and Section 4.5 extends it to a dynamic framework. Section 4.6 concludes.

4.2 Related Literature

This chapter is related to several strands of literature. First of all, it is related to the empirical literature that points to the dual role of securitization in exacerbating adverse selection and worsening moral hazard (Berndt and Gupta, 2009; Mian and Sufi, 2009; Pernanandam, 2011; Dell'Ariccia et al., 2012; Elul, 2015). This line of literature argues that securitization and the resulting liquid market for loans induce banks to originate and sell lower quality assets based on private information (adverse selection), and/or that this liquid market diminishes bank monitoring that affects loan quality ex-post (moral hazard). This chapter builds on the novel agency cost perspective of this dissertation to explain the moral hazard of weak screening and monitoring after fund raising.

On the theoretical side, this chapter is closely related to the literature studying endogenous information acquisition and security design. There is a long literature that studies the optimal security design to provide incentives to sell good loans (Innes, 1990; Gorton and Pennacchi, 1995; Hartman-Glaser et al., 2013) and to provide market liquidity (Myers and Majluf, 1984; Nachman and Noe, 1994; DeMarzo and Duffie, 1999; Biais and Mariotti, 2005; DeMarzo, 2005; Plantin, 2009). Parlour and Plantin (2008), Malherbe (2012), and Vanasco (2014) study the trade-off between incentives to issue good quality assets and to provide market liquidity.

Parlour and Plantin (2008) studies the impact of an active loan market on banks' monitoring efforts from an adverse selection perspective. In their model, the ability to benefit from inside trading reduces banks' incentives to monitor loans. In particular, banks monitor less to refrain from inside trading, which ameliorates potential adverse selection and improves market liquidity. In contrast to their work, this chapter studies the impact of an active market on banks from a moral hazard perspective. In my setting, weak monitoring is not driven by the motive of reducing adverse selection when selling old loans, but by the combination of the use of guarantees and the benchmark moral hazard of diverting assets.

This chapter abstracts from optimal security design for liquidity provision and focuses on the optimal contract between investors and intermediaries to induce the intermediary to put ex-post effort in an investment project that is consistent with investors' expectations. In this sense, this chapter is closely related to Innes (1990) who finds that the optimal security design in this context is debt. I compare monitoring incentives under different debt structures, i.e. debt structured with explicit and implicit guarantees. Gorton and Pennacchi (1995) studies incentive-compatible loan sales that allow for implicit guarantees. They show that, if loans are not fully guaranteed implicitly, banks do not undertake the level of credit evaluation or monitoring that they would were they to hold the entire loan. By contrast, this chapter shows that, in the presence of the moral hazard of insiders diverting assets, even full guarantees (either explicit or implicit) cannot assure the level of monitoring that would be implemented if assets were held on-balance sheet. To the best of my knowledge, this is the first paper that explicitly models and differentiates types of guarantees and studies their implications for monitoring incentives.

Fender and Mitchell (2009) study how retention mechanisms affect the incentives of originators to screen and monitor loans. They find that retention of the first-loss tranche cannot fully correct monitoring incentives when systematic risk factors dominate idiosyncratic factors in determining asset returns. My model delivers a similar result that providing guarantees cannot fully correct incentives, not because of systematic risk factors but because of the moral hazard of diverting assets. The linkage between the benchmark moral hazard and the induced moral hazard of weak monitoring is a novel result of this chapter.

This chapter is also related to the growing literature studying information acquisition and market competition in banking. Hauswald and Marquez (2006) argue that banks acquire information about clients to fend off competitors. However, Ahn and Breton (2014) argue that, in an environment where banks profit from poaching competitors' clients, banks securitize and strategically reduce monitoring to soften competition and increase profits from poaching. In contrast to their setting, banks in my model profit from tail risk of risky assets that is assumed to be not affected by competition.

4.3 Environment

Monitoring increases the expected return of risky assets, but is costly. Specifically, the BHC can monitor the asset after origination at a cost of C per unit of investment. The cost of monitoring, C, is publicly observable, but the monitoring action is unobservable and non-verifiable. If the BHC monitors, the low-state return is $\bar{L}$, otherwise it is $\underline{L} < \bar{L}$. The high-state return is unaffected by monitoring. Without loss of generality, I assume that the BHC only defaults in the low state. In order to affect the level of investment, monitoring must change the low-state return, as outside investors are infinitely risk-averse.

Let $\bar{\mu}$ denote the mean return of a monitored asset, and $\underline{\mu}$ the mean return of an unmonitored asset. I assume that the expected net unit profit from the risky asset is positive when the BHC monitors, i.e. $C < \bar{\mu} - 1$, and when the BHC does not monitor, i.e. $\underline{\mu} > 1$.

The timeline of the actions is the following. First, a funding mode is exogenously given. Then, both outside investors and the BHC observe C. After observing C, investors present two compensation schemes for the BHC to pick. Investors observe the BHC's choice and form an ex-ante belief about the BHC's ex-post monitoring action. Funds are provided according to their beliefs. After the asset is originated, the BHC decides whether or not to monitor the project. Finally, returns are realized, and the BHC chooses between defaulting or not. As in the benchmark, in the event of default, the BHC seizes a portion α of assets held on-balance sheet. The sequence of events is summarized in Figure 4.1.

Figure 4.1: Sequence of Events

Definition of Equilibrium *The equilibrium is defined as in Section 2.3.2 with an additional condition that in equilibrium the ex-ante belief must be consistent with the ex-post monitoring action.*

Given this notion of equilibrium, there are three possible outcomes: (1) a monitoring equilibrium, where investors ex-ante expect the BHC to monitor, and it indeed monitors; (2) a no-monitoring equilibrium, where investors ex-ante expect the BHC to shirk, and it indeed shirks; and (3) no equilibrium, where investors' ex-ante belief is not consistent with the BHC's ex-post action.

The analysis first derives for each given funding mode the maximum monitoring cost that can sustain a monitoring equilibrium, and then compares the thresholds under different funding modes. When the threshold under a certain funding mode is higher, the economy is more likely to arrive at a monitoring equilibrium under that funding mode, and therefore that funding mode induces a stronger monitoring incentive.

In the static benchmark model, I show how agency costs interact with monitoring decisions. Next, I introduce monitoring into the dynamic model and show that securitization reduces monitoring incentives.

4.4 Static Benchmark

I first characterize the condition on the monitoring cost under which the economy would arrive at a monitoring equilibrium for the case of deposit funding, and then repeat the analysis for securitization. To serve as a benchmark, if monitoring was contractible, the BHC would monitor if the total expected profit from monitoring is no less than the total expected profit from not monitoring, i.e.

$$(\bar{\mu} - 1 - C) \frac{A}{1 - \bar{L} + \alpha \bar{L}} \geq \left(\underline{\mu} - 1\right) \frac{A}{1 - \underline{L} + \alpha \underline{L}}.$$

This condition yields the first-best cutoff level of the monitoring cost that is given by:

$$\hat{C}_B^{FB} = (\bar{\mu} - 1) - \left(\underline{\mu} - 1\right) \frac{1 - \bar{L} + \alpha \bar{L}}{1 - \underline{L} + \alpha \underline{L}}.$$

The right-hand-side captures the total benefit of monitoring: the increase in the unit expected profit and the increase in leverage.

Since monitoring is not verifiable, any compensation scheme designed to induce monitoring must alter payments contingent on the low-state return. The realization of the low-state return conveys precise information on the BHC's monitoring action, i.e. if it turns out to be $\bar{L}$, the BHC must have been monitoring, and otherwise it must not have been monitoring. The high-state return conveys no information regarding the BHC's action. Therefore, the efficient compensation scheme to induce monitoring must satisfy the following conditions: (1) depositors get a non-contingent return if the BHC indeed monitors (given depositors' infinite risk-aversion), and (2) conditional on the level of investment determined ex-ante, the BHC's expected payoff from monitoring is not lower than its payoff from shirking.

Therefore, in a monitoring equilibrium, the compensation scheme must take the following form:

$$\omega^m = \begin{cases} H - \bar{L} + \alpha\bar{L} + \lambda & \text{if } H \text{ is realized,} \\ \alpha\bar{L} + \lambda & \text{if } \bar{L} \text{ is realized,} \\ \alpha\underline{L} & \text{otherwise,} \end{cases}$$

where ω is the BHC's payoff, and the superscript m stands for monitoring. λ is a non-negative scalar (to be determined) capturing the compensation for the BHC's cost of monitoring. The payoff when $\underline{L}$ is realized is the total value that the BHC can seize in a default.

In the no-monitoring equilibrium, investors do not need to compensate the bank for the monitoring cost, and the compensation scheme is simply

$$\omega^{nm} = \begin{cases} H - \underline{L} + \alpha\underline{L} & \text{if } H \text{ is realized,} \\ \alpha\underline{L} & \text{otherwise.} \end{cases}$$

where the superscript nm stands for no-monitoring.

With a sufficiently low C and the optimal λ, the monitoring scheme is sufficient to induce ex-post monitoring. Therefore, if the bank chooses the optimal monitoring scheme, investors know for sure that the bank will indeed monitor. Otherwise, investors believe that the bank will shirk.

I use backward induction to first derive the optimal λ and then the threshold C. Conditional on choosing the monitoring scheme and having originated the project, the optimal λ ensures that the bank would indeed monitor, by making the equilibrium expected profit equal to the off-equilibrium expected profit from shirking. The optimal λ is characterized in the following lemma. See Appendix A for derivation.

Lemma 9. *In the monitoring scheme, the optimal λ to induce ex-post monitoring is given by*

$$\lambda = max\left\{0, \frac{C}{1-q} - \alpha(\bar{L} - \underline{L})\right\}.$$

Lemma 9 states that when $C \leq \alpha(1-q)(\bar{L} - \underline{L})$, the optimal $\lambda = 0$, i.e. when monitoring is sufficiently low cost relative to its positive effect on the expected return, the bank monitors voluntarily. When $C > \alpha(1-q)(\bar{L} - \underline{L})$, extra compensation that materializes only in the high state and when the low state return is good is needed to induce the bank to monitor.

Since C is observable, outside investors offer the optimal λ for a given C and let the bank choose one compensation scheme. The bank chooses the monitoring scheme if the expected profit is greater than the expected profit from the no-monitoring scheme. To eliminate uncertainty about the bank's choice, I assume that when expected profits from the two schemes are equal, the bank chooses the monitoring scheme. The comparison of the profits from the two schemes yields a threshold C below which the bank chooses the monitoring scheme. See Appendix A for derivation.

Lemma 10. ***(Threshold monitoring cost when only deposit funding is available)*** *When only deposit funding is available, the economy arrives at a monitoring equilibrium if the monitoring cost is smaller than*

$$\hat{C}^D = (1-q)(\bar{L} - \underline{L}).$$

The economy follows the no-monitoring equilibrium when the monitoring cost is larger than $\hat{C}^D$*.*

One can check that $\hat{C}^D < \hat{C}_B^{FB}$. Because monitoring is non-contractible, investors must compensate the bank for monitoring, which reduces the bank's leverage and hence the benefit of monitoring.

Now I repeat the analysis for the case of securitization. Again, to serve as a benchmark, the first-best cutoff level of the monitoring cost if monitoring was contractible under securitization is given by:

$$\hat{C_S}^{FB} = (\bar{\mu} - 1) - \left(\underline{\mu} - 1\right) \frac{1 - \bar{L} + \alpha(H - \bar{L})/(1-\alpha)}{1 - \underline{L} + \alpha(H - \underline{L})/(1-\alpha)}.$$

Note that under securitization, the assets on-balance sheet are the reserves. In a monitoring equilibrium, the amount of reserves is $\frac{H-\bar{L}}{1-\alpha}$. In the high state, the bank keeps all the reserves. In the low state with $\bar{L}$, the bank keeps α of them plus extra compensation λ for monitoring. However, if the bank shirks and $\underline{L}$ is realized, the bank has insufficient reserves and defaults on its guarantees. In this case, the BHC seizes α of the reserves set aside ex-ante. Therefore, the monitoring and shirking payoff schemes are given by:

$$\omega^m = \begin{cases} \frac{H-\bar{L}}{1-\alpha} + \lambda & \text{if } H \text{ is realized,} \\ \alpha\frac{H-\bar{L}}{1-\alpha} + \lambda & \text{if } \bar{L} \text{ is realized,} \\ \alpha\frac{H-\bar{L}}{1-\alpha} & \text{otherwise.} \end{cases}$$

and

$$\omega^{nm} = \begin{cases} \frac{H-\underline{\underline{L}}}{1-\alpha} & \text{if } H \text{ is realized,} \\ \alpha\frac{H-\underline{\underline{L}}}{1-\alpha} & \text{otherwise.} \end{cases}$$

Using the monitoring compensation scheme, given the pre-determined level of investment and that the SPV chooses the monitoring scheme, the expected profit of an SPV that indeed monitors ex-post is

$$\pi_{eq}^m = [q\,(R+\lambda) + (1-q)\,(\alpha R + \lambda) - C]\,X_S - A,$$

whereas that of an SPV that shirks ex-post is

$$\pi_{offeq}^m = [q\,(R+\lambda) + (1-q)\alpha R]\,X_S - A.$$

To induce the SPV to indeed monitor after choosing a monitoring scheme, the following condition must hold

$$\pi^m_{eq} \geq \pi^m_{offeq}.$$

Therefore, the optimal incentive payment λ is given by

$$\lambda = \frac{C}{1-q}.$$

It is easy to see that the λ under securitization is strictly larger than the λ under deposit funding. This is because that the low-state payoff net of λ under securitization is only a function of the quantity of reserves, R, which is not affected by the monitoring action. Therefore, in order to induce the SPV to monitor, a higher incentive payment is needed. This intuition will be carried over into the dynamic framework.

Following the same comparison between the profits from the two schemes, one can easily derive the threshold monitoring cost under securitization. See Appendix A for derivation.

Lemma 11. ***(Threshold monitoring cost when only securitization is available)*** *When only securitization funding is available, the economy arrives at a monitoring equilibrium if the monitoring cost is smaller than*

$$\hat{C}^S = \frac{(\bar{\mu}-1)(1-\underline{L}+\alpha\frac{H-\underline{L}}{1-\alpha}) - (\underline{\mu}-1)(1-\bar{L}+\alpha\frac{H-\bar{L}}{1-\alpha})}{(\underline{\mu}-1)/(1-q)+1-\underline{L}+\alpha\frac{H-\underline{L}}{1-\alpha}}.$$

The economy follows the no-monitoring equilibrium when the monitoring cost is larger than $\hat{C}^S$.

One can check that $\hat{C}^S < \hat{C}_S^{FB}$. To determine the BHC's incentive to monitor, I compare the threshold monitoring costs under the two funding modes in Lemma 10 and Lemma 11. See Appendix A for the derivation of the following proposition.

Proposition 6. ***(Monitoring incentives in a static model)*** *The threshold monitoring cost under securitization is higher than that under deposit funding, i.e.* $\hat{C}^S > \hat{C}^D$.

If we regard C as a stochastic variable whose value is revealed publicly at the beginning of period 1, for any distribution of C, the probability of a monitoring equilibrium is higher under securitization than under deposit funding. This result critically hinges on the assumption that monitoring only increases the low-state return of the risky asset. The monitoring action affects the profit of the BHC via two channels: (1) the incentive payment, λ, and (2) the low-state return.

As discussed earlier, monitoring does not affect the return of the safe reserves, and thus the incentive payment under securitization is higher than that under deposit funding. The high incentive payment under securitization reduces the level of investment and the potential benefit of monitoring, thereby reducing the monitoring incentive. From this channel, monitoring affects the level of investment via the incentive payment, and securitization weakens monitoring incentive.

In the second channel, monitoring increases the low-state return, which boosts both the level of investment and the unit profit under either funding mode. Moreover, the increased low-state return due to monitoring also affects the agency costs. In particular, a higher low-state return elevates the agency costs under deposit funding but lowers those under securitization. Therefore, the benefit of monitoring is greater under securitization. From this channel, monitoring affects both the level of investment and the unit profit, and securitization strengthens monitoring incentive.

In the static framework, the second channel dominates the first one, and securitization induces stronger monitoring. In a dynamic framework, I will focus on the set of assets that the BHC can successfully use its franchise value to overcome the agency costs. As a result, the above second channel will vanish and the first channel will dominate.

4.5 Dynamic Framework

In the dynamic framework, the BHC can use its franchise value to commit to monitor, rather than relying on the incentive payment, λ. I derive the threshold level of the monitoring cost below which the BHC can credibly commit to monitor ex-post. Contrary to the result in the static model, securitization induces weak monitoring.

I will focus on the set of assets that the BHC can successfully use its franchise value to overcome agency costs. Therefore, the first-best cutoff level of the monitoring cost in the absence of both agency costs and moral hazard in monitoring, irrespective of the funding mode, is given by:

$$\hat{C}^{FB} = (\bar{\mu} - 1) - \left(\underline{\mu} - 1\right) \frac{1 - \bar{L}}{1 - \underline{L}}.$$

In the dynamic setting, the BHC's payoff in the event of default is crucial for its incentives to monitor. Under deposit funding, if the bank shirks and the risky asset doesn't yield enough return to fully repay depositors, the bank will default. Conditional on the level of investment determined ex-ante, in a default, the bank seizes $\alpha\underline{L}$ per unit of investment. Meanwhile, if the bank monitors, its low state payoff is $\alpha\bar{L}$. Therefore, the monitoring action affects the BHC's ex-post payoff in the low state.

On the contrary, under securitization, if the bank shirks, the reserves will not be sufficient to fully honor the guarantees. In a default, the bank seizes αR per unit of investment. Note that the size of reserves R is determined ex-ante, and hence the BHC's ex-post payoff in the low state is not affected by the monitoring action. Therefore, in the dynamic setting, the bank has less incentive to monitor securitized assets. This result is consistent with the empirical findings by Berndt and Gupta (2009) and Keys et al. (2010).

Moreover, implicit guarantees further weaken the incentive to monitor. Intuitively, with implicit guarantees, failing to honor guarantee payments doesn't trigger a legal default, which makes shirking more tempting. Therefore, the use of implicit guarantees further weakens monitoring incentives.

4.5.1 Monitoring in Deposit Funding

I first derive the threshold monitoring cost under deposit funding. Conditional on the ex-ante belief that the bank entity will monitor ex-post, if the bank entity indeed monitors, its low-state return is $\alpha\bar{L}$. However, if the bank entity shirks after having promised to monitor, the risky asset yields a rate of return $\underline{L}$, and the bank entity would fail to repay depositors in full, which constitutes a default. In the event of default, the bank entity seizes $\alpha\underline{L}$. Therefore, the bank entity's ex-post low-state return depends on its monitoring action.

The one-time unit gain from shirking is the monitoring cost minus the return difference, i.e. $C - \alpha(1-q)(\bar{L} - \underline{L})$. After a default, the bank loses its franchise value. Therefore, the incentive compatibility constraints under deposit funding are as follows:

$$\frac{C - \alpha(1-q)(\bar{L} - \underline{L})}{1 - \bar{L}} \leq \frac{\beta(1-q)}{1-\beta} \cdot \frac{\bar{\mu} - 1 - C}{1 - \bar{L}} \quad \text{if } \alpha < \bar{\alpha}^B, \tag{4.1}$$

$$\frac{C - \alpha(1-q)(\bar{L} - \underline{L})}{1 - \bar{L} + \alpha\bar{L}} \leq \frac{\beta(1-q)}{1-\beta} \cdot \frac{\bar{\mu} - 1 - C}{1 - \bar{L} + \alpha\bar{L}} \quad \text{otherwise}, \tag{4.2}$$

where

$$\bar{\alpha}^B = \frac{\beta}{1-\beta} \cdot \frac{\bar{\mu} - 1 - C}{\bar{L}}.$$

When $\alpha < \bar{\alpha}^B$, the level of investment is $\frac{A}{1-\bar{L}}$. Otherwise, investment is $\frac{A}{1-\bar{L}+\alpha\bar{L}}$. Conditions (4.1) and (4.2) lead to a unique threshold level of C as

$$\hat{C}^D_{mh} = \left[\frac{\beta(1-q)}{1-\beta}(\bar{\mu} - 1) + \alpha(1-q)(\bar{L} - \underline{L})\right] / \left[1 + \frac{\beta(1-q)}{1-\beta}\right].$$

The economy arrives at a monitoring equilibrium only when the monitoring cost is lower than $\hat{C}^D \equiv min\left\{\hat{C}^D_{mh}, \hat{C}^{FB}\right\}$.

4.5.2 Monitoring in Securitization with Explicit Guarantees

Now I turn to characterize the threshold monitoring cost in securitization with explicit guarantees. Under securitization, the amount of reserves R is determined ex-ante by outside investors' beliefs. If the BHC monitors as promised, it gets αR in the low state. If the BHC shirks after having promised to monitor, it will not have enough reserves to fully honor guarantees, and hence would default in the low state. In the event of default, the BHC seizes αR. Therefore, the BHC's ex-post low-state payoff is independent of the monitoring action, and the one-time unit gain from shirking is simply C.

This observation is crucial for the result. The moral hazard of misusing assets held on-balance sheet naturally gives rise to the moral hazard in ex-post monitoring. In an environment with moral hazard, the BHC's equilibrium payoff is determined by how much the BHC can divert off-equilibrium, which is a fixed fraction of the reserves set aside ex-ante. Therefore, the BHC's ex-post payoff in the bad state is not contingent on the performance of the securitized assets, precisely because of the moral hazard of misusing assets.

Intuitively, the BHC securitizes assets to reduce the moral hazard of insiders diverting assets by increasing the distance between the managers and the assets. The increased distance weakens managers' incentives to perform due diligence.

The incentive compatibility constraints under securitization with explicit guarantees are as follows:

$$\frac{C}{1-\bar{L}} < \frac{\beta(1-q)}{1-\beta}\cdot\frac{\bar{\mu}-1-C}{1-\bar{L}} \qquad \text{if } \alpha < \bar{\alpha}^S, \tag{4.3}$$

$$\frac{C}{1-\bar{L}+\frac{\alpha}{1-\alpha}(H-\bar{L})} < \frac{\beta(1-q)}{1-\beta}\cdot\frac{\bar{\mu}-1-C}{1-\bar{L}+\frac{\alpha}{1-\alpha}(H-\bar{L})} \quad \text{otherwise,} \tag{4.4}$$

where

$$\bar{\alpha}^S = \frac{\beta}{1-\beta}\cdot\frac{\bar{\mu}-1-C}{H-\bar{L}}$$

When $\alpha < \bar{\alpha}^S$, the level of investment is $\frac{A}{1-\bar{L}}$. Otherwise, investment is $\frac{A}{1-\bar{L}+\frac{\alpha}{1-\alpha}(H-\bar{L})}$. Conditions (4.3) and (4.4) lead to a unique threshold monitoring cost in securitization as

$$\hat{C}^S_{ex,mh} = \left[\frac{\beta(1-q)}{1-\beta}(\bar{\mu}-1)\right] / \left[1+\frac{\beta(1-q)}{1-\beta}\right].$$

The economy arrives at a monitoring equilibrium only when the monitoring cost is lower than $\hat{C}^S_{ex} \equiv min\left\{\hat{C}^S_{ex,mh}, \hat{C}^{FB}\right\}$. It is easy to see that $\hat{C}^S_{ex,mh}$ is strictly smaller than $\hat{C}^D_{mh}$. As a result, the economy is less likely to arrive at a monitoring equilibrium, if the BHC uses securitization with explicit guarantees.

4.5.3 Monitoring in Securitization with Implicit Guarantees

Finally, I derive the threshold monitoring cost under securitization with implicit guarantees. Since guarantees are implicit, the BHC is not legally obligated to honor them ex-post. However, since securitization with implicit guarantees is completely supported by bank reputation, if the bank shirks after having promised to monitor, it loses its reputation and can no longer securitize with implicit guarantees. Similar to the intuition in Section 3.3.2, given that the SPV can fail to honor its monitoring promise without being held liable in court, once the SPV loses its reputation, no outside investors would lend to the SPV. Thus, the BHC can only continue as a discredited bank entity after a "default" on its monitoring promise.

Specifically, conditional on the ex-ante belief that the BHC will monitor ex-post, if the BHC shirks, with probability $1-q$, the low state realizes, and it runs short of reserves to pay outside investors in full as they expected. In this case, the BHC "defaults" on its monitoring promise and loses the reputation that it needs to sustain securitization with implicit guarantees. Moreover, as the BHC is losing its reputation anyway because of shirking, it might as well just seize all the reserves, and it would still not be held liable in court. Therefore, the total one-time gain from shirking under securitization with implicit guarantees is

$$\frac{C}{1-\bar{L}} + (1-q)\,\frac{H-\bar{L}}{1-\bar{L}}.$$

The long-run cost is losing reputation and having to operate as a discredited bank entity that suffers agency costs.

Since I focus on the set of assets that the BHC can securitize with implicit guarantees in the first place, I restrict the following analysis in the region where $\alpha > \alpha_{IM}$, and α_{IM} is defined as

$$\alpha_{IM} = \frac{(H-\bar{L})/\bar{L}}{\frac{\beta}{1-\beta}\cdot\frac{\bar{\mu}-1-C}{1-L} - \frac{H-\bar{L}}{1-\bar{L}}}.$$

Conditional on a monitoring belief, securitization with implicit guarantees can be sustained only when $\alpha > \alpha_{IM}$. The derivation of this threshold simply follows the analysis in Section 3.3.2.

If $C \leq \hat{C}^D$, the post-default bank entity would monitor, and its per-period expected profit is

$$\frac{\bar{\mu} - 1 - C}{1 - \bar{L} + \alpha \bar{L}}.$$

The corresponding incentive compatibility constraint to ensure that the BHC would indeed monitor ex-post is

$$\frac{C}{1-\bar{L}} + (1-q)\,\frac{H-\bar{L}}{1-\bar{L}} \;<\; \frac{\beta(1-q)}{1-\beta}\left[\frac{\bar{\mu}-1-C}{1-\bar{L}} - \underbrace{\frac{\bar{\mu}-1-C}{1-\bar{L}+\alpha\bar{L}}}_{+}\right]. \tag{4.5}$$

If $C > \hat{C}^D$, the post-default bank entity would not monitor, and its per-period expected profit is

$$\frac{\underline{\mu} - 1}{1 - \underline{L} + \alpha \underline{L}}.$$

Similar to the previous case, the corresponding incentive compatibility constraint is

$$\frac{C}{1-\bar{L}} + (1-q)\,\frac{H-\bar{L}}{1-\bar{L}} \;<\; \frac{\beta(1-q)}{1-\beta}\left[\frac{\bar{\mu}-1-C}{1-\bar{L}} - \underbrace{\frac{\underline{\mu}-1}{1-\underline{L}+\alpha\underline{L}}}_{+}\right]. \tag{4.6}$$

The second term on the left had side is strictly positive in both (4.5) and (4.6). Moreover, the second term in the square bracket is also strictly positive in both (4.5) and (4.6). Therefore, the threshold monitoring cost with implicit guarantees, in either case, $\hat{C}^S_{im,mh}$, is smaller than that under securitization with explicit guarantees, i.e. $\hat{C}^S_{im,mh} < \hat{C}^S_{ex,mh} < \hat{C}^D_{mh}$. The economy arrives at a monitoring equilibrium only when the monitoring cost is lower than $\hat{C}^S_{im} \equiv min\left\{\hat{C}^S_{im,mh}, \hat{C}^{FB}\right\}$.

The relevant thresholds of the monitoring cost are summarized in the following proposition.

Proposition 7. ***(Monitoring incentives in a dynamic model)*** *Under deposit funding, the maximum monitoring cost in a monitoring equilibrium is given by $\hat{C}^D \equiv min\left\{\hat{C}^D_{mh}, \hat{C}^{FB}\right\}$, where*

$$\hat{C}^D_{mh} = \left[\frac{\beta(1-q)}{1-\beta}(\bar{\mu}-1) + \alpha(1-q)(\bar{L}-\underline{L})\right] / \left[1 + \frac{\beta(1-q)}{1-\beta}\right];$$

In securitization with explicit guarantees, it is given by $\hat{C}^S_{ex} \equiv min\left\{\hat{C}^S_{ex,mh}, \hat{C}^{FB}\right\}$, where

$$\hat{C}^S_{ex,mh} = \left[\frac{\beta(1-q)}{1-\beta}(\bar{\mu}-1)\right] / \left[1 + \frac{\beta(1-q)}{1-\beta}\right];$$

In securitization with implicit guarantees, it is given by $\hat{C}^S_{im} \equiv min\left\{\hat{C}^S_{im,mh}, \hat{C}^{FB}\right\}$, where $\hat{C}^S_{im,mh}$ is the solution to the following equation, if $C \leq \hat{C}^D$:

$$\frac{\hat{C}^S_{im,mh}}{1-\bar{L}} + (1-q)\frac{H-\bar{L}}{1-\bar{L}} = \frac{\beta(1-q)}{1-\beta}\left[\frac{\bar{\mu}-1-\hat{C}^S_{im,mh}}{1-\bar{L}} - \frac{\bar{\mu}-1-\hat{C}^S_{im,mh}}{1-\bar{L}+\alpha\bar{L}}\right];$$

or the solution to the following equation otherwise:

$$\frac{\hat{C}^S_{im,mh}}{1-\bar{L}} + (1-q)\frac{H-\bar{L}}{1-\bar{L}} = \frac{\beta(1-q)}{1-\beta}\left[\frac{\bar{\mu}-1-\hat{C}^S_{im,mh}}{1-\bar{L}} - \frac{\underline{\mu}-1}{1-\underline{L}+\alpha\underline{L}}\right].$$

Also $\hat{C}^S_{im,mh} < \hat{C}^S_{ex,mh} < \hat{C}^D_{mh}$, *and hence* $\hat{C}^S_{im} \leq \hat{C}^S_{ex} \leq \hat{C}^D$.

4.6 Conclusion

This chapter studies how securitization affects financial intermediaries' screening and monitoring incentives. I argue that securitization induces weak screening and monitoring due to the increased distance between managers and assets.

The combination of the use of guarantees and the benchmark moral hazard diminishes bank monitoring under securitization. This result is consistent with the recent empirical findings of high delinquency rates of securitized mortgages. The linkage between the benchmark moral hazard and the induced moral hazard of weak monitoring is a novel result of the dissertation.

In an environment with the moral hazard of diverting assets, banks' payoffs are determined by what can be diverted off-equilibrium. Under securitization, assets are moved to off-balance sheet vehicles, and only reserves are held on-balance sheet. Thus, banks' payoffs are determined solely by the amount of reserves set aside ex-ante. Incentives to monitor depend on the contingency of banks' payoffs on the monitoring action, and since neither the amount nor the return of reserves depend on ex-post monitoring, banks have less incentives to monitor securitized assets.

This chapter studies monitoring incentives under different guarantee structures. Among all guarantee types, the incentive to monitor is the weakest when guarantees are implicit, as these guarantees allow banks to renege on their monitoring promises without being declared bankrupt and punished.

Appendix A: Math Appendix

Corollary 1

Proof. From Proposition 1, securitization strictly dominates if

$$\alpha_S \frac{H - L}{1 - \alpha_S} < \alpha_B L.$$

Assuming $\alpha_S = \alpha_B$, the above condition becomes

$$\frac{H - L}{1 - \alpha} < L,$$

which yields the threshold

$$\alpha < \alpha_0 = 2 - H/L.$$

The monotonicity follows from above equation. □

Corollary 2

Proof. Let μ and σ denote the expectation and the standard deviation of the binomial distribution. It is easy to get

$$\begin{aligned} H &= \mu + \sigma\sqrt{\frac{1-q}{q}}, \\ L &= \mu - \sigma\sqrt{\frac{q}{1-q}}. \end{aligned}$$

The expression for α_0 follows. $\square$

Lemma 4

Proof. From Lemma 2 and Lemma 3, the minimum signaling costs for a bad bank under securitization with guarantees and under tranching satisfy the following equations respectively:

$$\frac{A\left[\mu - 1 - (1-q)\delta\right]}{1 - L + \delta + \frac{\alpha}{1-\alpha}(H - L + \delta)} = \frac{A - \underline{C}_b^W}{1 - L + \frac{\alpha}{1-\alpha}(H-L)}(\mu - 1) - \underline{C}_b^W, \quad \text{(A.1)}$$

$$\frac{A\left[\mu - 1 - (1-q)\delta\right]}{1 - L + \delta} = \frac{A - \underline{C}_b^T}{1 - L}(\mu - 1) - \underline{C}_b^T. \quad \text{(A.2)}$$

Let $\Phi = A\left[\mu - 1 - (1-q)\delta\right]$ and $\Psi = A(\mu - 1)$. Multiplying both sides of equation (A.1) by $\left[1 - L + \frac{\alpha}{1-\alpha}(H-L)\right]$, and both sides of equation (A.2) by

$(1-L)$, one can get:

$$\frac{1-L+\frac{\alpha}{1-\alpha}(H-L)}{1-L+\delta+\frac{\alpha}{1-\alpha}(H-L+\delta)}\Phi = \Psi-\underline{C}_b^W\left[\mu-L+\frac{\alpha}{1-\alpha}(H-L)\right], \quad (A.3)$$

$$\frac{1-L}{1-L+\delta}\Phi = \Psi-\underline{C}_b^T\left[\mu-L\right]. \quad (A.4)$$

First I prove that, when $\alpha > 0$, the ratio on the left-hand side (LHS) of equation (A.3) is strictly larger than the ratio on the LHS of equation (A.4).

One can rewrite the two ratios on the LHS of (A.3) and (A.4) as:

$$\frac{1-L+\frac{\alpha}{1-\alpha}(H-L)}{1-L+\delta+\frac{\alpha}{1-\alpha}(H-L+\delta)} = 1-\frac{\frac{\delta}{1-\alpha}}{1-L+\frac{\alpha}{1-\alpha}(H-L)+\frac{\delta}{1-\alpha}}, \quad (A.5)$$

$$\frac{1-L}{1-L+\delta} = 1-\frac{\delta}{1-L+\delta}. \quad (A.6)$$

Since $H > 1$ and $\alpha > 0$,

$$\frac{\delta}{1-L+\delta} > \frac{\delta}{1-L+\delta+\alpha(H-1)}. \quad (A.7)$$

Dividing both the numerator and the denominator of the RHS of (A.7) by $(1-\alpha)$, the following inequality holds:

$$\frac{\delta}{1-L+\delta} > \frac{\frac{\delta}{1-\alpha}}{1-L+\frac{\alpha}{1-\alpha}(H-L)+\frac{\delta}{1-\alpha}}.$$

Using (A.5) and (A.6), the following inequality holds:

$$\frac{1 - L + \frac{\alpha}{1-\alpha}(H - L)}{1 - L + \delta + \frac{\alpha}{1-\alpha}(H - L + \delta)} > \frac{1 - L}{1 - L + \delta}.$$

Therefore, the ratio on the left-hand side (LHS) of equation (A.3) is strictly larger than the ratio on the LHS of equation (A.4).

Moreover, since $\alpha > 0$,

$$\mu - L + \frac{\alpha}{1 - \alpha}(H - L) > \mu - L.$$

Therefore, for equations (A.3) and (A.4) to hold, the following inequality must hold:

$$\underline{C}_b^T > \underline{C}_b^W.$$

□

Lemma 5

Proof. From the condition $H - L < \alpha H$, one can get the threshold

$$\alpha_1^{DH} = 1 - \frac{L}{H}.$$

From (3.4) and (3.5), the threshold information intensities in the two cases are respectively:

$$\alpha_1^H = \frac{\beta}{1-\beta}\left[\mathbb{E}(x)-1\right]\frac{1}{H},$$
$$\alpha_1^L = \frac{\beta}{1-\beta}\left[\mathbb{E}(x)-1\right]\frac{1}{L}.$$

Therefore, if $\alpha \in \left((0,\alpha_1^{DH}) \cap (0,\alpha_1^L)\right) \cup (\alpha_1^{DH},1) \cap (0,\alpha_1^H)$, the bank can credibly commit. Since $\alpha_1^L > \alpha_1^H$, this range is equivalent to a region with a unique threshold α_1 given by:

$$\alpha_1 = min\left\{max\{\alpha_1^{DH}, \alpha_1^H\}, \alpha_1^L\right\}.$$

The monotonicity follows from above equations. □

Lemma 6

Proof. From (3.6), it is easy to see that the threshold information intensity is given by

$$\alpha_2 = \frac{\beta}{1-\beta}\left[\mathbb{E}(x)-1\right]\frac{1}{H-L}.$$

The monotonicity follows from above equation. □

Proposition 4

Proof. With implicit guarantees, the ex-post incentive compatibility constraint is given by

$$(H-L)X^{FB} \leq \beta\left(V^{FB} - V_d^B\right),$$

where

$$V_d^B = \frac{1}{1-\beta} \cdot \frac{A}{1-L+\alpha L} \left[\mathbb{E}(x) - 1\right],$$

and

$$V^{FB} = \frac{1}{1-\beta} \cdot \frac{A}{1-L} \left[\mathbb{E}(x) - 1\right].$$

This condition can be written as

$$(H-L)\frac{A}{1-L} \leq \frac{\beta}{1-\beta} \left[\mathbb{E}(x) - 1\right] \cdot \left[\frac{A}{1-L} - \frac{A}{1-L+\alpha L}\right],$$

which is equivalent to

$$\frac{\beta}{1-\beta} \left[\mathbb{E}(x) - 1\right] \cdot \frac{A}{1-L} - (H-L)\frac{A}{1-L} \geq \frac{\beta}{1-\beta} \left[\mathbb{E}(x) - 1\right] \cdot \frac{A}{1-L+\alpha L}.$$

The LHS can be written as

$$\frac{\beta}{1-\beta} \left[\mathbb{E}(x) - 1\right] \cdot \frac{A}{1-L+\phi_S},$$

where

$$\varphi_S \quad = \quad \frac{H-L}{\frac{\beta}{1-\beta} \cdot \frac{\mathbb{E}(x)-1}{1-L} - \frac{H-L}{1-L}} = \frac{R(1-L)}{\beta V^{FB} - R}.$$

If $\alpha L \geq \varphi_S$, the ex-post incentive compatibility constraint holds and the BHC can commit. Therefore, the threshold α_{IM} is given by $\alpha_{IM} = \varphi_S / L$.

The monotonicity, $\frac{\partial \alpha_{IM}}{\partial H} \geq 0$ and $\frac{\partial \alpha_{IM}}{\partial L} \leq 0$, follow from the above equations.

□

Lemma 7

Proof. ICCH can be written as

$$\alpha H \frac{A}{1-L} \leq \frac{\beta}{1-\beta}\left[\mathbb{E}(x)-1\right] \cdot \left[\frac{A}{1-L} - \phi \frac{A}{1-L+\alpha L}\right],$$

from which one can get the maximum α as

$$\alpha_1^H = \phi\left[\frac{\beta}{1-\beta}\left[\mathbb{E}(x)-1\right]\frac{L}{H} - 1 + L\right]\frac{1}{L} + (1-\phi)\frac{\beta}{1-\beta}\left[\mathbb{E}(x)-1\right]\frac{1}{H}.$$

Similarly, ICCL can be written as

$$\alpha L \frac{A}{1-L} \leq \frac{\beta}{1-\beta}\left[\mathbb{E}(x)-1\right] \cdot \left[\frac{A}{1-L} - \phi \frac{A}{1-L+\alpha L}\right],$$

from which one can get the maximum α as

$$\alpha_1^L = \phi\left[\frac{\beta}{1-\beta}\left[\mathbb{E}(x)-1\right] - 1 + L\right]\frac{1}{L} + (1-\phi)\frac{\beta}{1-\beta}\left[\mathbb{E}(x)-1\right]\frac{1}{L}.$$

If $\alpha \in \big((0,\alpha_1^{DH}) \cap (0,\alpha_1^L)\big) \cup (\alpha_1^{DH},1) \cap (0,\alpha_1^H)$, the bank entity can commit. Since $\alpha_1^L > \alpha_1^H$, the threshold information intensity is given by

$$\alpha_1^B = min\left\{max\{\alpha_1^{DH},\alpha_1^H\},\alpha_1^L\right\}.$$

$\square$

Lemma 8

Proof. ICCS can be written as

$$\alpha(H-L)X^{FB} \leq \phi\beta\left(V^{FB} - max\{V_d^S, V_d^B\}\right) + (1-\phi)\beta V^{FB}$$

Hence, the threshold α_2^B is a linear combination of the thresholds from the following two conditions:

$$\begin{aligned} \alpha(H-L)X^{FB} &\leq \beta V^{FB}, \\ \alpha(H-L)X^{FB} &\leq \beta\left(V^{FB} - max\{V_d^S, V_d^B\}\right). \end{aligned}$$

The first condition yields

$$\alpha_2^{con1} = \frac{\beta}{1-\beta}\left[\mathbb{E}(x) - 1\right]\frac{1}{H-L}.$$

The second condition yields

$$\alpha_2^{con2} = min\left\{\alpha_2^S, \alpha_2^D\right\},$$

where

$$\alpha_2^S = \frac{\frac{\beta}{1-\beta}\left[\mathbb{E}(x)-1\right]-(1-L)}{H-1},$$
$$\alpha_2^D = \frac{\frac{\beta}{1-\beta}\left[\mathbb{E}(x)-1\right]\frac{L}{H-L}-(1-L)}{L}.$$

The threshold α_2^B is given by

$$\begin{aligned}\alpha_2^B &= \phi\alpha_2^{con2}+(1-\phi)\alpha_2^{con1},\\ &= \phi min\left\{\alpha_2^S,\alpha_2^D\right\}+(1-\phi)\frac{\beta}{1-\beta}\left[\mathbb{E}(x)-1\right]\frac{1}{H-L}.\end{aligned}$$

□

Corollary 3

Proof. $\because \alpha_1^L = \phi\left[\frac{\beta}{1-\beta}\left[\mathbb{E}(x)-1\right]-1+L\right]\frac{1}{L}+(1-\phi)\frac{\beta}{1-\beta}\left[\mathbb{E}(x)-1\right]\frac{1}{L}.$

$$\begin{aligned}\therefore\ \frac{\partial\alpha_1^L}{\partial\sigma} &= \phi\left[\frac{\beta}{1-\beta}\frac{\left[\mu-1\right]\sqrt{\frac{q}{1-q}}}{\left(\mu-\sigma\sqrt{\frac{q}{1-q}}\right)^2}-\frac{\sqrt{\frac{q}{1-q}}}{\left(\mu-\sigma\sqrt{\frac{q}{1-q}}\right)^2}\right]\\ &\quad+(1-\phi)\left[\frac{\beta}{1-\beta}\frac{\left[\mu-1\right]\sqrt{\frac{q}{1-q}}}{\left(\mu-\sigma\sqrt{\frac{q}{1-q}}\right)^2}\right]\\ &= \phi\cdot\frac{-\sqrt{\frac{q}{1-q}}}{\left(\mu-\sigma\sqrt{\frac{q}{1-q}}\right)^2}+\frac{\beta}{1-\beta}\frac{\left[\mu-1\right]\sqrt{\frac{q}{1-q}}}{\left(\mu-\sigma\sqrt{\frac{q}{1-q}}\right)^2}.\end{aligned}$$

□

Lemma 9

Proof. After the asset is originated, the level of investment is fixed from the BHC's perspective. Using the monitoring compensation scheme, the expected return of a bank who chooses the monitoring scheme and indeed monitors is

$$\pi^m_{eq} = \left[q\left(H - \bar{L} + \alpha\bar{L} + \lambda\right) + (1-q)\left(\alpha\bar{L} + \lambda\right) - C\right] X_B - A,$$

By contrast, the expected return of a bank who chooses the monitoring scheme but shirks is

$$\pi^m_{offeq} = \left[q\left(H - \bar{L} + \alpha\bar{L} + \lambda\right) + (1-q)\alpha\underline{L}\right] X_B - A.$$

To induce the bank entity to indeed monitor after choosing the monitoring scheme, the following condition must hold

$$\pi^m_{eq} \geq \pi^m_{offeq}.$$

Therefore, the optimal non-negative incentive payment λ is given by

$$\lambda = max\left\{0, \frac{C}{1-q} - \alpha(\bar{L} - \underline{L})\right\}.$$

$\square$

Lemma 10

Proof. Conditional on investors' belief in a monitoring equilibrium, investors' payoff per unit of investment is $(1-\alpha)\bar{L}-\lambda$. Hence, the level of investment is given by

$$X_B = \frac{A}{1-\bar{L}+\alpha\bar{L}+\lambda}.$$

The expected return of a bank who chooses the monitoring scheme and indeed monitors is given by

$$\pi_{eq}^{m} = \frac{A}{1-\bar{L}+\alpha\underline{L}+\frac{C}{1-q}}\left[\bar{\mu}-1-C\right].$$

The bank compares π_{eq}^{m} with the expected return from the shirking equilibrium given by

$$\pi_{eq}^{s} = \frac{A}{1-\underline{L}+\alpha\underline{L}}\left[\underline{\mu}-1\right].$$

The bank would choose the monitoring scheme, if $\pi_{eq}^{m} \geq \pi_{eq}^{s}$. Therefore, in a monitoring equilibrium, the following must hold

$$\frac{A}{1-\bar{L}+\alpha\underline{L}+\frac{C}{1-q}}\left[\bar{\mu}-1-C\right] \geq \frac{A}{1-\underline{L}+\alpha\underline{L}}\left[\underline{\mu}-1\right],$$

which is equivalent to

$$C \leq \hat{C}_1^D = \frac{(\bar{\mu}-1)(1-\underline{L}+\alpha\underline{L})-(\underline{\mu}-1)(1-\bar{L}+\alpha\underline{L})}{(\underline{\mu}-1)/(1-q)+1-\underline{L}+\alpha\underline{L}} = (1-q)(\bar{L}-\underline{L}).$$

Using the shirking scheme, the expected return of a bank that chooses the shirking scheme and indeed shirks is

$$\pi_{eq}^{s} = \left[q \left(H - \underline{L} + \alpha \underline{L} \right) + (1-q)\alpha \underline{L} \right] X_B - A,$$

whereas that of a bank who chooses the shirking scheme but monitors is

$$\pi_{offeq}^{s} = \left[q \left(H - \underline{L} + \alpha \underline{L} \right) + (1-q) \left(\bar{L} - (1-\alpha)\underline{L} \right) - C \right] X_B - A.$$

To ensure that the bank indeed shirks in the shirking equilibrium, the shirking equilibrium payoff must be no less than the off-equilibrium payoff. Hence, the following condition must hold

$$\pi_{eq}^{s} \geq \pi_{offeq}^{s},$$

which is equivalent to

$$(1-q)\alpha \underline{L} \geq (1-q) \left(\bar{L} - (1-\alpha)\underline{L} \right) - C.$$

As a result, the minimum level of monitoring cost in a shirking equilibrium is

$$\hat{C}_2^D = (1-q)(\bar{L} - \underline{L}) = \hat{C}_1^D$$

Therefore, for any monitoring cost below $\hat{C}^D \equiv \hat{C}_2^D = \hat{C}_1^D$, the economy will arrive at a monitoring equilibrium. $\square$

Lemma 11

Proof. After the asset is originated, the level of investment X_S and the reserves $R = \frac{H-\bar{L}}{1-\alpha}$ are fixed from the BHC's perspective. Using the monitoring compensation scheme, the expected return of an SPV who chooses the monitoring scheme and indeed monitors is

$$\pi_{eq}^{m} = \left[q\left(R+\lambda\right) + \left(1-q\right)\left(\alpha R + \lambda\right) - C\right] X_S - A,$$

whereas that of an SPV who chooses the monitoring scheme but shirks is

$$\pi_{offeq}^{m} = \left[q\left(R+\lambda\right) + (1-q)\alpha R\right] X_S - A.$$

To induce the SPV to indeed monitor after choosing a monitoring scheme, the following condition must hold

$$\pi_{eq}^{m} \geq \pi_{offeq}^{m}.$$

Therefore, the optimal incentive payment λ is given by

$$\lambda = \frac{C}{1-q}.$$

Conditional on investors' belief in a monitoring equilibrium, the BHC sets aside safe reserves in the amount of $R = \frac{H-\bar{L}}{1-\alpha}$ per unit of investment. Hence, the level of investment is then given by

$$X_S = \frac{A}{1 - \bar{L} + \alpha \frac{H - \bar{L}}{1-\alpha} + \lambda}.$$

The expected return of an SPV who chooses the monitoring scheme and indeed monitors is given by:

$$\pi_{eq}^{m} = \frac{A}{1 - \bar{L} + \alpha \frac{H - \bar{L}}{1-\alpha} + \frac{C}{1-q}} \left[\bar{\mu} - 1 - C \right].$$

The bank compares π_{eq}^{m} with the expected return from the shirking equilibrium given by

$$\pi_{eq}^{s} = \frac{A}{1 - \underline{L} + \alpha \frac{H - \underline{L}}{1-\alpha}} \left[\underline{\mu} - 1 \right].$$

The bank would choose the monitoring scheme, if $\pi_{eq}^{m} \geq \pi_{eq}^{s}$. Therefore, in a monitoring equilibrium, the following must hold

$$\frac{A}{1 - \bar{L} + \alpha \frac{H - \bar{L}}{1-\alpha} + \frac{C}{1-q}} \left[\bar{\mu} - 1 - C \right] \geq \frac{A}{1 - \underline{L} + \alpha \frac{H - \underline{L}}{1-\alpha}} \left[\underline{\mu} - 1 \right],$$

which is equivalent to

$$C \leq \hat{C}_1^S = \frac{(\bar{\mu} - 1)(1 - \underline{L} + \alpha \frac{H - \underline{L}}{1-\alpha}) - (\underline{\mu} - 1)(1 - \bar{L} + \alpha \frac{H - \bar{L}}{1-\alpha})}{(\underline{\mu} - 1)/(1-q) + 1 - \underline{L} + \alpha \frac{H - \underline{L}}{1-\alpha}} > (1-q)(\bar{L} - \underline{L}).$$

Using the shirking scheme, the expected return of a bank that chooses the shirking scheme and indeed shirks is

$$\pi^s_{eq} = \left[q\left(\frac{H-\underline{L}}{1-\alpha}\right) + (1-q)\alpha\frac{H-\underline{L}}{1-\alpha}\right] X_S - A,$$

whereas that of a bank who chooses the shirking scheme but monitors is

$$\pi^s_{offeq} = \left[q\left(\frac{H-\underline{L}}{1-\alpha}\right) + (1-q)\left(\frac{H-\underline{L}}{1-\alpha} - (H-\bar{L})\right) - C\right] X_S - A.$$

The bank would indeed shirk in the shirking equilibrium if $\pi^s_{eq} \geq \pi^s_{offeq}$. Hence,

$$(1-q)\alpha\frac{H-\underline{L}}{1-\alpha} \geq (1-q)\left(\frac{H-\underline{L}}{1-\alpha} - (H-\bar{L})\right) - C.$$

Therefore, the minimum level of monitoring cost in a shirking equilibrium is

$$\hat{C}^S_2 = (1-q)(\bar{L}-\underline{L}).$$

Since $\hat{C}^S_1 > \hat{C}^S_2$, for any monitoring cost below $\hat{C}^S \equiv \hat{C}^S_1$, the economy will arrive at a monitoring equilibrium. □

Proposition 6

Proof. Since $\hat{C}^S_2 = (1-q)(\bar{L}-\underline{L})$ and $\hat{C}^S_1 > \hat{C}^S_2$, $\hat{C}^S > \hat{C}^D = (1-q)(\bar{L}-\underline{L})$. □

Appendix B: Proportional Signaling Cost

B.1 Setup

As in the benchmark fixed signaling cost setup, the BHC has access to one asset, and the quality of the asset is revealed only to the BHC before it meets with outside investors. Again, a good asset yields $H > 1$ in the high state and $L < 1$ in the low state, while a "lemon" yields the same in the high state but $L - \delta$ in the low state.

After observing the quality of the asset, the BHC observes the cost to signal. The cost of signaling is observable to both the BHC and outside investors. Per unit of investment, sending a positive signal incurs a cost C_g if the asset is a good one, or C_b if the asset is a lemon. After observing the asset quality and the signaling cost, the BHC decides whether or not to send a positive signal and announces a security structure.

Under the proportional signaling cost assumption, it is tricky in defining the timing of signaling and fund raising. In the benchmark fixed cost setting, it is very clear that the BHC signals first using its own capital and then attracts external funding. When the cost of signaling is proportional to the level of investment, the sequence of the move can be confusing. To clarify the timing, I assume that the

BHC has access to a credit source, similar to working capital financing, so that it can draw credit from it to finance the proportional signaling cost. The BHC signals while attracting funds from outside investors, and pays back the signaling credit using its profits ex-post.

After observing the signal and the security structure, investors form beliefs about the quality of the asset and provide funds to the BHC accordingly.

I assume that it is more costly to signal if the BHC is a bad bank. Formally, this assumption is given by:

$$C_g < C_b,$$

where the subscript "g" stands for good and "b" stands for bad.

As in the benchmark, under each security structure, two types of equilibria may arise in this signaling setting: a pooling equilibrium where both types either always signals or do not signals; and a separating equilibrium where only the good type signals.

The BHC would never signal in a pooling equilibrium, since signaling is costly. Therefore, when a certain security structure is superior in terms of inducing a separating equilibrium, it is equivalent to conclude that the security structure encourages information-equalizing investment.

Following the routine in the benchmark setting, I solve the BHC's optimal choice of security structure backwards. I first characterize the minimum signaling cost for a bad bank and the maximum signaling cost for a good bank that together can induce a separating equilibrium, under each security structure. Since I assume that signaling has become sufficiently costless for everyone, I focus on the comparison between the minimum signaling costs for a bad bank under the two security structures.

Then I show that the same result arises under the proportional signaling cost assumption, i.e. the minimum signaling cost for a bad bank is lower under securitization with guarantees. Again, this suggests that whole-piece securitization increases signaling efficiency and helps overcoming adverse selection.

Once this is proved, the rest of the results in the benchmark model follow.

B.2 Signaling under Securitization with Guarantees

This section characterizes the sufficient set of conditions on the signaling cost under which a separating equilibrium arises under securitization with guarantees.

For a separating equilibrium to exist, two incentive compatibility constraints must be satisfied – one that ensures that a bad bank would not signal, and one that ensures that a good bank would signal. In other words, it must be (i) sufficiently cheap for a good bank to signal and (ii) sufficiently expensive for a bad bank not to signal. I start by characterizing the threshold signaling cost that satisfies incentive compatibility (i).

Conditional on a separating belief, when a good bank signals, investors believe that the low state return of the asset is L, and the agency cost per unit of asset is then $\frac{\alpha}{1-\alpha}(H-L)$. Therefore, a good bank that signals achieves a level of investment given by

$$X^g_{eq} = \frac{A}{1 - L + \frac{\alpha}{1-\alpha}(H - L)},$$

where the superscript "g" stands for a good bank, and the subscript "eq" indicates that the BHC stays on the equilibrium path. It immediately follows that the equilibrium expected profit of a good bank is

$$\pi^g_{eq} = \frac{A}{1 - L + \frac{\alpha}{1-\alpha}(H - L)} (\mu - 1 - C).$$

Now consider the case where a good bank deviates from the equilibrium path and does not signal. In this case, investors do not observe the signal and believe that the low state return of the asset is $L - \delta$, and the agency cost per unit of asset is then $\frac{\alpha}{1-\alpha}(H - L + \delta)$. Conditional on this belief, the level of investment that the BHC can achieve is

$$X^g_{offeq} = \frac{A}{1 - L + \delta + \frac{\alpha}{1-\alpha}(H - L + \delta)}.$$

Following the same logic, the off-equilibrium expected profit of a good bank is then given by:

$$\pi^g_{offeq} = \frac{A}{1 - L + \delta + \frac{\alpha}{1-\alpha}(H - L + \delta)} (\mu - 1).$$

To induce a good bank to stay on the equilibrium path and signal, the equilibrium profit must be not smaller than the off-equilibrium profit, i.e. $\pi^g_{eq} \geq \pi^g_{offeq}$.

This condition gives rise to the maximum signaling cost for a good bank under whole-piece securitization with guarantees:

$$C_g \leq \bar{C}_g^W = [\mu - 1] \frac{\frac{\delta}{1-\alpha}}{1 - L + \frac{\alpha}{1-\alpha}(H - L) + \frac{\delta}{1-\alpha}}. \tag{B.1}$$

Intuitively, for a good bank, the cost of signaling must be smaller than the benefit. In a separating equilibrium, signaling increases the level of investment by

$$\frac{\frac{\delta}{1-\alpha}}{1 - L + \frac{\alpha}{1-\alpha}(H - L) + \frac{\delta}{1-\alpha}},$$

and each unit of investment in the good asset yields a net profit of $(\mu - 1)$.

Now I turn to characterize the threshold signaling cost that satisfies incentive compatibility constraint (ii): it is sufficiently expensive to signal so that a bad bank would not signal.

Conditional on a separating belief, if a bad bank does not signal, investors believe that the low-state return is $L - \delta$, and the agency cost per unit of asset is $\frac{\alpha}{1-\alpha}(H - L + \delta)$. It is easy to see that the expected profit on the equilibrium path under securitization with guarantees is given by:

$$\pi_{eq}^b = \frac{A}{1 - L + \delta + \frac{\alpha}{1-\alpha}(H - L + \delta)} \left[\mu - 1 - (1 - q)\delta\right].$$

As in the benchmark model, the off-equilibrium level of investment for bad bank is

$$X^b_{offeq} = \frac{A}{1 - L + \frac{\alpha}{1-\alpha}(H-L)}.$$

And following the same logic, the off-equilibrium expected profit is given by:

$$\pi^b_{offeq} = \frac{A}{1 - L + \frac{\alpha}{1-\alpha}(H-L)} \left[q\frac{H-L}{1-\alpha} + (1-q)\alpha\frac{H-L}{1-\alpha} - C \right] - A,$$

which can be easily simplified into:

$$\pi^b_{offeq} = \frac{A}{1 - L + \frac{\alpha}{1-\alpha}(H-L)} \left(\mu - 1 - C\right).$$

The incentive compatibility constraint to ensure that a bad bank does not signal is $\pi^b_{eq} \geq \pi^b_{offeq}$, which yields the minimum signaling cost for a lemon needed to sustain a separating equilibrium as:

$$C_b \geq \underline{C}^W_b = (\mu - 1) - \frac{1 - L + \frac{\alpha}{1-\alpha}(H-L)}{1 - L + \frac{\alpha}{1-\alpha}(H-L) + \frac{\delta}{1-\alpha}} \left[\mu - 1 - (1-q)\delta\right], \tag{B.2}$$

Intuitively, the cost of signaling must be high enough to outweigh the benefit of signaling for a bad bank not to signal. In a separating equilibrium, signaling increases not only the level of investment, but also the unit profit. This is because the BHC can always default in the low state and seize a fraction of the reserves. Therefore, the BHC's payoff in the low state from the investment is always equal to that of a good bank.

This lower bound, $\underline{C}^W_b$, is of particular interest, and it is easy to check that

$\underline{C}_b^W > \bar{C}_g^W$.

Collecting Condition (B.1) and (B.2), I summarize the above results in the following lemma:

Lemma 12. *Under securitization with guarantees (whole-piece securitization), the necessary and sufficient condition for a separating equilibrium to exist is:*

$$C_g \leq \bar{C}_g^W \text{ and } C_b \geq \underline{C}_b^W,$$

where $\bar{C}_g^W$ and $\underline{C}_b^W$ are given by (B.1) and (B.2) respectively.

B.3 Signaling under Tranching

It is easy to see that the equilibrium payoff of a good bank that signals is given by:

$$\pi_{eq}^g = \frac{A}{1-L}\left(\mu - 1 - C\right).$$

In the case where a good bank deviates from the equilibrium path and does not signal, its expected profit is:

$$\pi_{offeq}^g = \frac{A}{1-L+\delta}\left[q(H-L+\delta) + (1-q)\delta\right] - A,$$

which can be simplified to:

$$\pi_{offeq}^g = \frac{A}{1-L+\delta}\left(\mu - 1\right).$$

In a separating equilibrium, the incentive constraint $\pi^g_{eq} \geq \pi^g_{offeq}$ must hold, from which the maximum signaling cost for a good bank to sustain a separating equilibrium is:

$$C_g \leq \bar{C}^T_g = (\mu - 1)\frac{\delta}{1 - L + \delta}. \tag{B.3}$$

Similarly, the equilibrium expected profit of a bad bank is given by:

$$\pi^b_{eq} = \frac{A}{1 - L + \delta}\left[\mu - 1 - (1 - q)\delta\right].$$

Following the same logic in the benchmark, the off-equilibrium expected profit of a bad bank is given by:

$$\pi^b_{offeq} = \frac{A}{1 - L}\left[q(H - L) + (1 - q)0 - C\right] - A,$$

which is equivalent to

$$\pi^b_{offeq} = \frac{A}{1 - L}\left(\mu - 1 - C\right).$$

In a separating equilibrium, the incentive constraint $\pi^b_{eq} \geq \pi^b_{offeq}$ must hold, from which the minimum signaling cost for a bad bank to sustain a separating equilibrium is:

$$C_b \geq \underline{C}^T_b = (\mu - 1) - \frac{1 - L}{1 - L + \delta}\left[\mu - 1 - (1 - q)\delta\right]. \tag{B.4}$$

The two thresholds for the cost of signaling under tranching are summarized in the following lemma:

Lemma 13. *Under tranching, the necessary and sufficient condition for a separating equilibrium to exist is:*

$$C_g \leq \bar{C}_g^T \text{ and } C_b \geq \underline{C}_b^T,$$

where $\bar{C}_g^T$ and $\underline{C}_b^T$ are the solutions to equation (B.3) and (B.4) respectively.

Again, it is easy to check that $\underline{C}_b^T > \bar{C}_g^T$. The minimum signaling cost for a bad bank must be higher than that for a good bank to support a separating equilibrium.

B.4 Threshold Signaling Cost

After having characterize the range of signaling costs that can sustain a separating equilibrium under each security structure, I now compare the minimum signaling cost for a bad bank to sustain a separating equilibrium.

Using Lemma 12 and Lemma 13, we have the following lemma. See Appendix A for the proof.

Lemma 14. *When there is moral hazard, i.e. $\alpha \in (0, 1)$, the minimum signaling cost for a bad bank to sustain a separating equilibrium is higher under tranching:*

$$\underline{C}_b^T > \underline{C}_b^W.$$

Proof. From (B.2) and (B.4), the only difference between $\underline{C}_b^W$ and $\underline{C}_b^T$ is the giant term multiplying the square bracket. Since $H > 1$ and $\alpha > 0$,

$$\frac{\delta}{1 - L + \delta} > \frac{\delta}{1 - L + \delta + \alpha(H - 1)}. \tag{B.5}$$

Dividing both the numerator and the denominator of the RHS of (B.5) by $(1 - \alpha)$, the following inequality holds:

$$\frac{\delta}{1 - L + \delta} > \frac{\frac{\delta}{1-\alpha}}{1 - L + \frac{\alpha}{1-\alpha}(H - L) + \frac{\delta}{1-\alpha}}.$$

Therefore,

$$\frac{1 - L + \frac{\alpha}{1-\alpha}(H - L)}{1 - L + \delta + \frac{\alpha}{1-\alpha}(H - L + \delta)} > \frac{1 - L}{1 - L + \delta}.$$

The result that

$$\underline{C}_b^T > \underline{C}_b^W.$$

follows immediately. $\square$

Bibliography

Acharya, Viral, 2003, Is the International Convergence of capital adequacy regulation desirable?, *The Journal of Finance* 58, 2745-2782.

Acharya, Viral, and Matthew Richardson, eds., 2009, *Restoring Financial Stability: How to Repair a Failed System* (John Wiley & Sons, Inc., Hoboken, NJ).

Acharya, Viral, and Philipp Schnabl, 2010, Do global banks spread global imbalances? Asset-backed commercial paper during the financial crisis of 2007-09, *IMF Economic Review* 58, 37-73.

Acharya, Viral, Philipp Schnabl, and Gustavo Suarez, 2013, Securitization without risk transfer, *Journal of Financial Economics* 107, 515-536.

Adrian, Tobias, and Hyun Song Shin, 2009, The shadow banking system: Implications for financial regulation, Staff report no. 382, Federal Reserve Bank of New York.

Ahna, Jung-Hyun, and Regis Breton, 2014, Securitization, competition and monitoring, *Journal of Banking & Finance* 40, 195-210.

Allan, Franklin, and Elena Carletti, 2006, Credit risk transfer and contagion, *Journal of Monetary Economics* 53(1), 89-111.

Altunbas, Yener, Leonardo Gambacorta, and David Marques-Ibanez, 2009, Securitization and the bank lending channel, *European Economic Review* 53(8), 996-1009.

Ashcraft, Adam, and Til Schuermann, 2008, Understanding the securitization of subprime mortgage credit, Staff report no. 318, Federal Reserve Bank of New York.

Back from the dead, *The Economist*: Jan. 11, 2014, Print.

Bernanke, Ben, Carol Bertaut, Laurie Pounder DeMarco, and Steven Kamin, 2011, International capital flows and the returns to safe assets in the United States: 2003-2007, International Finance Discussion Papers No. 1014, Board of Governors of the

Federal Reserve System

Berndt, Antje, and Anurag Guptab, 2009, Moral hazard and adverse selection in the originate-to-distribute model of bank credit, *Journal of Monetary Economics* 56(5), 725-743.

Biais, Bruno, and Thomas Mariotti, 2005, Strategic liquidity supply and security design, *Review of Economic Studies* 72(3), 615-649.

Calomiris, Charles, and Joseph Mason, 2004, Credit card securitization and regulatory arbitrage, *Journal of Financial Services Research* 26(1), 5-27.

Counterparty Risk Management Policy Group III, 2008, *Containing systemic risk: The road to reform.*

Covitz, Daniel, Nellie Liang, and Gustavo Suarez, 2013, The evolution of a financial crisis: Collapse of the asset-backed commercial paper market, *Journal of Finance* 68(3), 815-848.

Dang, Tri Vi, Gary Gorton, and Bengt Holmstrom, 2009, Opacity and the optimality of debt for liquidity provision, Working paper, Yale University.

Dell'Ariccia, Giovanni, Deniz Igan, and Luc Laeven, 2012, Credit booms and lending standards: Evidence from the subprime mortgage market, *Journal of Money, Credit and Banking* 44(2-3), 367-384.

DeMarzo, Peter, 2005, The pooling and tranching of securities: A model of informed intermediation, *Review of Financial Studies* 18(1), 1-35.

DeMarzo, Peter, and Darrell Duffie, 1999, A liquidity-based model of security design, *Econometrica* 67(1), 65-99.

Deloitte & Touche LLP, 2007, *Consolidation of variable interest entities: A roadmap to applying Interpretation 46 (R)'s consolidation guidance.*

Demyanyk, Yuliya, and Otto Van Hemert, 2011, Understanding the subprime mortgage crisis, *Review of Financial Studies* 24(6), 1848-1880.

Elul, Ronel, 2015, Securitization and mortgage default, *Journal of Financial Services Research*, 1-29.

Farhi, Emmanuel, and Jean Tirole, 2015, Liquid bundles, *Journal of Economic Theory* 158(B), 634-655.

Federal Deposit Insurance Corporation, 2010, *Reporting Guidance for the Optional*

Transition Mechanism for Risk-Based Capital Requirements Associated with the Implementation of FAS 166 and FAS 167.

Fender, Ingo, and Janet Mitchell, 2009, The future of securitisation: How to align incentives?, *BIS Quarterly Review, September 2009*, 27-43.

Friedman, James, 1971, A non-cooperative equilibrium for supergames, *The Review of Economic Studies* 38(1), 1-12.

Gennaioli, Nicola, Andrei Shleifer, and Robert W. Vishny, 2012, Neglected risks, financial innovation, and financial fragility, *Journal of Financial Economics* 104(3), 452-468.

Gennaioli, Nicola, Andrei Shleifer, and Robert W. Vishny, 2013, A model of shadow banking, *Journal of Finance* 68(4), 1331-1363.

Gibbons, Robert, 1992, *Game theory for applied economists*, Princeton, New Jersey: Princeton University Press

Gilliam, Lee, 2005, Accounting consolidation versus capital calculation: The conflict over asset-backed commercial paper programs, *North Carolina Banking Institute* 2005(9), 291-316.

Gornicka, Lucyna, 2015, Big banks, big Shadow Banks? A new model of regulatory arbitrage, Tinbergen Institute Discussion Paper 14-035/VI/DSF74.

Gorton, Gary, and Andrew Metrick, 2010, Regulating the shadow banking system, *Brookings Papers on Economic Activity 2010*, 261-297.

Gorton, Gary, and Andrew Metrick, 2012, Securitization, NBER Working Paper no. 18611.

Gorton, Gary, and George Pennacchi, 1990, Financial intermediaries and liquidity creation, *Journal of Finance* 45, 49-71.

Gorton, Gary, and George Pennacchi, 1995, Banks and loan sales Marketing nonmarketable assets, *Journal of Monetary Economics* 35(3), 389-411.

Gorton, Gary, and Nicholas Souleles, 2007, Special purpose vehicles and securitization, in Rene Stulz and Mark Carey, eds.: *The Risk of Financial Institutions* (University of Chicago Press for NBER).

Hartman-Glaser, Barney, Tomasz Piskorskib, Alexei Tchistyic, 2012, Optimal securitization with moral hazard, *Journal of Financial Economics* 104(1), 186-202.

Hauswald, Robert, and Robert Marquez, 2006, Competition and strategic information acquisition in credit markets, *Review of Financial Studies* 19(3), 967-1000.

Higgins, Eric, and Joseph Mason, 2004, What is the value of recourse to asset-backed securities? A clinical study of credit card banks, *Journal of Banking and Finance* 28(4), 875-899.

Innes, Robert, 1990, Limited liability and incentive contracting with ex-ante action choices, *Journal of Economic Theory* 52(1), 45-67.

Kacperczyk, Marcin, and Philipp Schnabl, 2009, When safe proved risky: Commercial paper during the financial crisis of 2007-2009, NBER Working Paper no. 15538.

Kalemli-Ozcan, Sebnem, Bent Sorensen, Sevcan Yesiltas, 2012, Leverage across firms, banks, and countries, *Journal of International Economics* 88(2), 284-298.

Keys, Benjamin J., Tanmoy Mukherjee, Amit Seru, and Vikrant Vig, 2010, Did securitization lead to lax screening? Evidence from subprime loans, *Quarterly Journal of Economics* 125(1), 307-362.

Kohler, Matthias, 2015, Which banks are more risky? the impact of business models on bank stability, *Journal of Financial Stability* 16, 195-212.

Korinek, Anton, 2012, Financial innovation for rent extraction, Working paper, University of Maryland.

Malherbe, Frederic, 2012, Market discipline and securitization, Working paper, London Business School.

Mian, Atif, and Amir Sufi, 2009, The consequences of mortgage credit expansion: Evidence from the US mortgage default crisis, *Quarterly Journal of Economics* 124(4), 1449-1496.

Myers,Stewart, and Nicholas Majluf, 1984, Corporate financing and investment decisions when firms have information that investors do not have, *Journal of Financial Economics* 13(2), 187-221.

Nachman, David, and Thomas Noe, 1994, Optimal design of securities under asymmetric information, *Review of Financial Studies* 7(1), 1-44.

Ordonez, Guillermo, 2014, Confidence Banking and Strategic Default, Working paper, University of Pennsylvania.

Parlour, Christine, and Guillaume Plantin, 2008, Loan sales and relationship banking, *Journal of Finance* 64(3), 1291-1314.

Plantin, Guillaume, 2009, Learning by holding and liquidity, *Review of Economic Studies* 76(1), 395-412.

Pozsar, Zoltan, Tobias Adrian, Adam Ashcraft, and Hayley Boesky, 2010, Shadow banking, Staff report no. 458, Federal Reserve Bank of New York.

Purnanandam, Amiyatosh, 2011, Originate-to-distribute model and the subprime mortgage crisis, *Review of Financial Studies* 24 (6), 1881-1915.

Rajan, Raghuram, 2006, Has finance made the world riskier? *European Journal of Financial Management* 12, 499-533.

Segoviano, Miguel, Bradley Jones, Peter Lindner, and Johannes Blankenheim, 2013, Securitization: Lessons learned and the road ahead, IMF Working paper no. 13/255, IMF.

Segura, Anatoli, 2013, Why did sponsor banks rescue their SIVs? A reputational model of rescues, Working paper, CEMFI.

Shin, Hyun Song, 2009, Securitisation and financial stability, *The Economic Journal* 119(536), 309-332.

Wagner, Wolf, and Ian Marsh, 2006, Credit risk transfer and financial sector stability, *Journal of Financial Stability* 2(2), 173-193.

Vanasco, Victoria, 2014, Information acquisition vs. liquidity in financial markets, Working paper, Stanford Graduate School of Business.

Yorulmazer, Tanju, 2013, Has Financial Innovation Made the World Riskier? CDS, Regulatory Arbitrage and Systemic Risk, Working paper, Federal Reserve Bank of New York.