What is the Social Trade-off of Securitization? A Tale of Financial Innovation*

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Abstract

This paper conducts a macroeconomic welfare analysis of securitization in a real business cycle (RBC) with a banking sector. I model securitization as an optional interbank funding channel that credibly reduces the diversion ability on borrowed funds and increases operation costs on loan assets. In effect, securitization allows banks to increase the asset size while sacrificing the rate of return per unit of assets. Building on the mechanism of inefficient credit booms followed by a banking sector breakdown suggested by Boissay, Collard and Smets (2016), I demonstrate that the availability of securitization increases the resilience against banking sector breakdowns and increases the size of credit booms associated with a breakdown. As a result, the economy experiences less frequent financial recessions but once a financial recession occurs, it is likely to be more severe. In the presence of the savings glut externality where households do not internalize the effects of their savings behavior on credit booms and banking sector breakdowns, the financial innovation of increasing the profitability of securitization can make the social trade-off from securitization negative. This is because an abuse of securitization provides too much funding to the banking sector, causing an over-investment in production. Therefore, under highly developed securitization technology with minimal extra costs, regulation may be needed to balance the gains from the increased resilience against banking sector breakdowns and the losses from the exacerbated savings glut externality. In a calibrated version of the model, I illustrate that an optimal regulation on the incentives of securitization can make the availability of securitization socially beneficial.

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1 Introduction

This paper seeks to help understand the social trade-offs of securitization. Starting small in the early 1990s, securitization grew to be one of the largest capital market funding sources by the mid-2000s. We also observed that securitization led the credit boom of the early 2000s[1]. Given that securitization has long been considered a financial innovation of liquidity creation in the banking sector, there might be social benefits as to promoting consumption and investment in the real sector. On the other hand, it is widely believed that securitization played a key role in the emergence of the 2007-2008 financial crisis. The associated Great Recession[2] is known to be the worst economic downturn since the Great Depression. During the Great Recession, the economy had to pay enormous social costs, captured by significant reductions in output and consumption and a high unemployment rate.

There might be a link between a highly developed securitization technology and the emergence of an unusually large credit boom followed by a banking sector breakdown. However, as pointed out by Hansen (2014), we may be limited in our ability to provide meaningful quantification in the short run approach. Then, what are the long run horizon macroeconomic welfare implications of the link, if any? To answer this question, I set up a real business cycle model of securitization with the savings glut externality and endogenous banking sector breakdowns.

The financial crisis of 2007-2008 and the following Great Recession led to a large literature studying macroeconomic linkages to financial markets. For example, Gertler and Kiyotaki (2010), Gertler and Karadi (2011), and Meh and Moran (2010) consider the relationship between bank capital and bankers' incentives to moral hazard in macroeconomic models. These papers adopt the same dynamic modeling for bankers' wealth as the entrepreneurial capital dynamics in Kiyotaki and Moore (1997) and Carlstrom and Fuerst (1997), among others. Similar net-worth dynamics also appear in Brunnermeier and Sannikov (2014), and in He and Krishnamurthy (2014). In this strand of literature, it is common to assume that financial crises are triggered by a negative shock on the quality of capital or the value of net worth. More recently, Gertler and Kiyotaki (2016) present a macroeconomic model of banking crises that is representative of this literature and extends to feature a role for wholesale banking, providing some insight into the growth of wholesale banking and how this growth leads to a build-up of the systemic risk of a banking sector breakdown. They perform comparative statics on the fund diversion[3] parameter and show that a continuous decrease in

[1] Gorton (2013).

[2] December 2007 - June 2009. Source: NBER Business Cycles.

[3] In the corporate finance literature (e.g. Tirole, 2006), "fund diversion" refers to a moral hazard of an opportunistic behavior of borrowers where the borrowers transfer a fraction of the borrowed funds to their

the fund diversion parameter explains the expansion of the wholesale banking sector. They act out the thought experiment of gradually decreasing the fund diversion parameter as a series of financial innovations that increases the borrowing capacity of the bank borrowers by relying on securitization to raise funds provided by bank lenders. However, they do not explain why some banks would choose securitization while others would not. More importantly, a series of financial innovations is considered to be a long run event, so it is hard for it to be the sole deriving force for the short run event of the credit boom build up led by the securitization expansion as in early 2000s.

Boissay, Collard and Smets (2016) suggest a real business cycle framework with banking sector frictions featuring the savings glut externality and endogenous banking sector breakdowns. They take a different approach from the canonical model of this literature in that there are no bank net-worth dynamics because the banks live only one period in their model. However, they deliver a clear mechanism of a credit boom followed by a banking sector breakdown, with no need to consider a gradual change of a parameter or assuming a sizable negative shock on the bank net worth. In their model, households do not internalize the effects of their savings on the banking sector, so there might occur inefficiently large credit booms followed by interbank market breakdowns, which provide a source of unusually deep and long recessions. However, their model is silent about the potential role of securitization in the banking sector and how securitization would interact with the savings rate affecting the credit booms and the breakdowns.

I model securitization as an optional interbank market funding instrument that helps credibly reduce the fund diversion ability of the borrowers but increases the operation costs on loan assets, building on the banking sector modeling of Boissay, Collard and Smets (2016). Effectively, securitization enables banks to hold more assets, but the return rate per unit of assets net of the operation costs will be lower, compared to the traditional non-securitization funding option. That is, I model securitization by directly hard-wiring this trade-off to individual banks, rather than modeling the details of securitization and the asset-backed security (ABS) market per se.

I argue that this is a good way to model securitization for the following reasons, especially to explore macroeconomic issues. First, there is a wide variety of securitization in different forms in practice. Accordingly, security markets are often institution specific with large variations. Modeling the details of one form may risk missing out on the details of other forms. Second, even the definitive feature in the legal requirement of securitization—true sale of the underlying assets—is sometimes challenged[4]. The essential features of any secu-

personal funds and then walk away whenever it is profitable.

[4]The key issue is whether there was a "true sale" or not. In case of the true sale, the creditors of the

ritization—higher leverage, but lower return per unit of assets—are what I capture here in a straightforward manner[5].

In particular, the funding option of securitization is capturded by two model parameters: the fund diversion parameter and the parameter that controls the extra operation costs imposed by securitization. I assume that the fund diversion parameter of securitization is smaller than that of the traditional non-securitization funding option. This reflects the notion of the bankruptcy remoteness of securitization which is well explored in the corporate finance literature[6]. Assets sold for securitization cannot be clawed-backed even if the originator of the assets declared bankruptcy. In this sense, securitization is similar to constructing a "firewall" between the loan originator and the securitization vehicle, even if the the originator is a sole owner of the subordinate securitization vehicle. A smaller concern of fund diversion allows a higher borrowing capacity for securitization in the interbank market. On the other hand, the legal requirement of true sales of the assets or legal independence imposes extra operation costs on securitization. For example, special purpose entity (SPE) for securitization often takes the legal form of trust, which generates trustee fees. Also, asset-backed commercial papers (ABCP) are often traded with explicit guarantees provided by the sponsor banks[7], which requires guarantee fees. Moreover, the off-balance sheet operation of the ABCPs mandates extra credit reporting fees paid to the credit rating companies and special auditing fees paid to the accounting firms. Finally, since the originator-servicer of the assets should follow the pre-determined prospectus between the servicer and the SPE, the servicer loses some degree of managerial discretion and flexibility in the operation of loan assets. This can be the source of implicit extra costs.

By embedding the banking sector with a securitization option into an otherwise standard real business cycle (RBC) framework, the model preserves the savings glut externality and the endogenous banking sector breakdown mechanism inherited from Boissay, Collard and Smets (2016). I demonstrate that the availability of securitization increases the resilience against banking sector breakdowns in the sense that in an economy with a securitization option, a larger set of the parameter values supports the interbank market trading compared to a counterfactual economy without a securitization option. In effect, securitization increases the upper bound of aggregate capital stock sustainable with interbank market trading, allowing the economy to accumulate more capital until it hits the upper bound. However,

originator cannot claim to be entitled to the securitized assets. This issue broke out first in the bankruptcy case of LTV Steel Company in 2001. LTV claimed that its own securitization were not true sales.

[5]See Gorton and Souleles (2006) for an alternative securitization modeling with the trade-offs in the corporate finance literature .

[6]See Hunt, Stanton, and Wallace (2011) for a historical survey of bankruptcy remoteness.

[7]Acharya, Schnabl, and Suarez (2013)

on hitting the bound, the size of the corporate loan supply contraction will be larger in an economy with securitization, leading to a deeper recession. Simulating a long run horizon of a calibrated version of the model, I show that securitization indeed decreases the frequency of the recessions triggered by a banking sector breakdown but exacerbates the average severity of those recessions.

In addition, the financial innovation of increasing the profitability of securitization is captured by a parametric change decreasing the extra operation costs for securitization. I show that this type of financial innovation leads to a larger sized economy because a more profitable banking sector motivates more savings in the banking sector, which provides more funding in the production sector. However, since a wedge exists between the interest rate on household savings and the interest rate on the firm's capital rental, decentralized savings decisions are not necessarily efficient, and the overall welfare assessment remains as a quantitative issue. The long run horizon simulation results suggest that the welfare value of securitization increases as securitization technology develops up to a certain level, but it decreases if the securitization technology develops further, making the social trade-off of securitization negative under highly developed securitization technology.

I show that an optimal regulation[8] on securitization can make the availability of securitization socially beneficial. That is, by taxing or subsidizing securitization, the regulator can effectively attain the optimal profitability of securitization, which makes the household better off compared to an economy without a securitization option. Interestingly, the optimal profitability securitization allocation still with the savings glut externality beats the constrained efficient[9] allocation of a economy without a securitization option where the savings glut externality is eliminated. This is possible because, in the the optimal profitability securitization allocation, the decentralized securitization decisions make the benefits from the increased resilience against breakdowns larger than the costs from an exacerbated savings glut externality, compared to the constrained efficient allocation of a economy without a securitization option. I show that in the economies where the banks can decrease the fund diversion parameter to a lower value without extra operation costs, the resilience against breakdowns and the savings glut externality co-move in a way where the benefits from the increased resilience against breakdowns are lower than the costs from an exacerbated savings glut externality. The decentralized securitization generates the social value by tilting

[8]I assume that the optimal regulation on securitization controls only the banks' incentives to securitization, leaving the savings glut externality as uncotrolled.

[9]In Boissay, Collard and Smets (2016), the constrained efficient allocation is defined as an allocation where the benevolent social planner eliminates the savings glut externality to maximize the household's welfare. However, the social planner is constrained in the sense that he is not omnipotent lacking any information advantages over the agents living in the economy. Therefore, the constrained efficient economy still experiences periodic booms followed by a banking sector breakdown.

the way they co-move.

Roadmap of the paper The rest of the paper is as follows. In Section 2, I describe the model: I first characterize the banking sector with securitization and then embed it to an otherwise standard real business cycle framework. Section 3 discusses the modeling of securitization in this paper and the institutional background. In Section 4, I perform quantitative analysis with calibration and simulation of a long run horizon. In Section 5, I conduct a quantitative welfare analysis for the economies with different degrees of securitization efficiency and show that an optimal regulation can make securitization socially beneficial. Section 6 concludes.

2 Model

The model has a real business cycle (RBC) framework embedded by a baking sector. It builds on Boissay, Collard and Smets (2016, BCS henceforth) inheriting the following features. The competitive banking sector intermediates the household's savings and the firm's capital investment. Banks have heterogeneous skills on corporate loan operations. There are two frictions that limit the interbank market functioning, the moral hazard of fund diversion and the private information about corporate loan operation skills. Assuming the presence of private storage technology as an outside option for interbank market trading, these frictions may lead to an interbank market breakdown. However, since the households do not internalize the effects of their savings behavior on credit booms and interbank market breakdowns, savings glut externality arises, which may generate inefficient interbank market breakdowns following a credit boom even without negative aggregate shocks.

As a new feature, the banks have access to an additional interbank market funding option called securitization. I introduce securitization in terms of two model parameters: the reduced fund diversion parameter and the increased operational cost parameter compared to the traditional interbank market funding option of non-securitization. Given the two wholesale funding options, borrowing with securitization and borrowing without securitization, interbank market borrowers decide which option to choose, considering their own corporate loan operation skills. Availability of securitization affects the interbank market equilibrium and it alters the whole dynamic of the economy.

I first describe the one-period lived competitive banking sector and then embed it into the real business cycle (RBC) framework to show how the introduction of securitization generates interesting dynamic macroeconomic trade-offs.

2.1 The Banking Sector

2.1.1 Banks

There is a continuum of one-period lived banks of a unit measure. Each bank is a risk neutral competitive intermediation technology between the household's savings and the firm's capital investment, and it maximizes the intermediation profits over its life. On birth, banks are homogeneous taking the same amount of household savings a as a deposit.

After that, a competitive gross interest rate on household savings, r, and a competitive gross interest rate on corporate loans, R, are realized. However, each bank also draws a corporate loan operation skill $p \in [0, 1]$ from an identical cumulative distribution function $\mu(\cdot)$ independently, which makes the banking sector heterogeneous ex-post. After learning about its own p, each bank makes an investment decision. All banks can issue corporate loans at R but bank p can collect only p fraction of the corporate loan revenue. $1 - p$ fraction of the corporate loan revenue should be paid for the operations of the corporate loans[10]. That is, for bank p, the corporate loan return rate net of operation costs is pR.

Total operation costs from the whole banking sector are paid to the household as a lump sum. Therefore, there is no deadweight loss that comes from corporate loan operations by the banking sector. Moreover, each bank has access to a private storage technology with a constant gross return rate $\gamma > 0$ where we assume that $R > \gamma$. That is, the storage is free of operation costs but is considered as an inefficient investment device. At the end of the period, banks must return ra where r is the competitive gross interest rate on household savings deposit a. I assume that the banking sector is owned by the household, meaning that any intermediation profits should be returned to the household. However, since the banking sector is assumed to be competitive, r is decided such that given R, the total banking sector profit is zero.

2.1.2 Interbank Market Allocation Mechanism

Since the banks have heterogeneous corporate loan operation skills, there might arise interbank fund trading where less skilled banks lend to the more skilled ones so that the market participants split the trading surplus.

Walrasian Market Clearing

As in BCS, I assume that there exists an interbank market with competitive market clearing interest rate ρ. For the existence of a positive amount of interbank trading, it is

[10] The operations include the issuance and the management of the loans.

obvious that the interbank interest return rate to a lender, ρ, must be bigger than the storage technology return rate, γ, and smaller than the corporate loan return rate, R. If ρ was bigger than R, no bank would issue corporate loans, and if ρ was smaller than γ, no bank would lend to other banks. Therefore, it must be that $\gamma \leq \rho \leq R$.

Frictions

The principles of economics suggest that without frictions, the Walrasian market mechanism would lead to an efficient allocation. Without frictions, economic efficiency will require that only the most skilled banks with $p = 1$ can borrow without a borrowing limit. To rule out this scenario with the same frictions as in BCS, I impose that the moral hazard of fund diversion and the private information of operation costs restrict interbank market trading.

Moral Hazard of Fund Diversion The storage technology is a private savings device of a bank, providing limited tracking information to others so that a fraction of lent funds may not be recollected by the wholesale lenders. For example, bank borrowers may be able to transfer a fraction of the borrowed funds to their storage and lie, saying that they lost it. We also assume that borrowers can walk away with the entire amount of personal funds in their storage. In particular, let denote the wholesale borrowing amount of a bank as ϕ per unit of retail fund a. $\theta \in (0, 1]$ denotes the fraction of fund diversion[11]. The bank's total funds will be $(1 + \phi)\, a$ by combining its own retail fund a and the wholesale borrowing amount ϕa. The fund diversion issue on borrowed funds means that the bank can walk away with personal funds $(1 + \theta\phi)\, a$. In this case, a bank can make $\gamma\, (1 + \theta\phi)\, a$ as the fund diversion pay-off, by exploiting the storage technology.

Private Information on Operation Costs Operation skill p is privately known. The fact that p is private information deters discrimination on p in any lending contract. Therefore, even the most skilled banks ($p = 1$) cannot monopolize borrowing funds, facing the same borrowing limits as every other bank, if any. This opens up the possibility of borrowing for less skilled banks.

[11]Following the practice in the literature, e.g. Hart (1995), Burkart and Ellingsen (2004), Gertler and Kiyotaki (2010), and Boissay, Collard and Smets (2016), we call this type of behavior "diversion." Fund diversion is a popular reduced form modeling of a moral hazard behavior to impose a limit on the borrower's leverage.

2.1.3 Securitization

As a departure from BCS, I suppose that there are two wholesale funding options in the interbank market: securitization and non-securitization. The two funding options are distinct in terms of the two model parameters:

1. I assume that borrowers can credibly reduce the fund diversion ability if they securitize. The reasoning is as follows. The legal requirement of securitization is to sell some of the assets to an entity which is independent from the originator. It is pointed out in the literature that this feature concerns "bankruptcy remoteness." Even though this "legally independent" entity or a securitization vehicle is owned by the originator in many cases, such an entity is protected from the managerial discretion of the originator, which is supported by the law and the accounting rules. The issue of legal separation between the securitization vehicle and the originator is critical when the assets sold cannot be clawed back. When there is a concern of fund diversion and the originator can choose to walk away with his private funds, the legal separation of sold assets from the originator can alleviate the problem of fund diversion. By separating the sold assets from the originator's own balance sheet, the originator can credibly reduce the ability of fund diversion. I denote θ^{ι}, $\iota = 0, 1$ as the fraction of fund diversion depending on the securitization decision[12] and impose that $0 < \theta^1 < \theta^0 \leq 1$. Motivated by some of the few lawsuit cases where the concept of bankruptcy is challenged, I assume that θ^1 is strictly positive.[13]

2. I assume that securitization imposes extra operation costs, which are borne by the borrower[14]. Specifically, given the capital rental rate, R, bank p earns $\eta p R$ per unit of corporate loans where $\eta \in (0, 1)$. The operation cost fraction $(1 - \eta p)$ of the corporate loan rate of return R belongs to the lump sum payment amount χ[15]. As a justification, securitization is assumed to be more costly in terms of operations because it is asso-

[12] ι is a securitization decision indicator of a bank: $\iota = 1$ if and only if the bank securitizes.

[13] As discussed in the introduction, the LTV Steel case (In re LTV Steel, Inc., No. 00-43866, 2001 Bankr. LEXIS 131 (Bankr. N.D. Ohio Feb. 5, 2001)) is such an example.

[14] In the real world context of securitization with details, a borrower with securitization would mean an originator-servicer. I assume that the (un-modeled) incentive compatibility condition against the (un-modeled) moral hazard of risk shifting would require implicit or explicit recourse by the originator-servicer so that any extra costs due to implicit or explicit recourse should be paid by the originator-servicer. A model of implicit recourse has been suggested by Gorton and Souleles (2006). A leading example of the explicit recourse is the liquidity guarantee or the credit guarantee for the asset-backed commercial papers (ABCP). ABCP is one of the most popular securitization instruments used by financial intermediaries. Acharya, Schnabl, and Suarez (2013) reported that explicit recourse is very common in ABCP and the sponsor banks (originator-servicers) paid the guarantee fees for the conduit (a special purpose entity for securitization which is a legally independent subordinate of the sponsor).

[15] We define χ in terms of model variables in section 2.2.

ciated with un-modeled extra costs of setting up and managing an additional unit. In practice, the extra operation costs from securitization may include direct costs, such as fees[16], and indirect costs, such as hiring experts in structured finance.

I assume that the funding option decision is observable to others. Therefore, lending contracts may depend on the bank's securitization status. In particular, a wholesale borrowing contract of amount ϕ per unit of retail fund a can be contingent upon a securitization decision. The wholesale borrowing amount per unit of retail fund is denoted as ϕ^{ι} where the securitization decision is captured by the indicator $\iota \in \{0,1\}$. Even though the wholesale financing contracts are contingent upon a securitization decision, I assume that there may exist only one interbank market with market clearing interest rate ρ[17].

2.1.4 The Interbank Market Decision Problem

When interbank market trading exists, bank p with retail funds a chooses a wholesale trading operation out of three options: (i) non-securitization borrowing $\phi^0 a$ at borrowing rate ρ to issue corporate loans $(1+\phi^0)\,a$ at return rate pR, (ii), borrowing with securitization to issue corporate loans $(1+\phi^1)\,a$ at return rate ηpR and (iii) lending to other banks at return rate ρ. Let $r(p) = \max\{r^0(p), r^1(p), \rho\}$ denote the return rate from market participation per unit of a where $r^1(p) = \eta pR(1+\phi^1) - \rho\phi^1$ denotes the return rate to the borrowers with securitization, $r^0(p) = pR(1+\phi^0) - \rho\phi^0$ implies the return rate to the borrowers with non-securitization, and ρ is the return rate to the lenders. Then bank p's rate of return from the interbank market participation is

$$
\begin{aligned}
& r(p) = \max\Bigg\{ \underbrace{r^0(p)}_{\text{non-securitization borrowing}}, \underbrace{r^1(p)}_{\text{securitization borrowing}}, \underbrace{\rho}_{\text{lending}} \Bigg\} \\
s.t. \quad & r^0(p) = pR(1+\phi^0) - \rho\phi^0 \\
& r^1(p) = \eta pR(1+\phi^1) - \rho\phi^1 \\
& r(p) \geq \gamma(1+\theta^{\iota}\phi^{\iota}) \ \ \forall \iota \in \{0,1\}
\end{aligned} \tag{1}
$$

where the inequality constraint is the incentive compatibility condition against fund diversion. Note that when there exists interbank market trading, storage technology is not a relevant choice of investment because $\rho \geq \gamma$ is always satisfied.

[16] In practice, examples of the direct costs may include amortized upfront issuance costs, amortized upfront securitization costs, annual costs of guarantees and credit lines, annual additional costs (systems, reporting, trustee fees, etc), and the effect on sponsor's marginal cost of capita.

[17] Therefore, the rate of return of lending would be the same as ρ, regardless of which type of borrowers the lenders are lending to.

Incentive Compatibility Against Fund Diversion The opportunity cost of fund diversion is the pay-off from participating in the interbank market and then keeping the promise of the contracts. The incentive compatibility constraint against the fund diversion is captured by

$$r(p) \geq \gamma\left(1+\theta^{\iota}\phi^{\iota}\right).$$

This condition should be common for all p because p is unobservable. For banks with p high enough such that $\max\left\{r^{0}(p), r^{1}(p)\right\} > \rho$ this condition never binds as long as $\rho \geq \gamma\left(1+\theta^{\iota}\phi^{\iota}\right)$ is satisfied. That is, the incentive compatibility imposes restriction only on potential lenders with low p. This fact suggests that the incentive of fund diversion also concerns the adverse selection in p. Hence the incentive compatibility condition against diversion can be simplified as

$$\rho \geq \gamma\left(1+\theta^{\iota}\phi^{\iota}\right) \;\; \forall \iota \in \{0,1\} \tag{2}$$

This condition imposes a borrowing limit contingent on the securitization status ι:

$$\phi^{\iota} \leq \frac{1}{\theta^{\iota}}\left(\frac{\rho}{\gamma}-1\right) \;\; \forall \iota \in \{0,1\}$$

From the formula, we can see that the borrowing limit on ϕ^{ι} decreases in θ^{ι}. Since we assume that $\theta^{1} < \theta^{0}$, securitization allows a higher borrowing limit compared to non-securitization. Also, note that the incentive compatibility condition (2) would be relaxed if interbank market interest rate ρ increases. The borrowing limit on ϕ^{ι} increases in ρ, which implies that the borrowers will be better-off as the potential lenders' incentive to diversion decreases.

Solution to Interbank Market Decision Problem First note that the incentive compatibility condition is always binding, because wasting the borrowing capacity is less profitable. So, the incentive compatibility condition pins down the borrowing amount of each bank.

$$\phi^{\iota} = \frac{1}{\theta^{\iota}}\left(\frac{\rho}{\gamma}-1\right) \;\; \forall \iota \in \{0,1\}$$

By plugging the above equality into the problem, one can solve $r(p)$. Since $r(p)$ is piecewise linear in p, the solution is characterized by threshold values on p.

Proposition 1 [Solution to Interbank Market Decision Problem]

1. The solution to the interbank market decision problem is characterized by two thresholds on p:

   - $p = \underline{n}$ is the threshold value of corporate loan operation skill p, above which non-securitization borrowing is more profitable than lending to other banks.

   $$r^0(p) \geq \rho \Longleftrightarrow p \geq \underline{n} \equiv \frac{\rho}{R}$$

   - $p = \underline{s}$ is the threshold value of corporate loan operation skill p, above which borrowing with securitization is more profitable than borrowing with non-securitization .

   $$r^1(p) \geq r^0(p) \Longleftrightarrow p \geq \underline{s} \equiv \frac{\rho}{R} \frac{\frac{1}{\theta^1} - \frac{1}{\theta^0}}{\frac{\eta}{\theta^1} - \frac{1}{\theta^0} - \frac{\gamma(1-\eta)}{\rho-\gamma}}.$$

2. $0 < \underline{n} < \underline{s} < 1$ if and only if there occurs securitization in the economy.

Proof: See Appendix.

Figure 1 shows the threshold solutions of the interbank market decision problem of bank p. Banks with $p \geq \underline{n}$ become borrowers and banks with $p < \underline{n}$ become lenders. Given that securitization occurs in the economy, $\underline{n} < \underline{s}$ implies that among the borrowers, higher skilled borrowers with $p \geq \underline{s}$ securitize, and lower skilled borrowers with $p \in [\underline{n}, \underline{s}]$ do not securitize. If $\underline{s} > 1$, then securitization does not occur in the economy.

A necessary and sufficient condition for securitization to occur in the economy is that $r^1(p) > r^0(p)$ for some positive measure of $p \in [0,1]$ with respect to the c.d.f. $\mu(\cdot)$. Note that as the securitization technology η becomes more efficient, securitization turns out more attractive as a funding channel. Proposition 1.2. imposes restrictions on the parameters so that securitization occurs in the economy. Note that it is satisfied when η converges to 1. In this extreme case, securitization will impose no extra operation costs, while it only relaxes the borrowing limit because $\theta^1 < \theta^0$. Therefore, all borrowers would securitize. However, the effect of $\theta^1 \downarrow 0$ does not guarantee the occurrence of securitization in the economy if η is not high enough, because $\theta^1 \downarrow 0$ increases the slope of $r^1(p)$ to positive infinity but it also decreases the intercept of $r^1(p)$ to negative infinity. Even if securitization is available with an increased borrowing limit, securitization may not indeed arise in the economy if securitization efficiency η is not high enough. For this reason, I interpret η as the efficiency of securitization. Heuristically, in an economy with highly efficient securitization technology such that η is close to 1, high skilled banks can enjoy the benefits from the increased borrowing capacity, compensating the increased operation costs from securitization. In an economy with low η, securitization may not occur if securitization is institutionally prepared to be available.

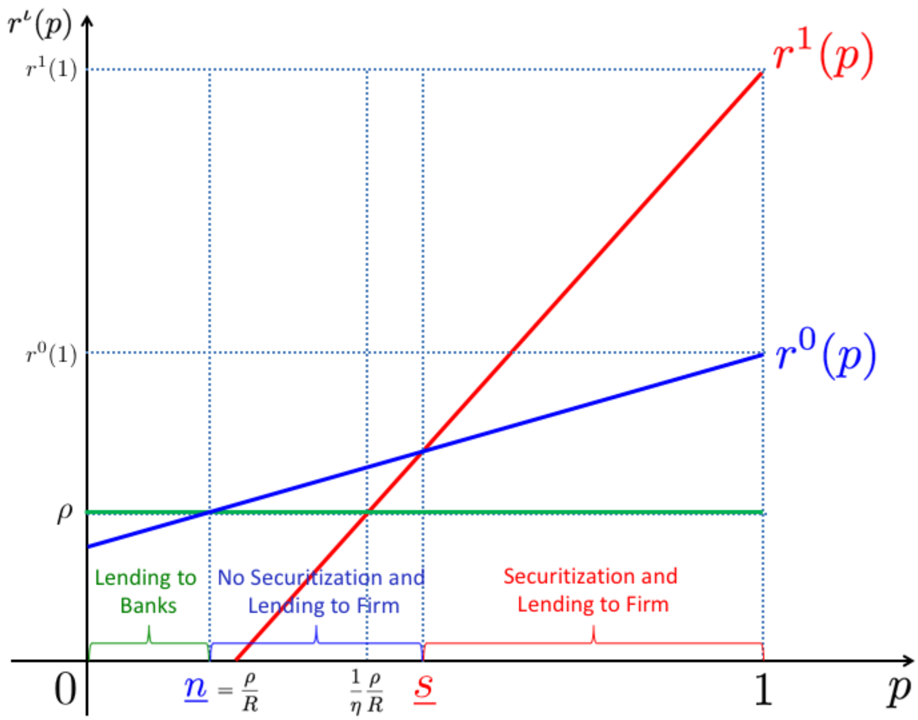

Figure 1: Interbank market decision of bank s

The interbank market solution suggests that whenever securitization occurs, securitization and non-securitization co-exist in the economy because $0 < \underline{n} < \underline{s} < 1$. In this case, the measure of the borrowers with securitization, the borrowers with non-securitization and the lenders is $1 - \mu(\underline{s})$, $\mu(\underline{s}) - \mu(\underline{n})$ and $\mu(\underline{n})$, respectively.

Interbank Market Equilibrium For obvious reasons, we are interested in the parametric conditions such that securitization arises, i.e., $\underline{s} < 1$, under some state of the economy. When there occurs securitization, the Walrasian market clearing interest rate is decided from the equilibrium condition:

$$Supply = Demand$$

where

$$
\begin{aligned}
Supply &= \underbrace{a}_{\text{intensive margin}} \underbrace{\mu\left(\underline{n}\right)}_{\text{extensive margin}} \\
Demand &= \underbrace{\underbrace{\phi^0 a}_{\text{intensive margin}} \underbrace{\left\{\mu\left(\underline{s}\right) - \mu\left(\underline{n}\right)\right\}}_{\text{extensive margin}}}_{\text{non-securitization}} + \underbrace{\underbrace{\phi^1 a}_{\text{intensive margin}} \underbrace{\left\{1 - \mu\left(\underline{s}\right)\right\}}_{\text{extensive margin}}}_{\text{securitization}} .
\end{aligned}
\tag{3}
$$

Note that $\phi^1 a$ and $\phi^0 a$ are the intensive margins of the credit demand, while $1 - \mu\left(\underline{s}\right)$ and $\mu\left(\underline{s}\right) - \mu\left(\underline{n}\right)$ capture the extensive margins. By cancelling a from both sides of (3) and plugging the expressions for $\underline{n}$ and $\underline{s}$ in the equilibrium condition, we obtain an equation for the interbank market interest rate ρ given a corporate loan interest rate R:

$$
\begin{aligned}
\mu\left(\underbrace{\frac{\rho}{R}}_{\underline{n}}\right) &= \underbrace{\frac{1}{\theta^0}\left(\frac{\rho}{\gamma} - 1\right)}_{\phi^0} \left\{ \mu\left(\underbrace{\frac{\rho}{R} \frac{\frac{1}{\theta^1} - \frac{1}{\theta^0}}{\frac{\eta}{\theta^1} - \frac{1}{\theta^0} - \frac{\gamma(1-\eta)}{\rho-\gamma}}}_{\underline{s}} \right) - \mu\left(\underbrace{\frac{\rho}{R}}_{\underline{n}}\right) \right\} \\
&\quad + \underbrace{\frac{1}{\theta^1}\left(\frac{\rho}{\gamma} - 1\right)}_{\phi^1} \left\{ 1 - \mu\left(\underbrace{\frac{\rho}{R} \frac{\frac{1}{\theta^1} - \frac{1}{\theta^0}}{\frac{\eta}{\theta^1} - \frac{1}{\theta^0} - \frac{\gamma(1-\eta)}{\rho-\gamma}}}_{\underline{s}} \right) \right\}
\end{aligned}
\tag{4}
$$

if $\underline{s} < 1$. If the solution ρ for (4) is such that $\underline{s} > 1$ at a given R, securitization does not arise in the economy and the interbank market equilibrium should coincide with the no securitization economy of BCS:

$$
\mu\left(\underbrace{\frac{\rho}{R}}_{\underline{n}}\right) = \underbrace{\frac{1}{\theta^0}\left(\frac{\rho}{\gamma} - 1\right)}_{\phi^0} \left\{ 1 - \mu\left(\underbrace{\frac{\rho}{R}}_{\underline{n}}\right) \right\}. \tag{5}
$$

Lemma 1 shows that there exists an upper bound $R = \bar{R}$ above which securitization does not occur in the economy. That is, if $R \leq \bar{R}$, there will arise securitization in the interbank market, and the equilibrium condition should satisfy equation (4). Otherwise, the interbank market equilibrium satisfies equation (5) without securitization.

Lemma 1 For any given set of parameters $(\theta^0, \theta^1, \gamma, \eta)$,

1. There exists a unique value $R = \bar{R}$ such that given $\bar{R}$, the solution for (4) implies $\underline{s} = 1$.

2. Secularization does not arise in the economy with $R \geq \overline{R}$, violating the condition $\underline{s} < 1$.

3. $\bar{R} \uparrow \infty$ as $\eta \uparrow 1$.

Proof: See Appendix.

Note that (θ^0, θ^1, γ, η) are model parameters, while the interest rate on corporate loans R is an endogenous variable decided in the competitive corporate loans market. However, since the banks participate in the wholesale trading taking R as given, the left hand side of equation (4) can be considered as a normalized[18] interbank market supply curve in ρ given R, and the right hand side of (4) would be a normalized interbank market demand curve in ρ given R. Given R, the normalized supply curve is simply increasing in ρ as $\mu(\cdot)$ is a cumulative distribution function. But there are two potentially competing forces in the demand side in response to changes of ρ. The intensive margins in both terms are increasing in ρ, which is not typical as a demand curve. This is because the intensive margin comes from the incentive compatibility constraints (2), which become tighter when ρ decreases. As ρ decreases and goes closer to γ, the intensive margins converge to zero and so does the market demand, as the extensive margins are finite. Therefore, the backward banding shape presents for low values of ρ. In contrast, as ρ increases and gets closer to R, the intensive margins increase but the extensive margins converge to zero because the borrowing cut off level $\underline{n} = \frac{\rho}{R}$ converges to 1, so does $\underline{s}$, because $\underline{n} < \underline{s} < 1$ as long as securitization occurs. For higher values of ρ, decreasing effects on the extensive margins dominate the increasing effects on the intensive margins. Therefore, there is a certain value of ρ above which the demand curve is downward sloping and below which the demand curve is backward bending.

Figure 2 shows that there are potentially three intersections between the normalized demand and supply curves. As in BCS, I assume that banks always coordinate to select E_1 over E_2 whenever E_1 is available. The other intersection marked with the clear circle can be ruled out because it is not Tâtonnement stable. Therefore, there will be a unique equilibrium E_1 given R. The differences between the baseline economy with a securitization option and the counterfactual economy with no securitization are summarized in Proposition 2. When there occurs securitization at given R, the normalized demand of the economy with a securitization option is bigger for all values of ρ than in the economy without a securitization option, but the normalized supply curves will be the same. Therefore, as shown in Figure

[18] Note that the equation is after cancelling a from both sides.

1, the equilibrium interest rate ρ is higher in the economy with securitization option than the equilibrium interest rate ρ^N of the counterfactual economy, and the intensive margin of equilibrium trading quantity $\mu\left(\frac{\rho}{R}\right)$ is also larger than its counterpart $\mu\left(\frac{\rho^N}{R^N}\right)$.

Proposition 2

1. Given $R < \bar{R}$, the normalized demand of the securitization economy is higher for all values of ρ, compared to the counterfactual economy without a securitization option.

2. The normalized supply curve remains the same regardless of the availability of a securitization option in the economy.

3. Equilibrium interest rate ρ is higher and the intensive margin of the equilibrium trading quantity $\mu\left(\frac{\rho}{R}\right)$ is larger in the economy with a securitization option than in the counterfactual economy without a securitization option.

Proof: See Appendix.

2.1.5 Interbank Market Breakdown

From (4) and (5), it is easy to see that as R decreases, the normalized supply curve would shift to the right, and the normalized demand curve would shift to the left. As in BCS, one can show that there exists a unique value of $R = \underline{R}$ such that the normalized demand curve tangents to the normalized supply curve at equilibrium interest rate $\underline{\rho}$ and normalized equilibrium quantity $\mu\left(\frac{\underline{\rho}}{\underline{R}}\right)$. Below $\underline{R}$, there will be only one intersection of E_2 shown in Figure 2, which implies that the only possible interbank market equilibrium is zero borrowing and lending, i.e, $\phi^0 = \phi^1 = 0$ at $\rho = \gamma$. In this case, we infer that there is an interbank market breakdown. Note that even if R decreases continuously, there will be a sudden jump down in the normalized aggregate trading quantity from $\mu\left(\frac{\underline{\rho}}{\underline{R}}\right)$ to zero. Proposition 3 shows that this threshold value of $\underline{R}$ is lower than the counterpart in the no securitization counterfactual economy, $\underline{R}^N$. Figure 3 graphically presents the idea. Suppose that the economy is currently at $R = \underline{R}^N$. If there was no securitization option in the economy, the normalized demand curve would tangent to the normalized supply curve. However, since the normalized demand is higher with securitization for all values of ρ as in the blue dotted line, the normalized demand curve would not tangent to the normalized supply curve. Since the normalized supply curve shifts to the right and the normalized demand curve shifts to the left as R decreases, the threshold value of $\underline{R}$ in the securitization economy must be lower than the threshold $\underline{R}^N$ of the economy without a securitization option.

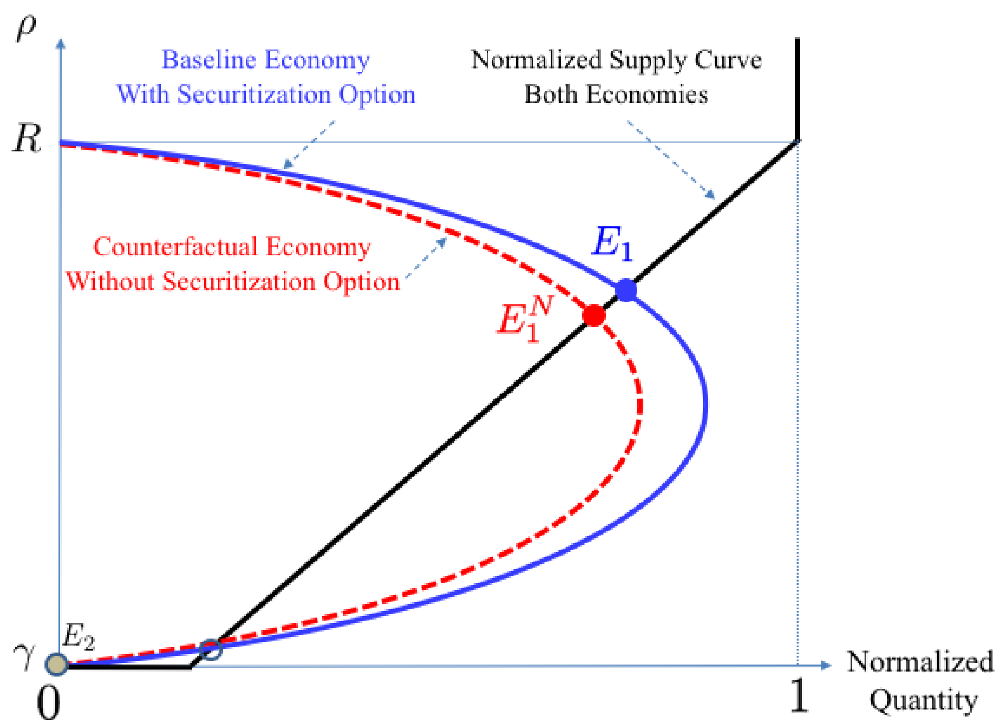

Figure 2: Interbank market equilibrium

Proposition 3

1. As R decreases, the normalized supply curve shifts to the right, and the normalized demand curve shifts to the left.

2. There exists a unique value of corporate loan interest rate $R = \underline{R}$ such that the normalized demand curve tangents to the normalized supply curve at interbank interest rate $\underline{\rho}$ and normalized quantity $\mu\left(\frac{\rho}{\underline{R}}\right)$.

3. For $R < \underline{R}$, the interbank market equilibrium is zero borrowing and lending at $\rho = \gamma$, which we define as the interbank market breakdown.

4. $\underline{R}$ is lower in the baseline economy with securitization option than its counterpart $\underline{R}^N$ for the counterfactual economy with no securitization option.

Proof: See Appendix.

The Bank's Problem When the Interbank Market Breaks Down

When the interbank market breaks down at given R, bank p would decide whether to use the whole amount of its own retail funds a to issue corporate loans or put into storage. In this case, the return rate of the investment net of operation costs is

$$r(p) = \max\{pR, \gamma\}. \tag{6}$$

The solution to this problem is simply captured by a threshold value $p = \frac{\gamma}{R}$, above which bank p issues corporate loans and uses the storage otherwise. Since securitization is a wholesale funding option, it is not a relevant choice when there is no interbank market trading.

2.1.6 Availability of Securitization and the Interbank Market Equilibrium

We can summarize the securitization effects on the interbank market equilibrium given the interest rate on corporate loans R and savings a. In particular, we compare two different economies for any given the same R and a: the baseline economy with a securitization option and the counterfactual economy where the securitization option is eliminated.

Increasing the Size of Interbank Market From proposition 2, recall that the baseline economy has a higher normalized trading quantity $a\mu\left(\frac{\rho}{R}\right)$ is bigger in the baseline economy with securitization than in the counterfactual economy with no securitization option. This is

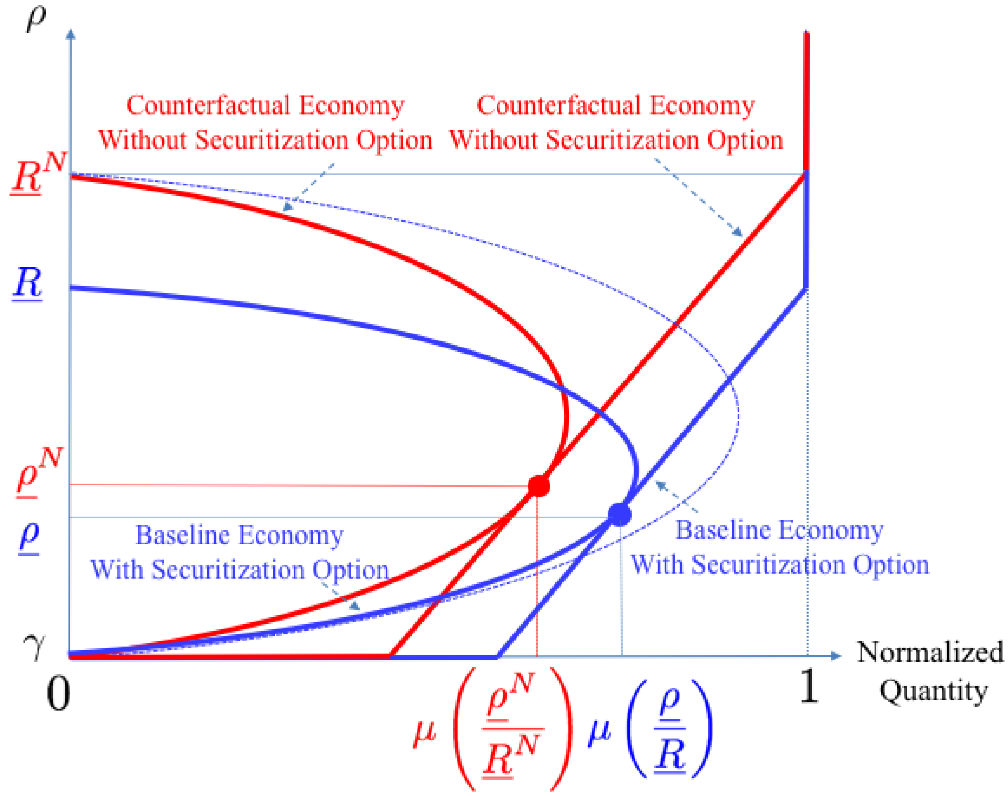

Figure 3: $\underline{R}$: Minimum R with Interbank Market Trading

because borrowing in the economy with securitization requires a higher standard in terms of corporate loan operation skill, so more banks are providing their retail funds a by becoming lenders. In other words, there will be a higher degree of specialization in corporate loan issuances and each borrower will borrow more.

- Specialization of Corporate Loan Issuances

  Note that the borrowing standard $\underline{n} = \frac{\rho}{R}$ is higher in the baseline economy with securitization. That means, a higher corporate loan operation skill is required to issue corporate loans.

- Higher Borrowing Capacity to Each Borrower

  Retail funds a are provided by more lenders, while there are fewer borrowers due to a higher specialization. Therefore, the equilibrium borrowing amount per borrower is bigger in the baseline economy with securitization.

Increasing the Resilience Against Interbank Market Breakdowns Since the set $\{R : R \geq \underline{R}\}$ includes the set $\left\{R : R \geq \underline{R}^N\right\}$, we infer that securitization increases the resilience against interbank market breakdowns in the space of R. That is, if both economies are given the same R such that $R \geq \underline{R}^N \geq \underline{R}$, the economy with a securitization option is more likely to stay above the threshold keeping against arrivals of a driving forces that push down R.

2.2 A Real Business Cycle (RBC) Model with a Banking Sector

In the previous section, we saw that securitization increases the trading volume of the interbank market and the resilience against interbank market breakdowns. Now I embed an infinite sequence of one-period lived banks into the real business cycle (RBC) framework to see how the availability of securitization affects the welfare through the changes in macroeconomic dynamics.

Household

There exists an infinitely-lived representative household. She owns a representative production technology, called a firm, but she is unable to directly invest in her own firm due to an un-modeled financial friction[19]. Instead, she owns a set of intermediation technologies called a banking sector. A unit measure of non-atomic banks intermediates the household's

[19]This assumption is rather standard in the recent macro-finance literature, e.g. Gertler and Kiyotaki, 2009 and Gertler and Karadi, 2011.

savings and the capital investment into firms. We keep the assumption of one-period lived banks of the previous section: each period, banks are born and banks die, and the new banking sector replaces the previous one. Since the banking sector is owned by the household, any intermediation profits from the banking sector belong to the household. We assume that the banking sector is competitive, meaning that r is decided such that the banking sector as a whole makes zero intermediation profits. That is,

$$r = \begin{cases} \left\{ \left(1+\phi^{0}\right) \int_{\underline{n}}^{1} p d\mu\left(p\right) \right\} R & \text{if } R \geq \bar{R} \\ \left\{ \left(1+\phi^{0}\right) \int_{\underline{n}}^{\underline{s}} p d\mu\left(p\right) + \eta \left(1+\phi^{1}\right) \int_{\underline{s}}^{1} p d\mu\left(p\right) \right\} R & \text{if } R \in \left[\underline{R}, \bar{R}\right) \\ \mu\left(\frac{\gamma}{R}\right) \gamma + \int_{\frac{\gamma}{R}}^{1} p d\mu\left(p\right) R & \text{otherwise} \end{cases} \tag{7}$$

Also, the corporate loan operation costs from the heterogeneous banking sector are transferred back to the household as a lump-sum χ, so there is no dead-weight loss from the loan operations. In particular,

$$\chi = \begin{cases} \left\{ \left(1+\phi^{0}\right) \int_{\underline{n}}^{1} \left(1-p\right) d\mu\left(p\right) \right\} R & \text{if } R \geq \bar{R} \\ \left\{ \left(1+\phi^{0}\right) \int_{\underline{n}}^{\underline{s}} \left(1-p\right) d\mu\left(p\right) + \eta \left(1+\phi^{1}\right) \int_{\underline{s}}^{1} \left(1-p\right) d\mu\left(p\right) \right\} R & \text{if } R \in \left[\underline{R}, \bar{R}\right) \\ \int_{\frac{\gamma}{R}}^{1} \left(1-p\right) d\mu\left(p\right) R & \text{otherwise} \end{cases} \tag{8}$$

We assume that the state of the economy is characterized by (a, z) where a is the amount of household savings transferred from the previous period and z is the current period total factor productivity (TFP) for the production technology. We assume that the logarithm of TFP z_t follows a stationary AR(1) process

$$\log z' = \rho_z \log z + \varepsilon'. \tag{9}$$

where $|\rho_z| < 1$ and the next period innovation ε' is normally distributed with mean zero and standard deviation σ_z.

Given the state of the economy (a, z) of the period, an infinitely-lived representative household makes a recursive decision on consumption, savings and labor supply (c, a', n) in order to maximize her life time utility subject to the budget constraint:

$$\begin{aligned} V\left(a,z\right) &= \max_{(c,a',n)} u\left(c,n\right) + \beta E_{\varepsilon'}\left[V\left(a',z'\right)\right] \\ &s.t. \\ &\quad c + a' = ra + wn + \pi + \chi \end{aligned} \tag{10}$$

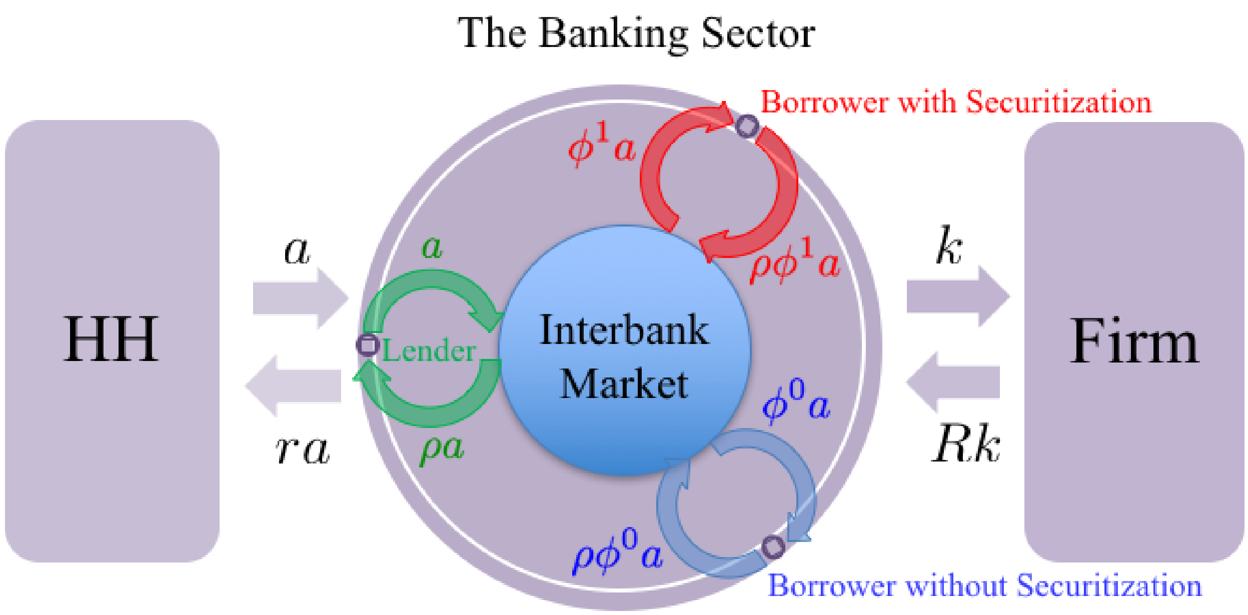

Figure 4: The Economy

where $u(c,n)$ satisfies the standard regularity conditions, i.e., $u_c > 0$, $u_n < 0$, $u_{cc} < 0$, $u_{nn} > 0$, $u_c(0,\cdot) = \infty$, $u_c(\infty,\cdot) = 0$, with $\beta \in (0,1)$. π and χ are lump-sum cash proceeds from the firm and the banking sector, respectively. The household also earns labor income by providing labor to the firm at competitive wage rate w.

Firm

The firm is a one-period lived production technology to produce a homogeneous good, $y = zF(k,l)$, using capital k and labor l as inputs. We assume that $F(\cdot,\cdot)$ is a constant returns to scale (CRS) technology satisfying the standard assumptions on the Neoclassical production function, i.e., $F_k > 0$, $F_l > 0$, $F_{kk} < 0$, $F_{ll} < 0$, $F_{kl} > 0$, $F_k(0,\cdot) = \infty$, $F_k(\infty,\cdot) = 0$, $F(0,\cdot) = F(\cdot,0) = 0$. The good produced by the firm can be either consumed or saved in the banks. Saved funds in the banks in the previous period can be lent to the firm in the form of corporate loans in the current period. The firm is born with no endowment and must acquire capital k by corporate loans at competitive interest rate R and hire labor l at wage rate w. The firm decides the production plan in order to maximize profit net of capital depreciation $\delta \in (0,1)$:

$$\pi = \max_{k,l} zF(k,l) + (1-\delta)k - Rk - wl. \tag{11}$$

Given R and w, the optimality conditions of k and l require

$$R = zF_k(k,l) + (1-\delta) \tag{12}$$

$$w = zF_n(k_t,l). \tag{13}$$

At the end of the period, the firm dies, and at the beginning of the next period, a new firm is born to serve for the next period. The firm's profits π are given to the household when the firm dies.

The Upper Bound of Sustainable Capital Investment In the previous section we characterized the resilience against interbank market breakdowns in terms of the lower bound of corporate loan interest rate $\underline{R}$. Given the TFP z , $\underline{R}$, is isomorphic to the upper bound of sustainable capital stock as the marginal return rate of capital R is decreasing in k. Given z, we denote the upper bound of capital investment against interbank market breakdown as $\bar{k}(z)$, which is implicitly defined using the optimality condition of production, i.e., $\underline{R} = zF_k\left(\bar{k}(z), l(z)\right) + 1 - \delta$. It is easy to see that $\bar{k}(z)$ increases in z. Following a symmetric argument as in Proposition 3, $\bar{k}(z)$ is higher in the economy with a securitization option for any given z. Proposition 4 summarizes the results.

Proposition 4

1. $\bar{k}(z)$ is strictly increasing in z.

2. For any given z, the upper bound of capital investment against interbank market breakdown $\bar{k}(z)$ is larger in the baseline economy with a securitization option compared to its counterpart in the economy with no securitization option.

Proof: See Appendix.

Aggregate Capital Investment in Production When there exists interbank market trading, the aggregate capital investment, k, is the same as the household savings, a. This is because low skilled banks with $p < \frac{\rho}{R}$ lend to high skilled banks with $p \geq \frac{\rho}{R}$, and there is no bank using the storage technology. However, when the interbank market breaks down, the banks with $p < \frac{\gamma}{R}$ cannot but use the inefficient storage technology.

$$k = \begin{cases} a & \text{if } a \leq \bar{k}(z) \\ \left(1 - \mu\left(\frac{\gamma}{R}\right)\right) a & \text{otherwise} \end{cases} \tag{14}$$

Note that aggregate investment loss during the breakdown period is captured by $\mu\left(\frac{\gamma}{R}\right) a$, which is the amount of household savings put in the storage by low skilled banks.

Timing and Breakdown Paths

An interbank market breakdown is unavoidable at the beginning of the current period if the household savings transferred from the previous period a turns out to be bigger than the upper bound of sustainable capital investment without interbank market breakdown $\bar{k}(z)$ which is realized at the beginning of the current period:

$$\begin{aligned} a \leq \bar{k}(z) & \quad \text{Interbank trading will occur} \\ a > \bar{k}(z) & \quad \text{Interbank market will break down} \end{aligned} \tag{15}$$

Therefore, a breakdown may occur if the economy is hit by a low TFP z in the current period, or if the household saved too much amount a in the previous period, or both.

Output Loss in a Breakdown Period

Securitization affects the output losses during the breakdowns by changing the investment losses. Proposition 5 states that given the TFP level z, the lower bounds for the investment losses and of the output losses are both bigger in the economy with a securitization option, compared to the counterfactual economy with no securitization option.

Proposition 5 Suppose that there occurs an interbank market breakdown in a period with (a, z) such that $a \geq \bar{k}(z)$. Then,

1. The period investment loss from the interbank market breakdown is

$$\mu\left(\frac{\gamma}{R}\right) a \geq \mu\left(\frac{\gamma}{\underline{R}}\right) \bar{k}(z)$$

   where $\mu\left(\frac{\gamma}{\underline{R}}\right) \bar{k}(z)$ is the lower bound.

2. The period output loss from the interbank market breakdown is

$$\begin{aligned} & zF(a, l(z)) - zF\left(\left(1 - \mu\left(\frac{\gamma}{R}\right)\right) a, l(z)\right) \\ \geq & zF\left(\bar{k}(z), l(z)\right) - zF\left(\left(1 - \mu\left(\frac{\gamma}{\underline{R}}\right)\right) \bar{k}(z), l(z)\right) \end{aligned}$$

   where the lower bound $zF\left(\bar{k}(z), l(z)\right) - zF\left(\left(1 - \mu\left(\frac{\gamma}{\underline{R}}\right)\right) \bar{k}(z), l(z)\right)$ increases in $\mu\left(\frac{\gamma}{\underline{R}}\right) \bar{k}(z)$.

3. Given z, both of the lower bounds in 1 and 2 are bigger in the baseline economy with a securitization option, compared to the counterfactual economy with no securitization option.

Proof: See Appendix.

Financial Crisis

If the interbank market breaks down in the current period after it worked properly during the previous period, there would occur a sizable decrease in the aggregate capital investment. To see this, let denote ωa with $\omega > 0$ as the aggregate capital investment in the previous period. The size of aggregate capital investment decrease will be captured by $\omega a - \left(1 - \mu\left(\frac{\gamma}{R}\right)\right) a = \left((\omega - 1) + \mu\left(\frac{\gamma}{R}\right)\right) a$ using (14). Since $R < \underline{R}$, we know that this term must be bigger than $\left((\omega-1)+\mu\left(\frac{\gamma}{\underline{R}}\right)\right)a$. Even if a is close to the aggregate capital investment of the previous period, i.e., $\omega \approx 1$, the decrease will be sizable amounting close to the current period's aggregate investment loss $\mu\left(\frac{\gamma}{R}\right)a$. The banking sector suddenly channels funds away from the firm into the storage, which we refer to as a "financial crisis." The financial crisis is defined by the initial period of a break down season. When a financial crisis arises, the economy might experience a recession accompanied by a significant reduction in outputs, and a multiple periods of a breakdown season may follow.

Securitization and the Savings Glut Externality

The household is affected if the interest rate on savings changes, or if the output losses occur due to interbank market breakdowns, both of which are endogenous to her own savings behavior. Note that the household's problem (10) does not internalize the impact of her savings behavior on the banking sector. As in BCS, this is the source of "savings glut" externality, which implies that the decentralized savings decision might negatively affect social welfare. Even if the household can calculate the likelihood of a breakdown in the next period, since she does not internalize the effects of her savings on the occurrence of a breakdown, if a breakdown is highly likely in the next period, she will save more to smooth consumption. This increases the chance of a breakdown even more, which affects her own welfare negatively.

From (7), it is obvious that the availability of securitization affects the interest rate on savings r for any given R. Changes in r affect the welfare via two channels. First, since there exists a wedge between the interest rate on savings r and the interest rate on corporate loan R in this economy, the optimal savings a given r does not simply lead to the optimal capital investment k given R even if a and k are equated when the interbank market trading occurs. Second, changes in savings may accelerate or slow down the occurrence of a breakdown. This is because, if the household saves more today, an interbank market is more likely to break down eventually. That is, if a increases getting closer to $\bar{k}(z)$, the chance of $a > \bar{k}(z)$ becomes higher.

Finally, we define a recursive competitive equilibrium of the system.

Recursive Competitive Equilibrium The recursive competitive equilibrium of the economy is defined by

- The price functions $(R(a,z), \rho(a,z), r(a,z), w(a,z))$,
- The policy functions $(c(a,z), a'(a,z), n(a,z), k(a,z), l(a,z))$,

- The value function $v(a,z)$

such that

1. Given the stochastic process (9) and price functions $(r(a,z), w(a,z))$, value function $v(a,z)$ solves the functional equation (10) with policy functions $(c(a,z), a'(a,z), n(a,z))$.

2. Given price functions $(R(a,z), w(a,z))$, the policy functions $(k(a,z), l(a,z))$ solve the optimality conditions (12) and (13).

3. $R(a,z)$ clears the corporate loan market as in (15).

4. $\rho(a,z)$ satisfies the interbank market equilibrium condition: (5) if $R(a,z) \geq \bar{R}$, (4) if $R(a,z) \in \left[\underline{R}, \bar{R}\right)$ and $\rho \equiv \gamma$ otherwise.

5. $w(a,z)$ clears the labor market such that $n(a,z) = l(a,z)$

6. $r(a,z)$ satisfies the relationship (7) to attain zero profits from the competitive banking sector.

3 The Institutional Background of the Modeling

Legal Separation and Extra Operation Costs Securitization is the process by which loans, otherwise held to maturity on the balance sheets of financial intermediaries, are sold in capital markets. The legal requirement of securitization is to sell the loan assets to an entity which is independent from the originator. The process of legal separation imposes extra operation costs such as amortized upfront securitization costs, annual costs of guarantees and credit lines, and other forms of annual costs such as reporting fees or trustee fees.

Bankruptcy Remoteness and Commitment Device to Reduce Fund Diversion The issue of a separation of the assets sold to the securitization vehicle from the originator is critical because a clawback can be asked otherwise. It is pointed out in the literature that this feature concerns "bankruptcy remoteness[20]." Even though this "legally independent" entity or a securitization vehicle is owned by the originator in many cases[21], such a subordinate entity is protected from the managerial discretion of the originator, which is supported by the law and the accounting rules.

[20] For example, see Gorton, 2013.

[21] For example, consider a conduit which is a special purpose entity (SPE) established to issue asset-backed commercial paper (ABCP) for off-balance sheet financing.

In the literature, "fund diversion" refers to a moral hazard of borrowers where the borrowers transfer a fraction of the borrowed funds to their personal funds and then walk away whenever it is profitable. This transferred fraction of the lent funds may not be recollected by lenders due to imperfect monitoring and enforceability. For example, borrowers may be able to transfer a fraction of the borrowed funds to their personal funds by simply lying and saying that they lost it. Fund diversion has been popular in particular in the recent macro-finance modeling such as Gertler and Kiyotaki (2011), Gertler and Karadi (2010), Gertler and Kiyotaki (2016) or Boissay, Collard and Smets (2016). However, to my best knowledge, there has been no research that directly connects the concept of fund diversion and the legal separation issue of securitization. I argue that when there is a concern of fund diversion and the originator can choose to walk away with his private funds at any time, the legal separation of sold assets from the originator can alleviate the problem of fund diversion. By separating the sold assets from the originator's own balance sheet, the originator can commit to reducing the fraction of fund diversion.

This interpretation of the value of securitization also helps understand some of the puzzles in the securitization literature[22]. For example, the choice of assets to pool and sell to the securitization vehicle remains a puzzle. Existing theories based on diversification as a key feature of securitization cannot address why securitized-loan pools are homogeneous— all credit cards or all prime mortgages, for example. The theory based on diversification suggests that credit card receivables, auto receivables, mortgages, and so on should be in the same pool for diversification, but this never happens. In contrast, securitization is even used to finance a single ship or an aircraft purchase. My focus on the value of securitization – a device to credibly alleviate fund diversion by legal separation - provides a link for solving this puzzle.

4 Quantitative Analysis

In this section, I quantitatively investigate how securitization affects the macroeconomic dynamics by increasing the size of the interbank market and the resilience against banking sector breakdowns. With intention to compare the baseline securitization economy with the economy of BCS as a counterfactual no-securitization economy benchmark, I use the same parametrization and calibration as in BCS whenever possible. The main focus of this section is to capture the macro dynamic effects of the availability of securitization by simulating the two economies for a long run horizon.

[22]For a survey, see Gorton, 2013, for example.

4.1 Parametrization

Distribution of Corporate Loan Operation Skill The cumulative distribution function for the corporate loan operation skill is adopted from BCS, which specifies simply as

$$\mu(p) = p^{\lambda}$$

for tractability.

Given the specification of the distribution function, we can obtain the lower bound and the upper bound values of the corporate loan interest rate that is sustainable with securitization in the interbank market, $\underline{R}$ and $\bar{R}$, as implicit functions of the banking sector parameters $(\gamma, \lambda, \theta^0, \theta^1, \eta)$ appearing in (4).

Utility function The utility function is taken from Greenwood et al. (1988),

$$u(c,n) = \frac{1}{1-\sigma}\left(c - \vartheta\frac{n^{1+\nu}}{1+\nu}\right)^{1-\sigma}$$

where $\frac{1}{\nu} \geq 0$ denotes the Frisch elasticity of labor supply, and ϑ captures disutility from labor. This utility function is particularly useful for tractability of the model because it is compatible with a balanced-growth path. I impose zero growth rate in the model to match to de-trended data[23].

Production function The production function is parametrized by $zF(k,n) = zk^{\alpha}n^{1-\alpha}$ with $\alpha \in (0,1)$. With the specifications of utility function and production function, we obtain a closed form solution for the upper bound of aggregate capital investment that is sustainable with interbank market trading:

$$\bar{k}(z) = \left(\frac{1-\alpha}{\vartheta}\right)^{\frac{1}{\nu}}\left(\frac{\alpha}{\underline{R}+\delta-1}\right)^{\frac{\nu+\alpha}{\nu(1-\alpha)}} \tag{16}$$

4.2 Calibration and Simulation

The model time period is considered as yearly to match to de-trended annual U.S. data. There are three groups of parameters: (R) real sector parameters in line with the standard RBC model, (B) banking sector parameters shared in the baseline securitization economy and in the counterfactual economy with no-securitization, and (S) the parameters that only

[23]One caveat is that, since the utility function is balanced-growth path with zero growth rate, the availability of securitization cannot impact on the growth rate of the economy. In this economy, economic growth can only occur through the innovation in the efficiency of the labor.

parameter values	target or source
$\beta = 1/1.03$	annual discount rate of 3%
$\nu = 0.5$	the labor supply elasticity is equal to 2.
$\vartheta = 1$	the household supplies one unit of labor in a deterministic version of the model.
$\sigma = 4.5$	the risk aversion parameter, lies within the range of estimated values.
$\alpha = 0.3$	capital share in the production function, by convention
$\delta = 0.1$	annual capital depreciation rate, by convention
$\rho_z = 0.89$	Consistent to Boissay, Collard, and Smets (2016)
$\sigma_z = 0.013$	Consistent to Boissay, Collard, and Smets (2016)
	Group (B): counterfactual economy in line with Boissay, Collard, and Smets (2016)
$(\gamma = 0.952, \theta^0 = 0.085, \lambda = 26)$	(i) average spread between the real corporate loan rate and the risk free rate equals 1.7%, (ii) average real corporate loan rate equals 4.4%, and (iii) a financial recession occurs on average every 42 years.
	Group (S): baseline economy with securitization replicates the eve of the Great Recession
$(\theta^1 = 0.034, \eta = 0.992)$	(i) average real corporate loan rate spread at crises equals 1.7% (ii) the ratio of wholesale fund trading to total intermediation volume equals to 40%

Table 1: Calibration of the Parameter Values

appear in the baseline securitization economy. All parameter values except the securitization parameters (θ^1, η) (group (S)) are in line with BCS[24]. The securitization parameters θ^1 and η are selected to mimic the eve of the great recession in terms of (i) the average corporate loan spread of 2006 (0.78%), and (ii) the ratio of asset-backed securities issuances to straight corporate debt issuances in 2006 (64%). Specifically, $\theta^1 = 0.034$ and $\theta^0 = 0.085$ imply that in the securitization economy, the borrowers with securitization borrow 2.5 times more than the borrowers with non-securitization in the same economy. $\eta = 0.992$ means that securitization reduces the corporate loan return rate net of operation costs by 0.8%. Table 1 summarizes the calibrated parameter values and their target or source.

4.3 Numerical Solution for the Interbank Market Equilibrium

Using the parameter values of Table 1 for group (B) and group (S) , we can calculate interbank market equilibrium for any given corporate loan interest rate R. Figure 5 shows

[24] In this version of the manuscript, I do not re-calibrate the group (R) and the group (B) parameters with an intention to directly compare the baseline economy with a securitization option and the BCS economy with no securitization option. Instead, I use the same calibrated parameters as in BCS for these two groups and additionally calibrate only the group (S) parameters. Even if this may not be a sensible calibration exercise, a refined calibration for the securitization parameters is hard to attain because the securitization driven credit boom followed by a banking sector break down was a just one time historic event of 2000s. In the online Appendix, I perform simulations for different combinations of group (S) parameters.

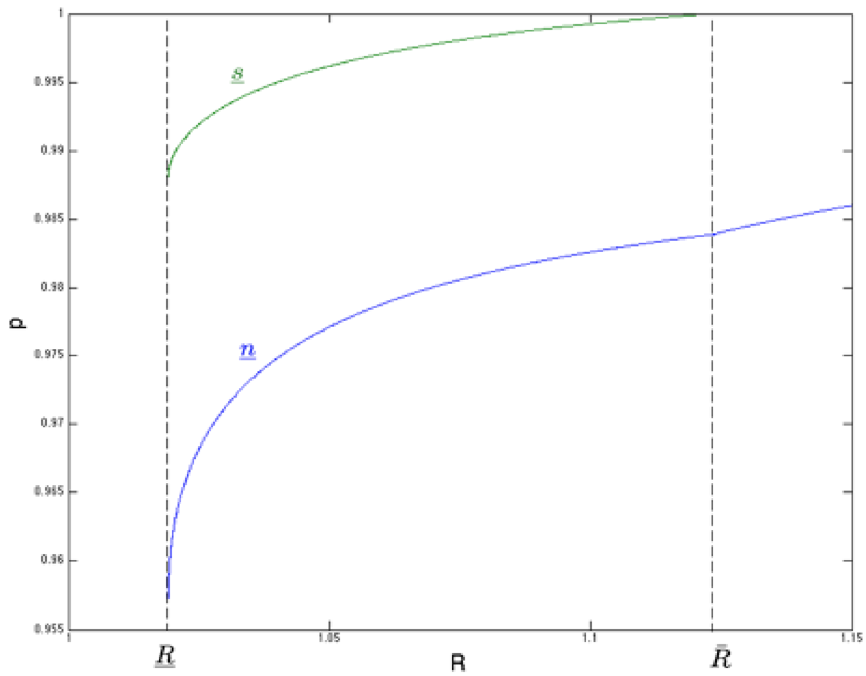

Figure 5: Cutoff Corporate Loan Operation Skills for Borrowing and Securitization

the interbank market solution in terms of the threshold values, $\underline{n}$ and $\underline{s}$ for any given R. It turns out that the steady state corporate loan interest rate of this economy is 1.0430, meaning that securitization occurs in the steady state. The lower bound corporate loan interest rate $\underline{R}$ that supports interbank market trading is 1.0191 and upper bound corporate loan interest rate $\bar{R}$ that supports securitization is 1.1232. Both of the threshold values increase in R. That is, as the economy accumulates capital, R decreases and the cutoff corporate loan operation skill for borrowing $\underline{n}$ and the cutoff corporate loan operation skill for borrowing $\underline{s}$ decrease, which means the specialization in corporate loan issuances becomes weaker. Moreover, more banks borrow to issue corporate loans, and more banks securitize to borrow.

Figure 6 simply shows that the cutoff corporate loan operation skill for borrowing $\underline{s}$ is strictly increasing and strictly convex in the cutoff corporate loan operation skill for borrowing $\underline{n}$ as long as securitization occurs in the economy. When the solution for equation (4) is such that $\underline{s} \geq 1$, the interbank market equilibrium satisfies equation (5) and there will be no securitizing bank in the economy.

Figure 7 shows the relationship among the three interest rates: the interest rate on corporate loans R, the interest rate on household savings r, and the interbank market interest

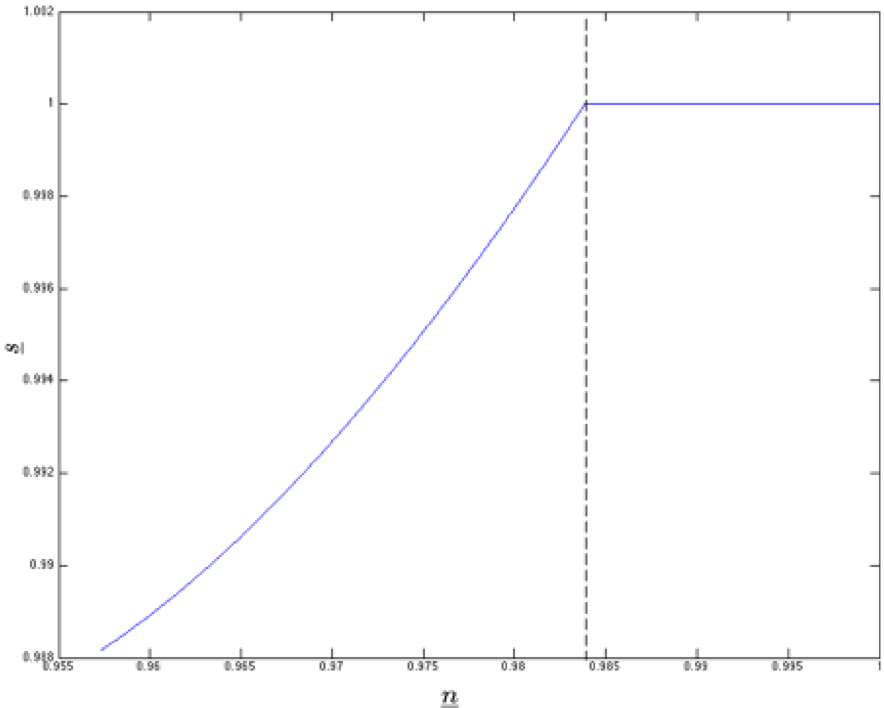

Figure 6: Relationship Between the Cutoff Corporate Loan Operation Skills $\underline{n}$ and $\underline{s}$

rate ρ. As the economy accumulates capital or R decreases, all three interest rates move to the same direction. That is, as the marginal rate of capital decreases, the profitability of interbank market lending and the rate of return for savings in the banking sector decreases. Due to the zero profit condition of the whole banking sector, (7), a lower rate of return for savings in the banking sector also implies a lower intermediation profit rate in the banking sector. Moreover, since r is always higher than ρ, we know that the funding costs of borrowing in the interbank market are cheaper than the funding costs of financing by retail funds a. In this context, we can re-interpret the trade-off of securitization to an individual bank as "cheaper financial costs" vs. "more expensive operation costs."

4.4 Securitization Effects on the Resilience and the Size

Using the calibrated banking sector parameters of groups (B) and (S), we can calculate the resilience measures in the space of corporate loan interest rate R: $\underline{R}$ for the baseline economy with a securitization option and $\underline{R}^N$ for the counterfactual economy without a se-

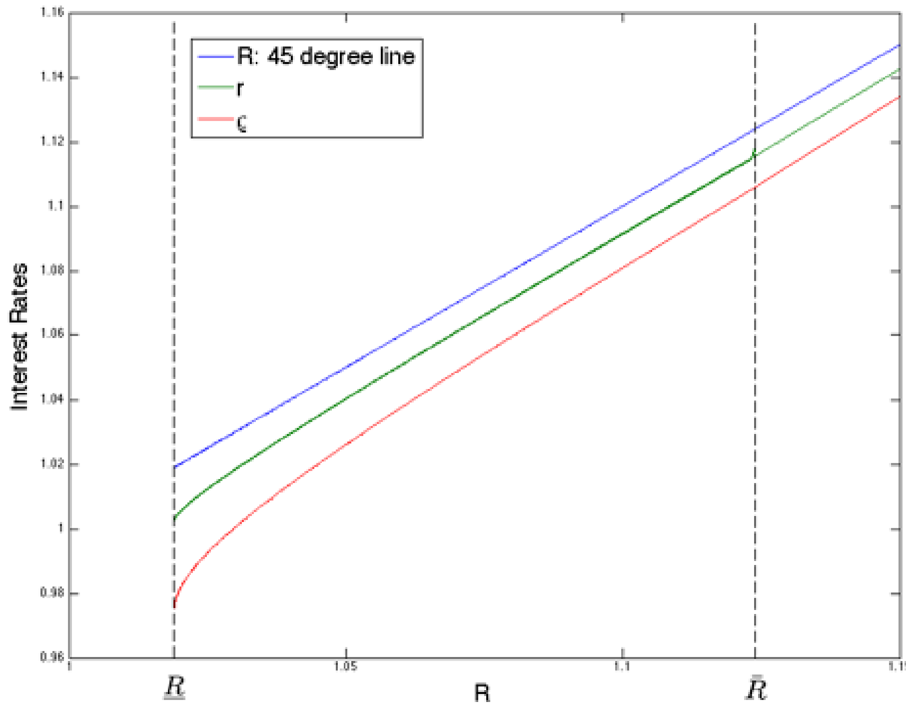

Figure 7: Interest Rate on Household Savings vs. Interest Rate on Corporate Loans

curitization option. Note that R captures the state of the economy (a, z) in one dimension[25], and $\underline{R}$ and $\underline{R}^N$ are decided as constants given the parameter values. The availability of securitization drops $\underline{R}$ from 1.0320 to 1.0142 as shown in Table 2 and Figure 8. This means that securitization increases the resilience against interbank market breakdowns, which is consistent with the prediction suggested in Proposition 3.4.

Table 2 and Figure 8 also show a full securitization economy as a benchmark of the other extreme, i.e., $\eta = 1$. In this economy, securitization does not generate any extra costs but it only increases the borrowing constraints. Since securitization is always beneficial to any borrowers, all borrowing banks securitize. The minimum corporate loan interest rate that supports interbank market trading is 1.0080, which is even lower than 1.191 of the baseline securitization economy with extra operation costs. With full securitization, the economy will be even more resilient against banking sector breakdowns.

However, there is another important dimension we have to consider: the size of the economy which is associated with the savings glut externality. For given values of R, the intermediation earning rate r of the baseline economy is between the two benchmark economies, the economy with no securitization option and the economy with full securitization due to no

[25]Given z, lower R implies higher a, and given a, lower R means lower z.

η	$\underline{R}$	R_{ss}	r_{ss}	k_{ss}
Full securitization ($\eta = 1$)	1.0080	1.0370	1.0300	2.9368
0.992	1.191	1.0420	1.0358	2.7620
No securitization ($\eta = 0$)	1.0320	1.0447	1.0383	2.7164

Table 2: Calibration of the Parameter Values

extra operation costs. However, as the marginal return rate of capital, R, becomes higher, the baseline economy converges to the no securitization benchmark, and when $R \geq \bar{R}$, there will occur no securitization in the baseline economy, and the intermediation earning rate r will be the same as in the no securitization benchmark. Note that an increase in r changes the marginal rate of substitution between the current period consumption and the future consumption (savings), motivating more savings in the banking sector. From (14), we know that more savings lead to more investment in the production sector, increasing the size of the economy. Securitization decreases the steady state interest rate on corporation loans and the steady state. Considering decreasing marginal returns to capital, a lower value of interest rate on capital rental is consistent with the increased capital investment due to securitization. Indeed, the steady state capital stock is 2.7620 in the economy with securitization, which is bigger than the steady state capital stock of the economy without a securitization option, 2.7174.

The reason why the steady state interest rate on corporation loans did not drop as much as the drop in $\underline{R}$ is because the increased interest rate on savings, r, is not large for all values of R limiting the acceleration of a credit boom. Considering that the drop in the lower bound of the sustainable corporate loan interest rate is much larger, the frequency of the financial recessions may decrease. As a hypothetical statement, starting from a steady state, it may take more time for the economy with a securitization option to accumulate capital until it hits the upper bound of the sustainable capital stock. In the next section, we check this prediction with long run horizon simulation results.

4.5 Long Run Simulation

Based on the calibration suggested in Table 1, I simulate three model economies, the baseline economy with a securitization option and extra operation costs, the counterfactual economy without a securitization option, and the counterfactual economy with a securitization option but with no extra operation costs, over a very long run horizon. Specifically, the

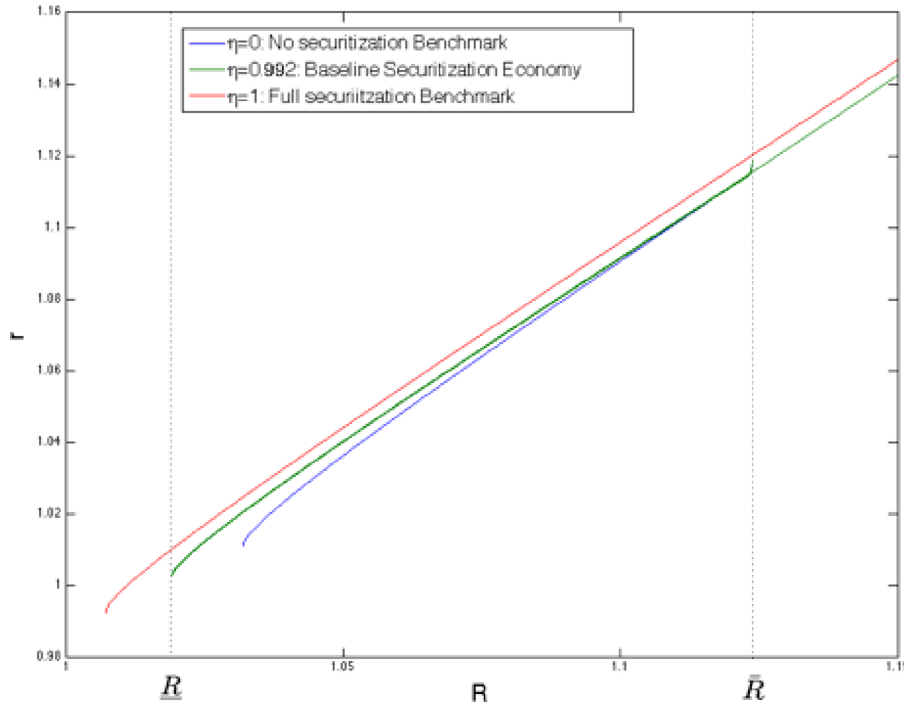

Figure 8: Interest Rate on Household Savings vs. Interest Rate on Corporate Loans

three model economies are simulated for 500,000 years to identify the periods of recessions and financial crises. A recession is defined as the contraction period between the peak and the trough such that the economy with no securitization experiences recessions for 11.29% of the time, which roughly coincides with the results in BCS, as expected. In the simulation results of the three economies, all financial crises lead to recessions, which are often associated with multiple years of interbank market breakdown and a severe recession.

Table 3 summarizes the results. In the baseline economy, the availability of securitization decreases the frequency of financial recessions more than 26 times but exacerbates the average output loss by 1.49 times and the average duration by 1.37 times. These effects are all amplified with full securitization. However, as we predicted in the previous section, the frequency of financial recessions decreases as the lower bound of sustainable corporate loan interest rate $\underline{R}$ decreases much more than the decrease in the state state corporate loan interest rate. Note that the frequency of non-financial recessions is higher in the economy with securitization. It suggests that many of normal recessions triggered by low TFP, z, did not develop as a financial recession, failing to pushing down $R = zF_k(k, l) + (1 - \delta)$ below $\underline{R}$. Proposition 5 provides a reasoning for deeper financial recessions with securitization. By increasing the sustainable capital investment size, the securitization economy with typical

	Baseline Economy ($\eta = 0.992$)	
	Financial Recession	Other Recession
Frequency (%)	0.09	10.85
Duration (year)	2.52	1.40
Output loss (%)	-14.46	-3.49

	No Securitization ($\eta = 0$)		Full Securitization ($\eta = 1$)	
	Financial Recession	Other Recession	Financial Recession	Other Recession
Frequency (%)	2.35	8.94	0.00	10.88
Duration (year)	1.84	1.34	3.40	1.41
Output loss (%)	-9.70	-3.23	-19.76	-3.53

Table 3: Long Run Horizon Simulation Results

	No Securitization	Full Securitization	Securitization
	$\eta = 0$	1	$\eta = 0.992$
Permanent % difference	0	-0.67	0.26

Table 4: Welfare Assessment of Securitization

securitization experiences larger financial recessions than the economy with no securitization option. The lower bound of the output loss is as shown in the distribution of output loss (%) conditional on the occurrence of a breakdown (Figure 6).

5 Welfare Analysis and Policy Implications

5.1 Welfare Assessment

Since the availability of securitization decreases the frequency and increases the severity of financial recessions as well as affects the size of the economy, welfare assessment is not trivial. Following a welfare evaluation method suggested by BCS in the spirit of Lucas (1987), I calculate the the percentage difference in consumption that leaves the household indifferent between the equilibrium allocation of the baseline economy and the benchmark allocation of the no-securitization counterfactual economy. Table 4 summarizes the results: in the baseline economy, the availability of securitization increases the welfare as much as 0.26% of the lifetime consumption in the counterfactual economy with no securitization option.

This is an interesting result, because a full securitization without extra operation costs makes the household worse off than the no securitization economy. As reported by BCS, the no securitization benchmark economy suffers from the savings glut externality: households already save too much without securitization. In this case, increased savings motivated by increased banking sector profits exacerbate the savings glut externality even further. As Figure 9 shows, in full securitization securitization uniformly increases r for all R values. However, in the baseline economy, the effects of increasing banking sector profits are muted for high values of R. If banks can decrease the fund diversion parameter to a lower value without extra operation costs, the resilience against breakdowns and the savings glut externality co-move in a way where the benefits from the increased resilience against breakdowns are lower than the costs from an exacerbated savings glut externality. The decentralized securitization generates the social value by tilting the way they co-move.

Importantly, the optimal profitability securitization allocation still with the savings glut externality beats the constrained efficient allocation of a economy without a securitization option where the savings glut externality is eliminated. In BCS, the constrained efficient allocation is defined as an allocation where the benevolent social planner eliminates the savings glut externality to maximize the household's welfare. However, the social planner is constrained in the sense that he is not omnipotent lacking any information advantages over the agents living in the economy. Therefore, the constrained efficient economy still experiences periodic booms followed by a banking sector breakdown. In BCS, the constrained efficient allocation increases the welfare by the amount equivalent to a 0.15% increase in permanent consumption, which is lower than the welfare gains from securitization in our baseline model. This is possible because, in the the optimal profitability securitization allocation, the decentralized securitization decisions make the benefits from the increased resilience against breakdowns larger than the costs from an exacerbated savings glut externality, compared to the constrained efficient allocation of a economy without a securitization option.

5.2 Financial Innovation and an Optimal Regulation

To explore the the implication of increasing the profitability of securitization, I consider different values of η that support interbank market trading [26]. As we discussed in section 2.1.4., η captures the profitability of securitization. Increasing η can be interpreted as a financial innovation increasing the profitability of securitization. Figure 9 shows the result. Securitization occurred when η is 0.986 or larger. The welfare value of securitization increases as securitization technology develops up to $\eta = 0.990$, but it decreases if the securitization technology develops further, making the social trade-off of securitization negative under highly developed securitization technology.

An optimal regulation[27] would be to tax or subsidize securitization. A regulator can have

[26] Recall that in section 2.1.4., we discussed about implications of the securitization parameters η and θ^1.

[27] I assume that the optimal regulation on securitization controls only the banks' incentives to securitization, leaving the savings glut externality as uncontrolled.

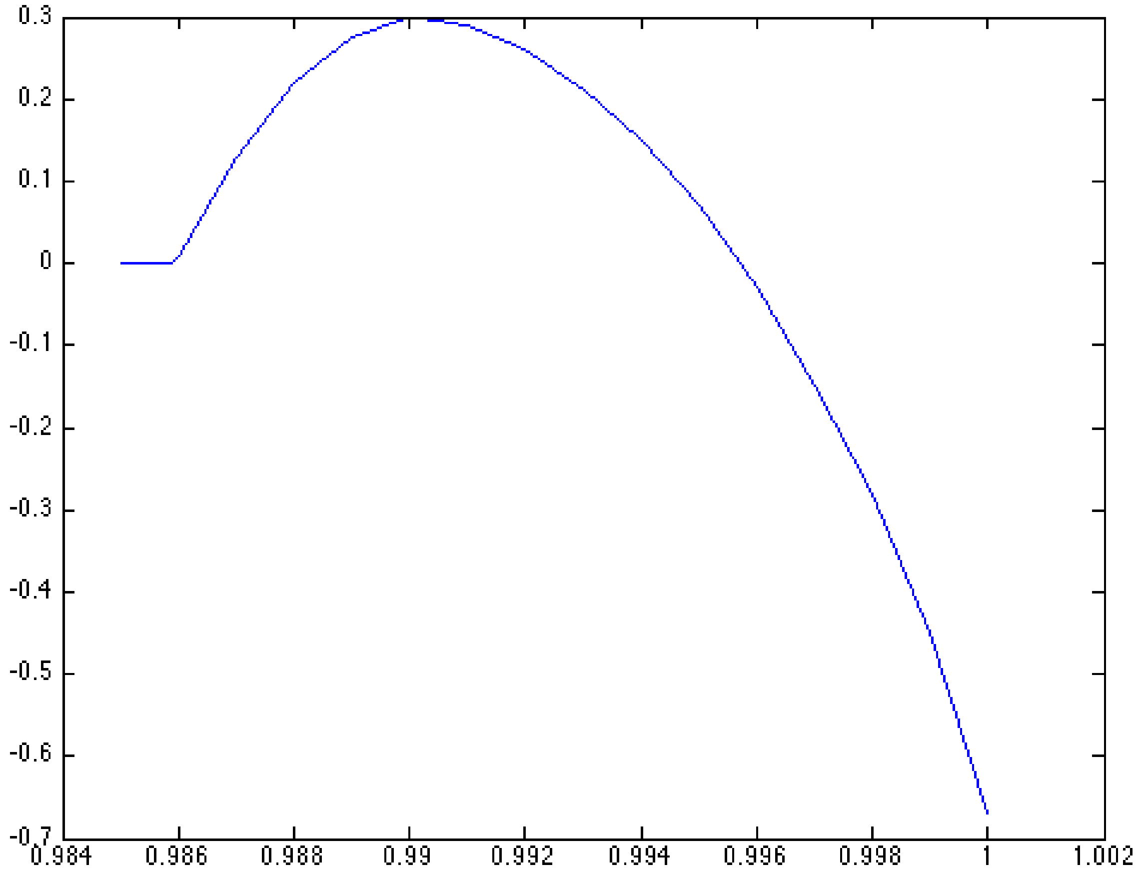

Figure 9: Welfare Gain of Financial Innovation in the Efficiency of Securitization

the economy mimic the optimal profitability of securitization, $\eta^* = 0.990$, by imposing tax or subsidy rate τ on securitization by $\eta^* = (1-\tau)\,\eta$. The tax revenue or the subsidy costs should be transferred to the household as a lump sum, making the equilibrium of the system exactly the same as in the economy with $\eta^* = 0.990$. In this case, the regulator can increase the social welfare 0.04% points more than the baseline economy, fully exploiting the value of securitization which is equivalent to a 0.30% increase in the permanent consumption.

6 Conclusion

There may be social benefits to securitization because the marketability of loan portfolios may lead to an increase in lending, nurturing investment and consumption. On the other hand, the financial crisis has dramatically raised the issue of the social costs of securitization. Does securitization indeed lead to fragility of the banking sector and to real effects such as investment booms and recessions?

There is mounting empirical evidence that the availability of securitization raised the size and the profitability of the whole banking sector. Moreover, Acharya, Schnabl, and Suarez (2013) suggested that the regulatory arbitrage may be an important motivation for securitization. Banks securitize if the gains from the increased asset size are bigger than the extra operation costs due to securitization. In the presence of savings glut externality, decentralized securitization based on an individual margin can have important implications for the social margins such as the amplification of the credit booms and the resilience against banking sector .

While there is a growing literature that studies the effects of securitization in short run environments, the implications for the long run horizon have received less attention. In this paper, I argue that the welfare effects of securitization can be assessed by comparing the long run margins on the resilience against banking sector breakdowns and on the savings glut externality. Furthermore, the financial innovation of increasing the efficiency of securitization may have non-trivial long run welfare effects depending on the stage of securitization technology.

When the profitability of securitization is not high enough, this type of innovation increases the welfare, however, if the securitization technology develops further, the welfare effects of the innovation can be negative. By regulating the incentives to securitization optimally, the economy can enjoy the benefits from the availability of securitization. This is possible because the decentralized securitization with the extra operation costs tilt the co-movement of the resilience against banking sector breakdowns and the savings glut externality so that the gains from an increased resilience against banking sector breakdowns can be bigger than the costs from the exacerbated savings glut externality.

Keywords: securitization, financial innovation, welfare analysis, RBC model.
JEL Classification: E32, E37, E44, G01, G21

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Appendix

1. Proofs

- Proposition 1

  Proof.

  Part 1 is trivial from the definitions of $\underline{n}$ and $\underline{s}$. Note that $0 < \underline{n} < 1$ whenever there occurs interbank trading. For part 2, define $\hat{r}(p) \equiv r^1(p) - r^0(p) = R\left\{\eta\left(1+\frac{1}{\theta^1}\left(\frac{\rho}{\gamma}-1\right)\right)-\left(1+\frac{1}{\theta^0}\left(\frac{\rho}{\gamma}-1\right)\right)\right\}p - \rho\left(\left(\frac{1}{\theta^1}-\frac{1}{\theta^0}\right)\left(\frac{\rho}{\gamma}-1\right)\right)$. If there occurs securitization in the economy, there exists a p' such that $\hat{r}(p') > 0$. Moreover, since $\hat{r}(0) = -\rho\left(\left(\frac{1}{\theta^1}-\frac{1}{\theta^0}\right)\left(\frac{\rho}{\gamma}-1\right)\right) < 0$ and $\hat{r}(p)' = R\left\{\eta\left(1+\frac{1}{\theta^1}\left(\frac{\rho}{\gamma}-1\right)\right)-\left(1+\frac{1}{\theta^0}\left(\frac{\rho}{\gamma}-1\right)\right)\right\}$ for all p, it must that $\hat{r}(p) > 0\ \forall p \geq p'$ and thus $\hat{r}(1) > 0$. Therefore, there exists a unique $\underline{s} \in (0,1)$ such that $\hat{r}(\underline{s}) = 0$. Also, since it must be that $r^1(p) \geq \rho$ whenever p securitizes , there exists some $\bar{p} = \frac{1}{\eta}\frac{\rho}{R} > \underline{n}$ such that $r^1(\bar{p}) = \rho$. Since $r^{1'}(p) > 0$, we know that $r^1(p) \geq \rho$ for all $p \geq \bar{p}$. Therefore, $0 < \underline{n} = \frac{\rho}{R} < \frac{1}{\eta}\frac{\rho}{R} < \underline{s} < 1$ whenever securitization occurs in the economy.

  □

- Proposition 2

  Proof.

  In the economy with securitization, if $R < \bar{R}$,

$$\mu\Bigg(\underbrace{\frac{\rho}{R}}_{\underline{n}}\Bigg) = \underbrace{\frac{1}{\theta^0}\left(\frac{\rho}{\gamma}-1\right)}_{\phi^0}\left\{\mu\Bigg(\underbrace{\frac{\rho}{R}\frac{\frac{1}{\theta^1}-\frac{1}{\theta^0}}{\frac{\eta}{\theta^1}-\frac{1}{\theta^0}-\frac{\gamma(1-\eta)}{\rho-\gamma}}}_{\underline{s}}\Bigg)-\mu\Bigg(\underbrace{\frac{\rho}{R}}_{\underline{n}}\Bigg)\right\} + \underbrace{\frac{1}{\theta^1}\left(\frac{\rho}{\gamma}-1\right)}_{\phi^1}\left\{1-\mu\Bigg(\underbrace{\frac{\rho}{R}\frac{\frac{1}{\theta^1}-\frac{1}{\theta^0}}{\frac{\eta}{\theta^1}-\frac{1}{\theta^0}-\frac{\gamma(1-\eta)}{\rho-\gamma}}}_{\underline{s}}\Bigg)\right\}, \tag{17}$$

  if $R \geq \bar{R}$,

$$\mu\Bigg(\underbrace{\frac{\rho}{R}}_{\underline{n}}\Bigg) = \underbrace{\frac{1}{\theta^0}\left(\frac{\rho}{\gamma}-1\right)}_{\phi^0}\left\{1-\mu\Bigg(\underbrace{\frac{\rho}{R}}_{\underline{n}}\Bigg)\right\}. \tag{18}$$

In the economy without securitization, for all R,

$$\mu\left(\underbrace{\frac{\rho}{R}}_{\underline{n}}\right) = \underbrace{\frac{1}{\theta^0}\left(\frac{\rho}{\gamma}-1\right)}_{\phi^0}\left\{1-\mu\left(\underbrace{\frac{\rho}{R}}_{\underline{n}}\right)\right\}. \tag{19}$$

We are interested in $R < \bar{R}$ for which securitization arises in the economy. By comparing (17) and (19), we obtain parts 1-2. The sketch of proof for part 3 is illustrated in Figure 2.

□

- Proposition 3

  Proof.
  Parts 1-3 are inherited from BCS. The sketch of proof for part 4 is illustrated in Figure 3.

  □

- Proposition 4

  Proof.
  Part 1 is trivial due to the properties of $F(\cdot,\cdot)$. Part 2 is a corollary of Proposition 3.4.

  □

- Proposition 5

  Proof.
  The results are trivial due to the results of Proposition 3 and Proposition 4 and the properties of $F(\cdot,\cdot)$.

  □

2. Online Appendix

In online appendix, I describe the solution methods and provide supplementary results on comparative statics, calculation of the steady states, and robustness check results for different calibration parameter values.