Incentive to Issue Low Quality Securitized Products in the OTD Business Model*

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Abstract

We consider an economy where a lender finances his loans to borrowers by issuing a securitized product to an investor and where the credit quality of the product may depend on whether the lender screens the borrowers. In the presence of asymmetric information between the lender and the investor about the credit quality of potential borrowers, overvaluation of the low quality securitized product may occur, which inefficiently induces the lender not to screen the borrowers and hence to issue the securitized product with low credit quality. This is likely to occur when the investor finds it difficult to distinguish the good state from the bad state, or when the seed of recession creeps toward the booming economy.

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Keywords: originate-to-distribute, securitization, asymmetric information, screening, verification.

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1 Introduction

The originate-to-distribute (OTD) business model in financial industry is said to have the virtue that the process can facilitate the matching between diverse risk preferences of investors and payoff characteristics of securitized products issued in the financial markets. It is expected that the motivation of each specialized player like originators and arrangers in the whole securitization process will be guided by price mechanism to create securitized products best matched with the risk-payoff preferences of the investors in the financial markets and this will yield efficient resource allocation. In other words, pricing of securitized products will provide us with potentially highest economic welfare.

Such belief about the OTD business model has helped the expansion of the market of securitized products in recent years. However, the sub-prime mortgage loan problem has given us a pause to reconsider the provoked efficacy of the business model. With the benefit of hindsight, it does not seem now to be extraordinary to point to incentive problems causing inefficiency in different steps in the whole securitization process. For example, moral hazard problem taking advantage of information superiority in the transactions or elusive evaluation of the value of securitized products has been cited as an underlying cause for the unraveled salient problems accumulated prior to the advent of the crisis.

In this paper, we focus on the effect of pricing of securitized products in the financial market on loan maker's screening incentive by explicitly modeling the link between the market price of securitized products and loan activity in the OTD business. We consider a possible inefficiency in the OTD business model from the view point. The basic setup of the model is as follows. The lender has costly screening and verification technologies,

and decides whether he screens the borrowers' credit quality or not when he makes loans to borrowers. There is asymmetric information between the lender and the securities investors concerning the state of economy determining the distribution of ultimate borrowers' credit quality. In the good state, all potential borrowers are of high credit quality, whereas in the bad state, some borrowers are of low credit quality. The lender observes the true state of the economy, but the investors can not. The investors can not observe the lender's screening activity either, and the lender has to verify his screening activity. The presence or absence of such screening affects the credit quality of the loan pool backing the securitized product, and in conjunction with the verification affects the price of securitized product that the investors are willing to pay. In turn, the price of securitized product affects whether the lender conducts the costly screening and verification or not. Since the screening and the verification are costly, the lender screens the borrowers and issues the securitized product of high credit quality only when the price of securitized product backed by screened loan pool is high enough relative to that of the securitized product backed by unscreened loan pool to cover the screening and verification cost.

In the following, we show that, under certain conditions, there exists an equilibrium in which the securitized product is mis-priced and such mis-pricing may distort the lender's incentive to screen borrowers. Indeed, we show the securitized product of low credit quality is overpriced in the bad state. When the overvaluation of the low quality product is large enough, the lender decides not to screen the borrowers and issues the low quality product, even in the case where he would screen the borrowers and issue the high quality product without the overvaluation. This happens because the gain from issuing the high quality product with the higher price does not

exceed the cost of screening and verification.

To our knowledge, our paper is the first piece that points out the importance of the price mechanism to the issuer's incentive in the OTD business model. We will derive the conditions for the emergence of inefficient equilibrium pricing and discuss the implications for policy measures to enforce the optimal level of screening effort to achieve the efficiency in the OTD business model.

The organization of this paper is as follows. Section 2 discusses related papers. Section 3 formulates the model. Section 4 derives the results of the model analysis and shows comparative statics based on the results. Section 5 delivers some discussions on the obtained results. Section 6 gives concluding remarks.

2 Related Papers

The interest in this paper is closely related with the one in Gorton and Pennacchi (1995) that study incentive compatible loan sales contracts by a bank (a lender). They investigate the situation where a bank originates loans after costly screening of borrowers' credit quality, and sells a potion of the loans to outside investors, and then investigate the optimal levels of screening effort and loan sales by the originator bank.[1] Our model considers a similar (albeit more stylized) situation and analyzes the optimal screening level by the bank.

Our work is also closely related to Holmstrom and Tirole (1997) that analyze the effect of wealth distribution among all risk-neutral and capital constrained firms, intermediaries, and investors to investment, interest

[1]Gorton and Pennacchi (1995) point out that their model can also be interpreted as a costly monitoring model.

rates, and the intensity of monitoring. In their model, monitoring by the intermediaries improves quality of projects that the firms undertake, which increases the return of investment in the firms and hence increases the aggregate amount of capital that the intermediaries and investors are willing to provide. Thus, in equilibrium, the investors' required rate of return should affect the monitoring intensity by the intermediaries and hence the quality of projects. In this paper, also, the price of securitized product that the investor gives affects the lender's incentive to screen the borrowers and the credit quality of the loan pool. However, unlike Holmstrom and Tirole (1997), there is asymmetric information about the true state of the economy between the lender and the investor, and the prices in the pooling and separating equilibria endogenously determine the lender's screening intensity and the credit quality of the loan pools and the corresponding securitized products.

In the literature of security design, Allen and Gale (1988) is closely related with this paper. Allen and Gale (1988) that analyze security innovation by producers who maximize the profits from selling securities backed by their production to consumers. Our model can be regarded as an extension of Allen and Gale (1988) to the specific context of loan screening where the presence of asymmetric information between the lenders and the investors yields complex relationship between state of economy, market price of securitized products and loan screening incentive.

This paper is also closely related with DeMarzo (2005) and DeMarzo and Duffie (1999) that analyze the optimal payoff design of the securitized product in the presence of asymmetric information between the originator and the investor. In these papers, the credit quality of securitized product is determined by tranching the underlying loan pool, or creating the senior

claim. Instead, in this paper, the securitized product is backed by the whole loan pool, and its credit quality is determined by screening the borrowers in the loan pool.

Our paper is also closely related with the strand of empirical studies on the determination of loan standards. Jimenez and Saurina (2006) show from their study of Spanish banks that it is more likely riskier borrowers are granted loans during booms than during leaner times. Dell'Ariccia et al (2008) investigate the determination of lending standards in the US mortgage loan markets and discuss its relationship with the current delinquencies in the subprime mortgage market. They find that a decrease in lending standards associated with an increase in the number of loan applicants, which suggests a credit boom affects lending standards. They also find that an increase in the degree of competition and in securitization transactions decreases lending standards. Such a decrease in lending standards has not been related with economic fundamentals of the loan applicants and, as a result, delinquency rates rose more sharply in areas that experienced larger increases in the number and volume of originated loans, competition, and securitization transactions.

Berger and Udell (2004) have developed the so-called institutional memory hypothesis in order to explain the cyclical profile of loans and nonperforming loan losses. It states that as time passes since the last loan bust, loan officers become less and less skilled to grant loans to high-risk borrowers. Then, it becomes difficult to find skilled loan officers inside a bank and, at the same time, it becomes difficult to hire skilled loan officers in labor markets. During the next boom with an increase in loan applicants, deterioration in loan processing and risk assessment occurs due to the lack of skilled loan officers and this leads to a lower profitability of the bank. Its

empirical analysis on the US banks supports the hypothesis. Focusing on how reward and punishment are implemented in a bank, Rajan (1994) provides a theoretical possibility that incentive mechanisms for bank managers explain fluctuations in loan standards.

These works basically find that in boom, credit quality of loans tends to be low, while in recession, it tends to be high. The result in this paper is consistent with them but it points to a more subtle phenomenon. The lender refrains from screening the borrowers and the low credit quality securitized product is issued, when the bad state where some borrowers are of low quality may occur with relatively low probability against the good state where all borrowers are of high quality in terms of credit quality of borrowers. This result seems to be very realistic. When the state of economy is good and all borrowers are of high quality, no effort for screening is necessary and the equilibrium without screening or verification should emerge. Then, when the state of economy starts deteriorating, or when the bad state may occur with low probability, as long as the investor can not tell the true state, the price that the investor gives to the securitized product is the same for both states and still high because the product is of high credit quality with high probability. However, since the price is the same for both credit quality and high enough, the lender loses incentive to do costly quality verification in the good state, or to do costly screening of the borrowers in the bad state. Consequently, the low quality securitized product may be issued. Finally, when the state of economy is bad with high probability, much effort for screening will be necessary because the loan pool surely includes borrowers of low credit quality and the equilibrium with screening can realize.

Financial system perspective theory developed in Shin (2008) is used to explain a mechanism behind the expansion of the sub-prime mortgage loan

problem in Shin (2009). In the theory, the inflow of funds from outside the leveraged financial institution sector enables the sector to expand its total asset holdings against ultimate borrowers. As the loan capacity of the sector expands, the financial institutions starts filling the capacity by finding borrowers even by descending the ladder of credit quality. In relation with the result in this paper, loan standards may become loose as the financial institutions start trying eagerly to find borrowers and the loan pool will include higher ratio of low credit quality borrowers in such a phase. Although financial system perspective theory is on the loan capacity and this paper focus on the relationship between securities price and loan screening incentive, we think they are complementary.

3 The Model

There are two periods, period 0 and period 1. There are borrowers, a lender, and an investor, all of whom live for two periods. The lender makes loans to the borrowers in period 0 and collects the repayment in period 1. The lender finances the loans by selling a securitized product backed by the loans to the investor in period 0 There are two possible states of the economy, the good state ω_g and the bad state ω_b. In the good state, all borrowers are of high credit quality. In the bad state, some borrowers are of low credit quality. The good state occurs with probability $1-p$ $(0 < p < 1)$, and the bad state occurs with probability p. Although all the borrowers, the lender, and the investor know what probability the good or bad state occurs, only the lender observes which state has occurred in period 0.

3.1 Borrowers and Loan Opportunities

There are continuum of borrowers, each of whom borrows D (< 1) amount of loan in period 0 by promising to repay 1 amount in period 1. They are, however, of either high or low quality. A high quality borrower will repay the loan with probability 1 by paying 1 back to the lender when it is due. A low quality borrower may default with probability q by repaying only partially z ($0 < z < 1$) to the lender when it is due, while he can repay fully the loan by paying 1 with probability $1 - q$. We assume that the defaults of the low quality borrowers are perfectly correlated. We also assume that the default of the low quality borrowers is independent of the state of the economy to make the exposition of the essence of the main results clear. Note that the expected repayment of a low quality borrower is given by $(1 - q)1 + qz$.

The composition of high and low quality borrowers in the loan markets is given exogenously, and depends on the state of the economy. In the good state, there are only high quality borrowers. In the bad state, some are low quality borrowers, and the ratio of high quality borrowers in the all loan opportunities is $1 - \alpha$ and the one of low quality borrowers is α. For the ease of analysis below, we assume that the mass of borrowers is greater than $\frac{1}{1-\alpha}$.[2]

Finally, we assume that each borrower obtains the same amount u_B of utility by borrowing D from the lender, regardless that he is of high credit quality or of low credit quality.

[2]This assumption guarantees that the number of good borrowers are large enough so that the lender can make loans only to the high credit quality borrowers by screening in the bad state ω_b.

3.2 A Lender and Securitization

There is a lender that makes loans to the borrowers in period 0 and collects the repayments in period 1. The lender finances the loans by selling a securitized product backed by the loans to the investor in period 0. Thus, the lender is the originator of loans and the issuer of the securitized product.[3] The payoff of the securitized product is equal to the total amount of repayment by the borrowers in period 1. We assume that the nominal amount of the securitized product issued by the lender is fixed to be 1. That is, the lender has an exogenously given target for the issue amount of the securitized product. We also assume that the lender sells all portion of the securitized product in period 0 for the need of cash.[4]

The lender can screen the quality of loan opportunities if he bears screening cost $\gamma_s > 0$. Thus, in the bad state ω_b where there are low quality borrowers, whether the lender pays this cost or not determines the credit quality of the loan pool. If he pays the screening cost, the lender makes loans only to the high quality borrowers, and issues the securitized product backed by only the high quality loans. If he does not pay the screening cost, the lender can still issue the securitized product, which however is backed by the mixture of high and low quality loans. In other words, the lender makes the loans randomly to the borrowers and originates the securitized product backed by such a loan pool. The credit quality of the loan pool is reflected in the payoff of the securitized product issued by the lender.

[3] A non-bank MBS originators is the example for the lender in this paper. An overview of the subprime mortgage securitization process and problems arising from the informational frictions between the players in the process is summarized in Ashcraft and Schuermann (2008).

[4] As DeMarzo and Duffie (1999) and DeMarzo (2005), we may assume that it is costly for the lender to hold assets other than cash from period 0 to period 1. We then assume that the cost is so high that it is beneficial for the lender to sell all assets in period 0.

Let y be the payoff of the securitized product in period 1. Note that y depends on the credit quality of the loans that the lender makes. In the good state ω_g where all borrowers are of high credit quality, and in the bad state ω_b if the lender screens the borrowers and makes only the high quality loans, then $y = 1$ i.e., the high credit quality securitized product is riskless. In the bad state ω_b, if the lender does not screen and the loan pool includes low quality borrowers, then y is a random variable to take the value 1 with probability $1-q$, and $(1-\alpha)+\alpha z$ with probability q i.e., the low credit quality securitized product is defaultable. We define $x = (1-q)1 + q\{(1-\alpha)+\alpha z\}$.

There is a costly verification technology by which the lender can verify the credit quality of the securitized product to the investor. The cost of verification that the lender bears is $\gamma_v > 0$.[5] We assume that the verification is accurate so that the investor can fully trust the verified credit quality.

The lender can observe which state of the economy, ω_g or ω_b, occurs in the beginning of period 0. However, the lender can not credibly inform the investor of the true state of the economy for free. Let $S(\gamma, \omega)$ be the price of the securitized product when the lender pays the cost(s) γ of screening and/or verification in state ω. Note that $\gamma = 0$ implies that the lender does neither screening nor credit-quality verification, $\gamma = \gamma_s$ only screening, $\gamma = \gamma_v$ only verification, and $\gamma = \gamma_s + \gamma_v$ both screening and verification.

After observing the true state of the economy, the lender decides whether he does screening and/or verification to maximize the profit from the OTD business. That is, for each state $\omega = \omega_g, \omega_b$, the lender

[5]This verification technology may be interpreted as a benevolent and reliable rating agency. We do not investigate moral hazard problem or inability of such rating agency, although it is an important issue.

$$Max_{\gamma}[S(\gamma,\omega)-\gamma-D]$$
$$s.t.\ \ \gamma \ = \ 0,\ \gamma_s,\ \gamma_v,\ or\ \gamma_s+\gamma_v.$$

3.3 An Investor

There is a risk-neutral investor who represents the whole financial markets. In period 0, the investor purchases the securitized product. In period 1, she consumes the proceed from her investment. For simplicity, we assume that the investor has no discount between period 0 and 1. We also assume that the investor behaves competitively. Thus, the price of the securitized product that the investor purchases is given by the investor's expected payoff of the securitized product.

We assume that unlike the lender, the investor does not observe the true state of the economy. There is asymmetric information between the lender and the investor. That is, she does not observe whether she is in the good state ω_g where all borrowers are of high quality or in the bad state ω_b where some borrowers are of low quality. Moreover, the investor does not observe the credit quality of the securitized product, either. The lender can verify the credit quality of the securitized product by paying the verification cost γ_v. The investor observes whether the lender does the verification, infers the credit quality, and prices the securitized product according to her inference.

4 Equilibrium and Incentive to Issue a Low Quality Securitized Product

Let S_h be the price that the investor gives to the high quality securitized product, whose payoff in period 1 is 1 with probability 1, when the investor knows the securitized product is of high quality. Also, let S_l be the price that the investor gives to the low quality securitized product, whose expected payoff in period 0 is x, when the investor knows the securitized product is of low quality. Note that $S_h = 1$ and $S_l = x$.

We assume the following condition to hold.

$$x < 1 - \gamma_s - \gamma_v, \tag{1}$$

or equivalently $S_l < S_h - \gamma_s - \gamma_v$. That is, in the bad state ω_b, it is more profitable for the lender to screen the borrowers and issue a high credit-quality securitized product by paying the screening and verification costs than not to screen and issue a low credit-quality securitized product.

4.1 A Benchmark Case Where the Investor Knows the True State of the Economy.

In this subsection, for a benchmark, we consider the case where the investor knows which state of the economy, good or bad, occurs before she purchases the securitized product in period 0. We, however, assume that the investor cannot observe whether the lender screens the borrowers or not.[6]

Since the investor knows the true state, in the good state ω_g where all borrowers are of high credit quality, the securitized product is of high quality

[6]If in addtion the investor can observe whether the lender screens the borrowers or not, the investor and the lender have symmetric information. In this case, the lender does not have to verify the credit quality of the securitized product, and we obtain the same result as below where the verification cost γ_v is set to be zero.

and its price is $S_h = 1$. On the other hand, in the bad state ω_b where some borrowers are of low credit quality, the credit quality and the price of the securitized product depend on whether the lender screens the borrowers and verifies the credit quality of the product. In this case, since $S_l < S_h - \gamma_s - \gamma_v$, the lender screens the borrowers, makes the loans only to the high quality borrowers, verifies the credit quality, and sells the high quality securitized product to the investor at the price S_h. Thus, in the equilibrium, only the high credit quality securitized product is issued by the lender without paying the verification cost in the good state and with paying the screening and verification costs in the bad state.

Note that since each borrower obtains the same amount u_B of utility from borrowing, and the lender makes the same amount of loans to the borrowers, the welfare of the borrowers stays the same. Also, since the investor is risk-neutral, the net gain of her expected utility, or the expected payoff less the price of the securitized product, is always zero *ex ante* or before the true state occurs. Hence, the net *ex ante* gain of welfare in this economy can be measured by the expected value of the securitized product less the amount of loans and the screening and verification costs, or the profit of the lender, with respect to the state of the economy.

Since the net *ex post* gain of welfare is $S_h - D$ in the good state and $S_h - D - \gamma_s - \gamma_v$ in the bad state, the net *ex ante* gain of welfare is $(1 - p)(S_h - D) + p(S_h - D - \gamma_s - \gamma_v)$ in the benchmark case where the investor knows the true state of the economy but can not observe whether the lender screens the borrowers or not.[7]

[7]If the investor and the lender have symmetric information so that the investor knows the true state of the economy and observes whether the lender screens the borrowers or not, there is no need for verification in the bad state, and the net gain of welfare becomes $S_h - D$ in the good state and $S_h - D - \gamma_s$ in the bad state. This is the first best of this economy.

4.2 A Pooling Equilibrium with Low Quality Securitized Product

Recall that there is asymmetric information between the lender and the investor so that unlike the lender, the investor does not observe the true state of the economy. Such asymmetric information between the lender and the investor may result in mis-pricing of the securitized product, which may affect the lender's incentive to screen the borrowers' credit quality. To describe such a situation, we are interested in a pooling equilibrium where the high quality securitized product is issued in the good state, the low quality securitized product is issued in the bad state, and both are given the same price by the investor.

Consider an equilibrium in which the lender does not verify the credit quality of the securitized product in both good state ω_g and the bad state ω_b. Since the investor can observe only whether the lender does the verification or not, she can not tell whether she is in the good state or the bad state. Hence, the investor prices the securitized product as the average of its values in the good state and the bad state. In the good state, all borrowers are of high credit quality, the securitized product is of high quality, and hence the value should be $S_h = 1$. In the bad state, some borrowers are of low credit quality. Now, assume that the lender does not screen the borrowers, makes the loans randomly, and hence issues the low quality securitized product. (We will soon give a condition under which this is true.) Then, the value of the product should be $S_l = x \equiv (1-q)1 + q\{(1-\alpha)1 + \alpha z\}$ in the bad state. Thus, the price that the investor gives to the securitized product is $\bar{S} = (1-p)S_h + pS_l = (1-p)1 + px$. By definition, $S_l < \bar{S} < S_h$ holds.

In the good state ω_g, the lender decides whether he verifies the credit quality of the securitized product or not. (Note that all borrowers are of high

quality so that there is no need for screening.) If he does the verification, the investor knows that the credit quality of the securitized product is high, and gives the price S_h to the product. If he does not, the price will be $\bar{S}$. Thus, in the pooling equilibrium that we consider, $\bar{S} < S_h$ i.e., the product is undervalued. Despite this underpricing, the lender decides not to do the verification in the good state, if

$$S_h - \gamma_v \leq \bar{S}.$$

where we assume that when $S_h - \gamma_v = \bar{S}$, the lender chooses not to verify the credit quality.

In the bad state ω_b, the lender may be able to issue a high quality product at the price S_h by screening the borrowers and verifying the quality. However, he decides not to do so, if it is more profitable not to screen or verify i.e.,

$$S_h - \gamma_s - \gamma_v \leq \bar{S}.$$

Clearly, $S_h - \gamma_s - \gamma_v \leq S_h - \gamma_v$. Thus, if $S_h - \gamma_v \leq \bar{S}$, there exists a pooling equilibrium where the lender neither screens the borrowers nor verifies the credit quality in both good and bad states, but sells the securitized product of high quality in the good state and of low quality in the bad state at the same price $\bar{S}$.

Recall that $S_h = 1$ and $S_l = x$. With a simple calculation shown in the appendix, we have the following claim:

Proposition 1

> There exists a pooling equilibrium in which the lender neither screens the borrowers nor verifies the credit quality in both good

and bad states, but sells the securitized product of high (resp. low) quality in the good (resp. bad) state at the price $\bar{S}$, if

$$1 - x \leq \frac{\gamma_v}{p}. \tag{2}$$

Moreover, *ex ante*, the pooling equilibrium is less efficient than the benchmark by the expected loss

$$p(1 - x - \gamma_s - \gamma_v).$$

of issuing low quality securitized product in the bad state.

In the good state, the net *ex post* gain of the economy is the sum of the lender's gain $\bar{S} - D$ and the investor's $S_h - \bar{S}$, which is $S_h - D$. This is equal to the net *ex post* gain $S_h - D$ in the good state of the benchmark equilibrium. Thus, the inefficiency of the pooling equilibrium must be due to the inefficient lending/screening in the bad state of the pooling equilibrium.

Such inefficient screening occurs for the following reason: In the bad state of the pooling equilibrium, the low credit quality securitized product is issued, but its price is overvalued to be $\bar{S}(> S_l)$ because the investor cannot distinguish it from the high quality product. Due to this overvaluation, the lender has less incentive to screen the borrowers than he does when the low quality product is correctly priced to be S_l. This is because the lender's net gain $(S_h - \gamma_s - \gamma_v) - \bar{S}$ from screening to issue the high quality product when the low quality product is overpriced to be $\bar{S}$ is less than his net gain $(S_h - \gamma_s - \gamma_v) - S_l$ from screening to issue the high quality product when the low quality product is correctly priced to be S_l.

In other words, because of the overvaluation, the punishment for not screening becomes less severe so that the lender has less incentive to screen

the borrowers, which results in the inefficient screening. Thus, the market price may not provide an appropriate incentive for the lender to screen borrowers and issue securitized products efficiently.

Finally, it is worth pointing out that the mis-pricing above tends to occur when the probability of bad state p is relatively small and when the expected payoff x of the low quality securitized product is relatively large. That is, the low quality securitized product due to inefficient screening is likely to be issued when the investor finds it difficult to distinguish the good state from the bad state, or when the seed of recession creeps toward the booming economy.

4.3 An Equilibrium with Only High Quality Securitized Product

Depending on the parameter values of the economy, there also exists an equilibrium in which the lender issues only the securitized product of high credit quality in both good and bad states. We consider the case where

$$\bar{S} < S_h - \gamma_v,$$

or equivalently $1 - x > \frac{\gamma_v}{p}$.

Note that in this case, the lender in the good state has no incentive to issue the securitized product without verification as long as its price is less than $S_h - \gamma_v$. Hence, we assume that the investor gives the price S_l to the securitized product without verification. Then, in the good state, the lender verifies the securitized product. Also, in the bad state, the lender conducts screening and verification because without verification, the price of the product will be S_l which is less than $S_h - \gamma_s - \gamma_v$. Consequently, in both

good and bad states, only the securitized product of high credit quality is issued and verified.

The net *ex post* gain in the good state is $S_h - \gamma_v - D$, which is less than the benchmark net *ex post* gain $S_h - D$ by the verification cost γ_v. On the other hand, the net *ex post* gain in the bad state is $S_h - \gamma_s - \gamma_v - D$, which is equal to that of the benchmark. Thus, the net *ex ante* gain is less than that of the benchmark by the amount of the expected verification cost $(1-p)\gamma_v$.

From the arguments above, we have the following claim:

Proposition 2

> There exists an equilibrium in which the lender issues only the high quality securitized product with screening and verification in the bad state and with verification in the good state, if
>
> $$1 - x > \frac{\gamma_v}{p}. \tag{3}$$
>
> Moreover, *ex ante*, this equilibrium is less efficient than the benchmark by the expected cost
>
> $$(1-p)\gamma_v.$$
>
> of verification in the good state.

It is worth noting that in our setting, the verification cost γ_v should be wasted in the good state in order for the lender to separate the high quality product in the good state from the low quality product in the bad state. This situation occurs when the probability of bad state p is relatively large and when the expected payoff x of the low quality securitized product is

relatively small. Thus, when the investor knows that the economy is highly likely to be in the bad state, the lender tends to issue only the high quality securitized product with the cost of separation in the good state.

4.4 Comparative Statics

Note that the inefficient screening level described in the previous section occurs due to the investor's mis-pricing of the securitized product, and that the mis-pricing occurs since the investor can not distinguish the high quality one from the low quality one. We have derived the conditions for such mis-pricing and the inefficient screening level. In this section, we provide comparative statics concerning the conditions and thereby we investigate the relationship between the state of economy and the realizing equilibria.

The conditions for the pooling equilibrium (equation (2)) is to be rewritten as

$$p \leq \gamma_v \left(\frac{1}{1-x} \right)$$

Figure 1 shows the areas separated by those this condition for different types of equilibrium. The area marked as A is the area for the separating equilibrium in which only high quality securitized product is issued realizes. We call this equilibrium as the separating equilibrium because the choice of action by the lender is different in each state of the economy: in the good state the lender pays the cost for verification while in the bad state he pays the cost of verification and screening. Meanwhile, the area marked as B is the area in which the pooling equilibrium realizes.

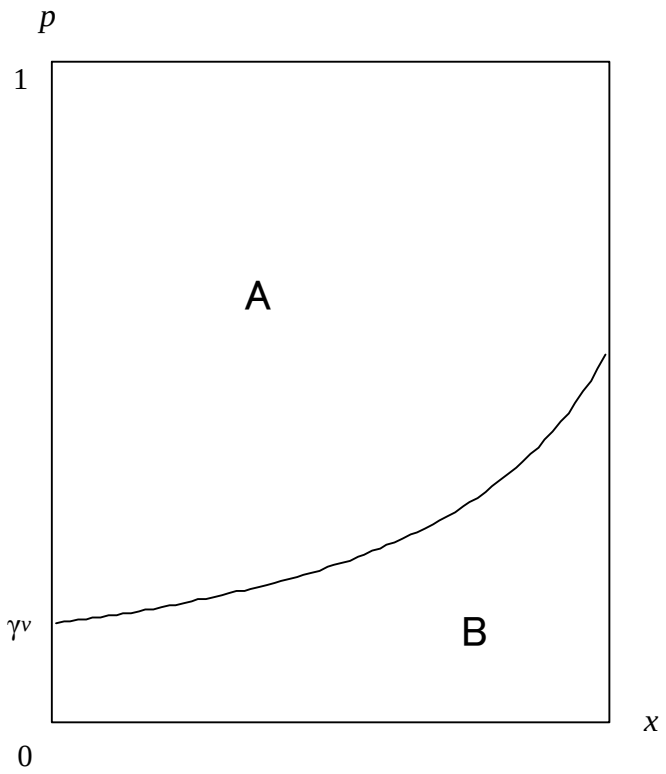

Figure 1. Areas for Different Types of Equilibrium

We have an interesting observation in the figure. In the area above $p = \gamma_v$, the area with smaller x with a certain value of p tends to be the one for the separating equilibrium. This is intuitive: the worse the average quality of borrowers' pool, the more sense it makes to do screening.

A decrease in r_v in the figure shift down the curve of $p = \gamma_v (1/(1-x))$. The mechanism behind the shift of the curve is that, for a certain set of x and

p just below the curve with a certain value of γ_v, it is rational for the lender to pay the verification cost for avoiding mis-pricing of the securitized product by the investor when the verification cost becomes less expensive. The effect of decrease in γ_v on the welfare loss in different equilibria discussed in the last section is as follows. In the separating equilibrium, the welfare loss, $(1-p)\gamma_v$ decreases because the unavoidable cost for verification to attain the equilibrium without mis-pricing of the securitized product is reduced. In the pooling equilibrium, the welfare loss, $p(1-x-\gamma_s-\gamma_v)$, increases. This result may look a little counter-intuitive because it is generally believed that a reduction in any cost in financial transactions will lead to higher efficiency. In fact, the net *ex ante* gain of welfare in the benchmark equilibrium, where the investor knows the true state of the economy, is $(1-p)(S_h-D)+p(S_h-D-\gamma_s-\gamma_v)$ and the value increases as γ_v decreases. This is consistent with the general belief on the benefit of sophistication of financial transactions. The point is that the inefficiency in the pooling equilibrium is a relative notion. In the pooling equilibrium, the attainable welfare in the benchmark case is larger for a smaller γ_v, while the attained welfare in the equilibrium is invariant to the verification cost because verification is not done. Therefore, the difference increases, which appears as an increase in the welfare loss.

5 Implication and Discussion

The main result of this paper is that, in the OTD business model, overvaluation of the low quality securitized product induces the lender to conduct insufficient screening and to issue the low quality product inefficiently. This occurs when the investor finds it difficult to distinguish the good state from the bad state, or when the probability of being in the bad state is relatively

small. Thus, when the peak of boom with an ample pool of good quality borrowers has passed, the good borrowers are decreasing, but it is not yet well recognized, the credit quality of the securitized product is likely to be deteriorated.

In the recent sub-prime mortgage loan problem, it is suspected that one of the reasons behind the expansion of the problem is lack of necessary screening of the low quality borrowers. It seems that the aspect of the problem had been aggravated as it had become more difficult to find high quality borrowers in the borrower pool after they had already borrowed mortgage loans. In the context of the model in this paper, the difficulty can be expressed as an increase in α resulting in a decrease in x and it is more likely that the pooling equilibrium with inefficient screening level realizes in such a situation. In this way, we think the mechanism in the model, i.e., the relationship between the price of securitized products and the incentive of screening, can shed some light on the observation about the sub-prime mortgage loan problem.

The other important point shown in this paper is that if the probability of being in the bad state is large, the lender tends to issue only the high quality securitized product. This is, however, with the inefficient cost of verification in the good state. Since the investor can not distinguish between the good state and the bad state, the lender in the good state has to separate his high quality product from the low quality product in the bad state to keep the price high by conducting costly quality verification. Thus, at least in our stylized setting where there is asymmetric information between the lender and the investor about the state of economy, and where the lender has to verify the credit quality of the securitized product, the OTD business model will not work efficiently. It is only when all borrowers are of high quality or of low quality that the OTD business model results in efficient securitization.

Finally, it is interesting to observe that in this paper, the inefficiency of the financial markets occurs even with the perfectly credible rating. This is in contrast with the argument stressing the inefficacy or moral hazard of rating agencies in the securitization process. In our model, the rating is perfectly credible once it is provided but there still can be inefficient rating. The inefficiency arises because the lender decides whether he conducts costly verification or not, and because his incentive to screen the borrowers and verify the quality of the securitized product is related to the price of securitized product. This is a fundamental issue worth investigating.

6 Concluding Remarks

We have shown that in the OTD business model in which the lender finances his loans to the borrowers by issuing the securitized product to the investors, the price of the securitized product affects the lender's incentive to screen the borrowers and consequently the credit quality of the securitized product. Moreover, inefficient screening level will realize depending on the state of economy and the cost of screening and verification. The mechanism behind the result is that the lenders compare the price of securitized products backed by screened loans (high quality securitized products) with the one of securitized products backed by unscreened loans (low quality securitized products), and that the asymmetric information between the lenders and the investors yields to relative overvaluation of low quality securitized products. The credit quality of securitized products should be closely related to the state of economy and the cost of screening and verification.

Gorton and Pennacchi (1995) pointed out, in the context of loan sales by banks, that by forcing the lender to give partial guarantee to the payoff

of loans in loan sale markets, the lender has more incentive to screen the borrowers and increases the credit quality. Although the setup is different, our results suggest that the appropriateness of such requirement to the lender may depend on the state of economy.

What kind of incentive scheme we have to put on the lender? What is the optimal design? These are the questions that we seek in our future research.

Appendix

This appendix provides the proof of the proposition 1. Inserting the equation $\bar{S} = (1-p)S_l + pS_h$, $S_h = 1$ and $S_l = x$ into the condition for the pooling equilibrium $S_h - \gamma_v \leq \bar{S}$, we have the condition for the pooling equilibrium in the proposition. As for the welfare loss, note that the net *ex ante* gain of welfare in this pooling equilibrium is $(1-p)(\bar{S}-D)+p(\bar{S}-D)$. Recall that the net *ex ante* gain of welfare in the benchmark equilibrium, where the investor knows the true state of the economy, is $(1-p)(S_h-D)+p(S_h-D-\gamma_s-\gamma_v)$. Subtracting the *ex ante* gain in the pooling equilibrium from the one in the benchmark equilibrium, we have the difference as $p\left((S_h - S_l) - (r_s + r_v)\right)$ that is positive if and only if $r_s + r_v < S_h - S_l$. The condition is equivalent to $S_l < S_h - \gamma_s - \gamma_v$ that we assume in this paper. Inserting $S_h = 1$ and $S_l = x$ into $p\left((S_h - S_l) - (r_s + r_v)\right)$, we obtain the value of welfare loss as $p\left(1 - x - r_s - r_v\right)$.

References

[1] Allen, Franklin, and Douglas Gale, "Optimal Security Design," *Review of Financial Studies* 1 (1988) 229-263

[2] Allen, Franklin, and Douglas Gale, *Financial Innovation and Risk Sharing*, (1994) MIT Press

[3] Ashcraft, Adam B, and Til Schuermann, "Understanding the Securitization of Subprime Mortgage Credit," Federal Reserve Bank of New York Staff Reports no.318, (2008)

[4] Berger, Allen, and Gregory Udell, "The Institutional Memory Hypothesis and the Procyclicality of Bank Lending Behavior," *Journal of Financial Intermediation* 13, 458-495

[5] Dell'Ariccia, Giovanni., Deniz Igan., and Luc Laeven, "Credit Booms and Lending Standards: Evidence from the Subprime Mortgage Market," CEPR Discussion Paper Series No. 6683 (2008)

[6] DeMarzo, Peter., "The Pooling and Tranching of Securities: A Model of Informed Intermediation," *Review of Financial Studies* 18 (2005) 1-35.

[7] DeMarzo, Peter., and Darrell Duffie, "A Liquidity-Based Model of Security Design," *Econometrica* 67 (1999) 65-99.

[8] Gorton, Gary B., and George G. Pennacchi, "Banks and loan sales marketing nonmarketable assets," *Journal of Monetary Economics* 35 (1995) 389-411

[9] Holmstrom, Bengt, and Jean Tirole, "Financial Intermediation, Loanable Funds, and the Real Sector," *Quarterly Journal of Economics* CXII (1997) 663-691

[10] Jimenez, Gabriel., and Jesus Saurina, "Credit Cycles, Credit Risk, and Prudential Regulation," *International Journal of Central Banking* Vol.2 No 2 June (2006) 65-98

[11] Rajan, Rghuram, "Why Bank Credit Policies Fluctuate: A Theory and Some Evidence," *Quarterly Journal of Economics* (1994) 399-441

[12] Shin, Hyun Song, "Risk and Liquidity in a System Context," *Journal of Financial Intermediation* (2008), 17, 315-329

[13] Shin, Hyun Song, "Securitisation and Financial Stability," *Economic Journal* (2009), 119, 309-332