Securitization, Competition and Monitoring[☆]

Jung-Hyun Ahn[a], Régis Breton[b,c,*]

[a] *Rouen Business School, Dept. of Economics and Finance, 1, rue du Maréchal Juin - BP 215, 76825 Mont-Saint-Aignan Cedex, France.*
[b] *Banque de France, 35-2341 DGO-DSF-SMF,75049 PARIS Cedex 01, France*
[c] *CNRS*

Abstract

We analyze the impact of loan securitization on competition in the loan market. Using a dynamic loan market competition model where borrowers face both exogenous and endogenous costs to switch between banks, we uncover a softening competition of securitization that allows banks to extract rents in the primary loan market. By reducing monitoring incentives, securitization leads to lower winner's curse effects in future stages of competition thereby decreasing *ex ante* competition for a greater initial market share. Due to this softening competition effect, securitization can adversely affects loan market efficiency while leading to higher equilibrium profits for banks. This effect is driven by primary loan market competition, not by the exploitation of informational asymmetries in the secondary market for loans. We also argue that banks can use securitization as a strategic response to an increase in competition, as a tool to signal to signal a reduction in monitoring intensity for the sole purpose of softening *ex ante* competition. Our result suggests that current securitization reform exclusively focusing on informational asymmetries in securitization market may not be enough.

Keywords: securitization, loan sales, banking competition, monitoring, rent extraction
JEL: G21, L12, L13

[☆] We are grateful to Vincent Bignon, Jean Cartelier, Vittoria Cerasi, Xavier Freixas, Bertrand Gobillard, Nobu Kiyotaki, Antoine Martin, Bruno Parigi, Guillaume Plantin, Jean-Charles Rochet, Jean-Paul Pollin, Laurence Scialom and Tianshu Zhao for helpful discussions. Part of this paper was written while Ahn was a visiting scholar at Pompeu Fabra University, where the hospitality of Xavier Freixas is gratefully acknowledged. Thanks also to the seminar participants at IFABS (Valencia), FEBS (London), MFA (New Orleans), AMES(Seoul), FMA (NewYork), AFSE (Paris), EEA (Barcelona), SMYE (Istanbul), the International Financial Research Forum (Paris), Tor Vergata (Rome), MMF (London) and Symposium on Money, Banking and Finance (Luxembourg), as well as at Pompeu Fabra University, the Univ. of Orléans, and the Univ. of Paris 10. The usual disclaimer applies. The opinions expressed in this paper are those of the authors and do not necessarily reflect the views of the Banque de France or the Eurosystem.

[*] Corresponding author. Tel.: +33 0 41 92 38 22, Fax: +33 1 42 92 68 75.
Email addresses: jung-hyun.ahn@rouenbs.fr (Jung-Hyun Ahn), regis.breton@banque-france.fr (Régis Breton)

July 25, 2012

1. Introduction

The financial crisis triggered by the US subprime mortgage sector has had an unprecedented negative impact on the real economy and on the banking sector. There is widespread consensus that losses related to securitized products such as MBS or CDOs were at the heart of the financial crisis, and a number of discussions have followed among practitioners, academics and regulators concerning how to reform securitization activities.[1]

Indeed, several recent empirical studies suggest that higher securitization activity is associated with a reduction in loan quality. Evidence along this line has been documented for subprime mortgages (Dell'Ariccia et al., 2008, Mian and Sufi, 2009, Keys et al., 2010, Purnanandam, 2011) as well as for corporate loans (Berndt and Gupta, 2009, Gaul and Stebunovs, 2009). This literature argues that the originate-to-distribute (OTD) model of lending based on securitization was a main cause of the crisis. When lenders and securitizers retain insufficient skin in the game, incentives get distorted along the securitization chain, leading to lax monitoring and screening, as well as intentional sales of low quality loans. Theoretical contributions with opaque secondary markets have analyzed these incentive dilution effects (Morrison, 2005, Parlour and Winton, 2008, Hakenes and Schnabel, 2010).

This negative view of securitization raises a fundamental question. According to contemporary banking theory, screening and monitoring are at the core of banks' expertise (Bhattacharya and Thakor, 1993). Reduction in those core activities should therefore lead to an erosion in value creation by (and profits of) banks. One may thus ask why, unless there are huge direct benefits, banks' increasing participation in the OTD model before the crisis was not penalized by decreasing profits or share prices.

In this paper, we argue that higher securitization can allow banks to make more profits by extracting rents from their borrowers in the primary loan market. An alternative explanation, consistent with the above cited papers, is that originating banks exploit investors' inability to understand and price securitized products. In other words, banks' profits are simply the counterpart of (future) losses by unsuspecting final investors in the secondary market. However, this reasoning hinges on the notion that buyers of securitized products are unsophisticated investors, contradicting the fact that many buyers were themselves banking institutions. We find it more natural to explore potential rent extraction from other agents that are much less sophisticated than banks: clients in the primary loan market.

Our paper analyzes the interaction between securitization and loan market competition and point to a softening competition effect of securitization. Specifically, we consider a simple duopoly model of the loan market where banks compete for borrowers over two periods. The framework has two main ingredients: borrowers face exogenous costs when switching from one bank to its competitor,

[1] See for example American Securitization Forum et al. (2008), ECB (2008), Franke and Krahnen (2008).

and banks strategically choose the intensity of monitoring of their borrowers during the first period. As monitoring entails private information, the initial lending bank (which will be referred to as the relationship bank) has an informational advantage in the second period, when competing with the outside bank that tries to poach its first-period clients. A key aspect of the framework is that, due to the presence of switching costs, banks earn profits from poaching their competitors clients. In equilibrium, banks make positive profits equal to these poaching profits.

In this setup, we show that securitization has a softening competition effect. Selling to outsiders the cash flow that will be generated by (a fraction of) the loan portfolio reduces banks' monitoring incentives, in line with the papers on the dark side of securitization. As a side effect, banks have less private information about their own clients, which in equilibrium makes poaching more profitable, because of the less acute informational asymmetry that exists between the relationship bank and the outside bank. In turn, the *ex ante* (first period) market share becomes less important, as banks can more profits from poaching in the second. This soften *ex ante* competition, and increasing overall equilibrium profits of the banks.

Those results have two broad implications. First, we highlight an additional effect—a rent extraction, or surplus distribution effect—of securitization, thereby contributing to the literature on the *consequences* of securitization. As we discuss in section 4.1, due to the softening competition effect, under certain conditions securitization can increase banks' profits but worsens overall loan quality and loan market efficiency. As mentioned above, this increase in profits is not driven by the exploitation of informational asymmetries in the secondary market for loans, but by rent extraction in the primary market. Secondly, our results suggest that banks can strategically use loan securitization to soften the effect of loan market competition, thereby contributing to the literature on the the *motivation* for securitization. We provide in section 4.2 an extension showing that, because of the softening competition effect, securitization can be used as a response to an (exogenous) increase in competition. In this extension, securitization is used as a tool to signal a reduction in the intensity of monitoring, which in turn mitigates *ex ante* competition as competitor banks know that they can poach their rival's borrowers in a future round of competition. As we argue in section 4.3, this may explain the concomitant increase in competition, massive securitization, and reduction in credit standard that took place before the crisis.

Regarding policy implications, our results suggests that new regulations that only target securitization markets may not be sufficient. In the US, the main recommendations (on securitization) of the Dodd-Frank Wall Street Reform and Consumer Protection Act enacted on July 2010 require better information disclosure on securitized products, and more skin in the game for securitizers through a 5% minimum retention of the securitized portfolio. The European Union has also adopted a similar proposal requiring originators to hold at least 5% of the securitized portfolio.[2] As such, these reforms focus exclusively on the problems related to informational asymmetries between sellers and buyers in the secondary market. However, this line of prescription may overlook the other side of securitization activity: the market for the underlying asset (in particular the loan market).

The rest of the article is as follows. In the reminder of this section we discuss related literature. Section 2 presents the general environment of the model. Section 3 proceeds with the equilibrium analysis and states the main result regarding the softening competition effect of securitization. Section 4 discusses the effect on loan market efficiency, provide an extension where securitization is used as a response to an increase in competition, and discuss some empirical implications. Most proofs are relegated to an appendix.

1.1. Related literature

Our paper is related to several strands of the literature. First of all, our analysis is related to the literature on the relationship between securitization and banks' monitoring incentives. Parlour and Plantin (2008) and Hakenes and Schnabel (2010) showed that securitization reduces banks' incentives to monitor their borrowers when there is informational asymmetry between loan-selling banks and buyers, a situation that is harmful in terms of social welfare. In our article, we demonstrate similar results regarding monitoring incentives and social welfare. However, the reduction of incentives to monitor is not derived from the moral hazard, or from the informational asymmetry between loan sellers and buyers, as suggested in their models, but from the intention to soften competition in the future. Our analysis thus sheds light on the current discussion on regulations in the securitization market, and suggests a new dimension that policy makers must consider.

On the other hand, our study is also obviously related to the literature on the motivation of loan securitization. One commonly held idea concerning the rationale for securitization is banks' perspective on risk management, according to which banks use securitization to transfer or diversify credit risks (Allen and Carletti, 2006, Wagner and Marsh, 2006, etc.). Another well-known argument is that of the regulatory arbitrage associated with capital requirements (Acharya et al., 2010, Calomiris and Mason, 2004, Carlstrom and Samolyk, 1995, Duffee and Zhou, 2001, Nicolo and Pelizzon, 2008). Given that capital is more costly than debt, the retention of a proportion of capital for loans in a balance sheet creates additional cost for banks. By taking this loan off their balance sheet, they can save their capital. A third argument is related to the more efficient recycling of bank funds (Gorton and Pennacchi, 1995, Parlour and Plantin, 2008). With a constraint on funds, retaining a loan until maturity involves an opportunity cost if banks have other more profitable lending opportunities. By using securitization, banks can recuperate their funds earlier, and redeploy them

[2]For more details, see IX.D. of the Dodd-Frank Act "Improvements to the Asset-Backed Securitization Process" and Article 122a, European Parliament, 2009.

in another investment project. However, there are few articles that explicitly analyze the link between loan market competition and securitization. Our article offers a novel explanation of why banks securitize their loans, focusing on loan market competition.

Thirdly, this article is related to the literature concerning the link between relationship banking and loan market competition. Peterson and Rajan (1995) show that banks have a greater incentive to develop their relationship with new borrowers when loan markets are less competitive and more concentrated. Boot and Thakor (2000) show that banks may refocus on relationship lending in order to survive in the face of interbank competition, because this allows banks to shield their rent better. However, we show that a relationship banking orientation can increase *ex ante* competition in order to capture more new clientele so as to extract rent in the future, which in turn reduces overall profit. We hence add a dynamic perspective to the link between relationship banking and loan market competition.

Our analysis also contributes to the literature on the strategic use of information in imperfectly competitive credit markets. Hauswald and Marquez (2006) analyze banks' strategic use of information acquisition as a barrier to entry. In our environment with competition over multiple periods, banks strategically reduce information acquisition to mitigate the consequences of entry. In a framwework related to ours, Gehrig and Stenbacka (2007) and Bouckaert and Degryse (2004) show that, when the initial lender automatically obtains proprietary information about former clients, banks can use information sharing to soften *ex ante* competition. We show that securitization has a similar softening competition effect, in a setup with endogenous monitoring.

2. Environment

We consider a two-period duopoly model with two banks, A and B. They compete in two subsequent periods over loan rates (Bertrand price competition) by offering short-term loan contracts to a unit mass of borrowers.

2.1. Borrowers and banks

Borrowers can be of two types, $\theta \in \{H, L\}$. H borrowers (a fraction λ) have access to one positive NPV project in each period that yields output Y with probability $p_H > 0$ (and 0 otherwise) for a fixed outlay of I. Type H are good borrowers that never shirk when managing a project.[3]

In contrast, type L borrowers (a fraction $1 - \lambda$) have access to two different *negative* NPV projects in the first period. His "best" project yields output Y with probability $p_L > 0$ and no private benefits; however, he can also choose a project that delivers private benefits $B > 0$ but always fail. Private benefits B are large enough so that unmonitored (L-)borrowers always choose their worst

[3] Or borrowers who never engage in excessive side consumption when they borrow to finance a home/car.

alternative ("shirking"). As in (Holmstrom and Tirole, 1997), banks can prevent shirking by monitoring. Monitoring has two important effects. First, it raises the success probability of loans for L-types; in addition, by monitoring the borrower's behavior, the bank learns its type. This information is relationship specific and cannot be transferred to outsiders ("soft information"). To sum up, we posit

$$p_H Y > I > B > p_L Y$$

We note by $\sigma_A, \sigma_B \in [0,1]$, the intensity of monitoring that banks choose strategically. It is unobservable by third parties and monitoring is costly. Higher intensity of monitoring gives more precise signal on the type of the borrowers but incurs higher cost. In other words, the intensity σ requires a monitoring cost σc with $c > 0$. The bank i with σ_i receives a a perfect signal on the the type of the borrowers (H or L) with probability σ_i and does not receive any signal ($\varnothing$) with probability $1 - \sigma_i$. As two extreme cases, $\sigma_i = 1$ denotes the case in which bank i can distinguish perfectly H-type from L among its clientele, and $\sigma_i = 0$ corresponds to the case in which bank i does not monitor at all its clientele, implying that it has no additional information other than publicly observable one.

As we focus on how bank's monitoring incentives are shaped by the prospect of *future* competition, we abstract from monitoring in the second period, and simply assume that in the second period type L borrowers have access to one project that delivers private benefits B and fails surely.

Projects' outcome are observable (*e.g.* due to a credit bureau or a credit registry, in which the default record of borrowers are registered). Banks can use this information to update their beliefs about a borrower's type. The information content of the first period result depends on the monitoring behavior. Specifically, for a borrower financed by a bank that is expected to monitor its clients with intensity σ^e:

$$\begin{aligned}
\Pr\left[H \left| Y, \sigma^e \right.\right] &= \frac{\lambda p_H}{\lambda p_H + (1-\lambda)\,\sigma^e p_L}, \\
\Pr\left[H \left| 0, \sigma^e \right.\right] &= \frac{\lambda (1-p_H)}{\lambda (1-p_H) + (1-\lambda)\,(1-\sigma^e p_L)}.
\end{aligned}$$

For tractability, we assume that without additional pieces of information, it is always unprofitable to lend to a borrower who defaulted in the first period whereas the period 2-project of a borrower who succeeded in the first period has a *ex ante* positive NPV , that is,

$$\Pr\left[H \left| 0, \sigma^e = 1 \right.\right] p_H Y - I < 0 \tag{1}$$

$$\Pr\left[H \left| Y, \sigma^e = 1 \right.\right] p_H Y - I > 0 \tag{2}$$

We also assume that making a loan in the first period is ex ante efficient, that is $\lambda p_H Y - I > 0$, and

$$\lambda (1-p_H)(p_H Y - I) + (1-\lambda)\, p_L I > c \tag{3}$$

Condition (3), in particular, ensures that the net value of the monitoring is positive in monopoly case.

2.2. Switching Costs

Borrowers can switch their banks in the second period but this incurs a switching cost. We consider this switching cost to be heterogeneous among borrowers, assuming that they incur an idiosyncratic switching cost (s) distributed uniformly on $[0, \bar{s}]$ for tractability. They learn their individual switching cost only at the end of the first period, and it is not observable by other parties, including banks. As a consequence, banks cannot make a contract conditional on individual switching costs. This allows the banks to make a positive profit on the Bertrand price competition. The heterogeneity and private character of switching costs renders poaching a rival's borrowers profitable. A fraction of high quality borrowers, whose switching cost is low, will have an incentive to switch their bank if the loan rate offer made by outside banks is more attractive.

This assumption about the switching cost is quite natural, to the extent that borrowers' satisfaction or dissatisfaction with a bank may differ depending on the individual preference for the bank's services, and borrowers can only measure them exactly once they have had a relationship. Switching costs may capture the direct cost of closing an account with one bank and opening it elsewhere, the cost associated with a different application procedure with other banks, and also the loss of the relationship benefit between the borrower and his former bank.[4]

2.3. Securitization

Banks securitize their loan portfolio during the period 1 after granting loans to their borrowers. Precisely, they sell a fraction $\tau \in [0, 1]$ of their loan portfolio at a price P to outside investors. For the main part of the analysis, we focus on the analysis of the impact of an exogenous change of the extent of securitization. In other words, for the time being, we consider τ exogenous, and we endogenize τ later in the section 4.

For simplicity, we assume that banks issue pass-through securities on their whole loan portfolio, and sell a fraction of τ to outside investors and retain $1 - \tau$ in their own balance sheet.[5] In other words, banks transfer a fraction τ of the revenue of each loan to buyers. The market for securitization is perfectly competitive and investors are rational, so that they expect the present value of the securities from all observable information, R_1^i, τ.

We denote $V\left(\tau, R_1^i\right)$, the expected present value of the securities backed by a fraction τ of the loan portfolio of bank i with loan rate R_1^i.

$$V\left(\tau, R_1^i\right) = \tau \bar{p}^e R_1^i$$

where $\bar{p}^e = \lambda p_H + \sigma_i^e (1 - \lambda) p_L$, the expected probability of repayment of loans, which depends on bank i's monitoring intensity expected by investors. As market

[4]The assumption on switching cost is supported by empirical evidence in the banking and credit card sector. See, for example, Barone et al. (2011), Kim et al. (2003) and Stango (2002).

[5]Alternatively, by this assumption, we can consider that the quality of the sold loan portfolio and that of loans retained by the bank is same. Or banks sell their loans before monitoring if they intend to do so. This assumption makes sense in that we consider interim monitoring.

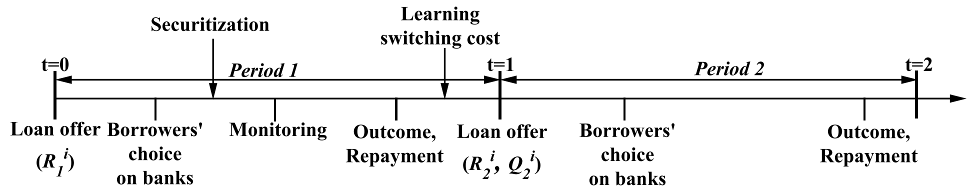

Figure 1: Timing

is perfectly competitive, the loan portfolio is sold at the price same as its present value expected by investors. Hence, the price of the securitized loan portfolio is

$$P\left(\tau,\sigma_i^e,R_1^i\right) \quad = \quad \tau\left(\lambda p_H+\sigma_i^e\left(1-\lambda\right)p_L\right)R_1^i \tag{4}$$

2.4. Timing

The sequence of the game is described as follows: Two banks simultaneously offer a first period loan rate, R_1^i. Borrowers accept one of the banks and execute their project. Banks securitize a fraction τ of their loan portfolio. Banks choose their monitoring intensity σ_i and execute monitoring their own borrowers. They observe the projects' return, and the borrowers repay their loan in the case of success. Banks transfer a fraction of τ of their cash-flow from borrowers to investors. Borrowers learn their switching cost. Each bank makes a loan offer regarding second-period projects to its own borrowers, R_2^i, and his rival's borrowers, Q_2^i. Q_2^i is the poaching rate by which bank i tries to attract entrepreneurs belonging to its rival's first-period clientele. If borrowers receive an offer from both banks, they decide whether to continue their relationship with the first-period bank, or to change their bank. The rest is similar to the first period. The timing is summarized in Figure 1.

3. Equilibrium analysis

3.1. Second-period competition

We first characterize the outcome of second-period competition, taking as given first-period market shares (μ^A,μ^B). In the second period, banks compete for two groups of borrowers, *i.e.*, their own clientele and the rival's in the first period.

Banks' loan offers depend on public information (period 1-default record) and, when relevant, on inside information for a monitored client. Let R_2^A (respectively Q_2^A) be the interest rate offered by bank A to borrowers among its clientele (respectively, within bank B's clientele). Analogously, denote bank B's strategy by $\left(R_2^B,Q_2^B\right)$.

Let $\iota\in\{H,L,\varnothing\}$ denote the insider bank's information about the type of its borrowers. Clearly, bank i does not make any offer when $\iota=L$ and makes an offer to type H who failed. Under assumption (1) and (2), i makes an offer to $\varnothing$ that succeeded and does not make any offer to $\varnothing$ that defaulted. The rival makes an offer Q to borrowers who succeeded and no offer to borrowers who defaulted.

Bank i offers $R_1^i = Y$ to H that defaulted as it does not receive any offer from the rival bank (captive clientele). They always accept this offer and remain with i. On the other hand, L that succeeded always change their bank as they receive only one offer from the external bank. H that succeeded receive an offer from each bank then face a tradeoff between interest rate and switching cost. A type H receiving would switch to the rival bank whenever

$$p_H \left(Y - R_2^i\right) < p_H \left(Y - Q_2^j\right) - s,$$

This yields a switching threshold

$$s = \frac{1}{p_H} \left(R_2^i - Q_2^j\right)$$

We can obtain a unique Nash equilibrium associated with the competition for bank i's clientele in the period 2-competition subgame.

Proposition 1. *The period-2 competition subgame over bank i's clients admits a unique equilibrium in pure strategies, with*

$$R_2^i = \frac{1}{p_H} \left(I + \frac{2}{3}\bar{s}\right), \qquad Q_2^i = \frac{1}{p_H} \left(I + \frac{1}{3}\bar{s}\right).$$

The associated (per-borrower) profits of bank i and rival j on i's first period clients are given by

$$\begin{aligned} \tilde{\pi}^{i/i} (\sigma_i) &\equiv \sigma_i \lambda (1 - p_H) (p_H Y - I) + \lambda p_H \frac{4}{9}\bar{s}, \\ \tilde{\pi}^{j/i} (\sigma_i^e) &\equiv \lambda p_H \frac{1}{9}\bar{s} - \sigma_i^e (1 - \lambda) p_L I. \end{aligned}$$

Proof. See Appendix. □

The required condition to obtain a pure strategy equilibrium is

$$\lambda p_H \frac{1}{9}\bar{s} > (1 - \lambda) p_L I \tag{5}$$

It is noteworthy that banks make a positive profit in the second period. This is related to the presence of the switching cost.

3.2. First-period competition and overall equilibrium characterization

At the beginning of the first period, no banks have private information, and thus they compete only with the first-period loan rate. As a result, first period market shares obey

$$\mu^i = 1 - \mu^j = \begin{cases} 0 & \text{if } R_1^i > R_1^j, \\ 1/2 & \text{if } R_1^i = R_1^j, \\ 1 & \text{if } R_1^i < R_1^j. \end{cases}$$

We assume that banks do not discount future profits. Overall profits can be written as

$$\Pi^i = \mu^i \left[\begin{array}{l} -I + (1-\tau)(\lambda p_H + \sigma_i (1-\lambda) p_L) R_1^i - \sigma_i c \\ +P\left(\tau, \sigma_i^e, R_1^i\right) + \tilde{\pi}^{i/i}(\sigma_i) \end{array} \right] + \mu^j \tilde{\pi}^{i/j}\left(\sigma_j^e\right)$$

We can rewrite $\tilde{\pi}^{i/i}(\sigma_i)$ and $\tilde{\pi}^{i/j}(\sigma_j)$ as

$$\tilde{\pi}^{i/i}(\sigma_i) = \sigma_i \bar{\pi}^{i/i} + (1-\sigma_i)\pi^{i/i} \tag{6}$$

$$\tilde{\pi}^{j/i}(\sigma_i^e) = \sigma_i^e \bar{\pi}^{j/i} + (1-\sigma_i^e)\pi^{j/i} \tag{7}$$

where

$$\begin{aligned} \pi^{i/i} &= \lambda p_H \frac{4}{9}\bar{s} \\ \bar{\pi}^{i/i} &= \lambda(1-p_H)(p_H Y - I) + \lambda p_H \frac{4}{9}\bar{s} \\ \pi^{j/i} &= \lambda p_H \frac{1}{9}\bar{s} \\ \bar{\pi}^{j/i} &= \lambda p_H \frac{1}{9}\bar{s} - (1-\lambda) p_L I \end{aligned}$$

π and $\bar{\pi}$ stand for the second-period profits when $\sigma = 0$ and when $\sigma = 1$ respectively. Using (4), (6) and (7), we can write bank i's overall profits as a function of first-period interest rate policies, and the monitoring strategy of the two banks:

$$\begin{aligned} \Pi^i = {} & \mu^i \left[\begin{array}{l} -I + (\lambda p_H + \sigma_i^e \tau (1-\lambda) p_L) R_1^i \\ +\sigma_i \left(-c + \bar{\pi}^{i/i} + (1-\tau)(1-\lambda) p_L R_1^i\right) + (1-\sigma_i)\pi^{i/i} \end{array} \right] \\ & +\mu^j \tilde{\pi}^{i/j}\left(\sigma_j^e\right) \end{aligned} \tag{8}$$

The linearity of formula allow us to characterize bank i's optimal decision on monitoring intensity.

$$\sigma_i = \begin{cases} 0 & \text{if } c > (1-\tau)(1-\lambda) p_L R_1^i + \left(\bar{\pi}^{i/i} - \pi^{i/i}\right), \\ (0,1) & \text{if } c = (1-\tau)(1-\lambda) p_L R_1^i + \left(\bar{\pi}^{i/i} - \pi^{i/i}\right), \\ 1 & \text{if } c < (1-\tau)(1-\lambda) p_L R_1^i + \left(\bar{\pi}^{i/i} - \pi^{i/i}\right). \end{cases}$$

As this condition applies to all banks, we can characterize symmetric pure strategy equilibrium.

Proposition 2. *(Under assumption* (5)*) There exists a unique equilibrium in which both banks are active in the first period. This equilibrium is symmetric and characterized by the monitoring intensity*

$$\sigma^* = \begin{cases} 0 & \textit{if } c_\tau < c, \\ \sigma(c,\tau) & \textit{if } \bar{c}_\tau \le c \le c_\tau, \\ 1 & \textit{if } \quad c < \bar{c}_\tau. \end{cases}$$

where

$$c_{\tau} \equiv \lambda(1-p_H)(p_H Y - I) + (1-\tau)(1-\lambda)p_L \frac{I - \lambda p_H \frac{1}{3}\bar{s}}{\lambda p_H},$$
$$\bar{c}_{\tau} \equiv \lambda(1-p_H)(p_H Y - I) + (1-\tau)(1-\lambda)p_L \frac{I - \lambda p_H \frac{1}{3}\bar{s} - (1-\lambda)p_L I}{\lambda p_H + \tau(1-\lambda)p_L},$$

and $\sigma(c,\tau)$ *is the unique solution to*

$$\lambda(1-p_H)(p_H Y - I) + (1-\tau)(1-\lambda)p_L \frac{I - \lambda p_H \frac{1}{3}\bar{s} - \sigma^*(1-\lambda)p_L I}{\lambda p_H + \sigma^* \tau(1-\lambda)p_L} = c \quad (9)$$

Equilibrium profits and first period interest rate are given by

$$\Pi^* = \frac{1}{9}\lambda p_H \bar{s} - \sigma^*(1-\lambda)p_L I,$$
$$R_1^* = \frac{I - \lambda p_H \frac{1}{3}\bar{s} - \sigma^*(\lambda(1-p_H)(p_H Y - I) + (1-\lambda)p_L I - c)}{\lambda p_H + \sigma^*(1-\lambda)p_L}.$$

Proof. See the appendix. □

One interesting feature of proposition 2 is that banks make strictly positive profits in equilibrium. The intuition for this is as follows. As already mentioned, the presence of switching costs allows each bank to make positive profits in the second stage not only on its own clients but also on its rival's clients. In contrast to future rents on one's clients, future profits on the competitor's clients cannot be passed on to borrowers through lower rates in the first period. Future profits from poaching thus act as a form of "opportunity return" on funds, and price competition in the first stage drives down interest rates to the point where banks' profits on their clients are equal to future profits on their competitor's clients.

On the other hand, from the condition (9), we can obtain the equilibrium level of monitoring intensity for intermediate level of $c \in [\bar{c}_{\tau}, c_{\tau}]$.

$$\sigma^* = \frac{(1-\tau)(1-\lambda)p_L\left(I - \lambda p_H \frac{1}{3}\bar{s}\right) - (c - \lambda(1-p_H)(p_H Y - I))\lambda p_H}{(1-\lambda)p_L\left[(1-\tau)(1-\lambda)p_L + \tau(c - \lambda(1-p_H)(p_H Y - I))\right]}$$

From its first derivation on τ, we can easily check that this is a decreasing function of the level of securitization. In addition, we know that the two threshold level of c, that is, $\bar{c}_{\tau}$ and c_{τ} are decreasing in the level of securitization. We can obtain the following proposition.

Proposition 3. 1. *For intermediate level of monitoring cost* $c \in [\bar{c}_{\tau}, c_{\tau})$, *an increase in the level of securitization* (τ) *leads to*

   (a) *a decrease in the monitoring intensity in the equilibrium* (σ^*),
   (b) *an increase in equilibrium loan rate in the first period* (R_1^*)*and*
   (c) *an increase in equilibrium profits* (Π^*)*for all banks.*

2. *For low level of monitoring cost* $c < \bar{c}_{\tau}$, *a small increase in the level of securitization either has no effect on* σ^*, R_1^* *and* Π^*. *A sufficient increase in* τ *has the same effect as the case* $c \in [\bar{c}_{\tau}, c_{\tau})$.

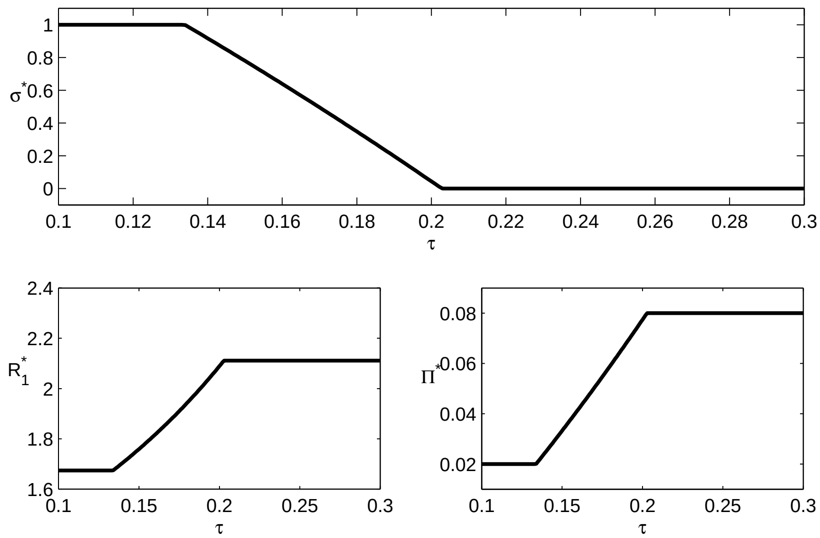

Figure 2: Effect of an increase in τ

3. *For high level of monitoring cost $c \geq c_\tau$, changes in the securitization level have no effects and banks never monitor.*

Proof. See the appendix. □

The intuition behind the proposition 3 is straightforward. As the level of securitization increases, the gain from monitoring in first period decreases. By more proportion of securitization, banks have to transfer more part of their monitoring gain in the first period to investors. This decreases the incentive of monitoring for banks.

However, as the level of securitization increases, the equilibrium interest rate in the first period and overall profits for banks increase in spite of the lower monitoring intensity in equilibrium. It is related to the mitigation of winner's curse problem in period 2. Monitoring creates an informational asymmetry between the first period lending bank and the external bank. If period-1 banks had monitored and learned the type of borrowers, they would not offer a loan to type L. Only external banks offer a loan to L type clientele that succeeded in period 1 (lucky L), which worsens the adverse selection problem when banks try to poach their rival's clients. Each bank would take all the lucky L type clientele of its rival. Inversely, banks are less affected by a rival's L type clientele when its rival monitors with less intensity. This effect renders poaching in period 2 more profitable and in turn, softens the competition in the first period. This leads to an increase in the loan rate in the first period and then an increase in overall profits in equilibrium. Figure 2 illustrates the abovementioned effect of an increase in securitization.

4. Discussion

4.1. Securitization and welfare

Proposition 3 shows that higher securitization can lead to higher equilibrium profits for banks. We now discuss the effect of an exogenous increase in securitization on total surplus In equilibrium, total surplus (S) can be expressed as[6]

$$\begin{aligned} S &= \lambda\left(p_H Y - I\right) + (1-\lambda)\left(\sigma^* p_L Y - I\right) - \sigma^* c \\ &\quad + \lambda\left[p_H\left(p_H Y - I - \frac{1}{18}\bar{s}\right) + (1-p_H)\,\sigma^*\left(p_H Y - I\right)\right] \\ &\quad + (1-\lambda)\left(1-\sigma^*\right)p_L\left(-\frac{1}{2}\bar{s} - I\right) \end{aligned}$$

The first line of S stands for the total surplus of the first period and the second and third line for those of the second period. The effect of securitization on welfare can be measured by

$$\begin{aligned} \frac{\partial S}{\partial \tau} &= \frac{\partial \sigma^*}{\partial \tau}\frac{\partial S}{\partial \sigma^*} \\ &= \frac{\partial \sigma^*}{\partial \tau}\left[\lambda\left(1-p_H\right)\left(p_H Y - I\right) + (1-\lambda)\,p_L\left(Y - I - \frac{1}{2}\bar{s}\right) - c\right] \end{aligned}$$

The effect of securitization on welfare is ambiguous. As we have analyzed, securitization always has a negative effect on the monitoring intensity in equilibrium for $\bar{c}_{\mathcal{T}} \leq c < c_{\mathcal{T}}$ and may have a negative effect for $c < \bar{c}_{\mathcal{T}}$ However, it is not clear whether a decrease in monitoring intensity drives down total surplus. Higher intensity of monitoring is always beneficial for type H-borrowers, as it allows more unlucky H-borrowers that default in the first period to finance their project in the second period. This benefit is captured in $\lambda\left(1-p_H\right)\left(p_H Y - I\right)$. However, there is a tradeoff in monitoring type L-borrowers. On the one hand, higher intensity of monitoring allows banks to control type L-borrowers in the first period, which generates a gain, $(1-\lambda)\,p_L Y$. On the other hand, at the same time, more intense monitoring leads external bank to finance more type L-borrowers that will fail certainly in the second period, incurring switching cost. This has a negative effect on the total surplus, $-(1-\lambda)\,p_L\left(I + \frac{1}{2}\bar{s}\right)$. When this L-borrower-go-around effect is not prevailing, the global effect of increase in the level of securitization on the welfare is negative. In this case, an increase in the overall profits for banks as a result of higher level of securitization comes to the detriment of welfare.[7] An increase in profits of banks is just derived

[6] In equilibrium, switching occurs for successful H type borrowers with switching costs below $s^* \equiv \frac{1}{3}\bar{s}$ and lucky type L. Overall switching costs for the former is given by $\int_0^{\frac{1}{3}\bar{s}} s ds = \frac{1}{18}\bar{s}$, and for the latter $\int_0^{\bar{s}} s ds = \frac{1}{2}\bar{s}$.

[7] In related theoretical analysis, Parlour and Plantin (2008) and Hakenes and Schnabel (2010) showed that securitization reduces banks' incentive to monitor their borrowers, and is harmful in terms of social welfare. Morrison (2005) demonstrated a similar result in the context of the use of CDS.

from the extraction of rent from borrowers. This is summarized in the following proposition.

Proposition 4. *When the L-borrower-go-around effect is not prevailing, an increase in the securitization level has a negative effect on welfare whereas it increases overall profits for banks. In that case, the increase in banks' profits is the result of pure extraction of rent from borrowers.*

4.2. Extension: endogenous securitization

Our analysis so far has illustrated the softening competition effect of an *exogenous* increase in securitization. The reduction in monitoring intensity across the board associated with securitization diminishes the importance of initial market shares which in turn results in higher interest rates and equilibrium profits.

We now illustrate how, under some conditions, this competition softening effect can be used strategically by banks to mitigate the impact of an exogenous increase in competition. Specifically, we show that an incumbent bank, A, can use its own level of securitization as a strategic tool to respond to entry on its market.

In the monopoly case, A clearly sets rate $R = Y$ on each loan he grants, and maximizes his profit by fully monitoring all borrowers ($\sigma = 1$).[8] Given that securitization can only reduce monitoring, it follows that securitization is never be used, and A earns monopoly profits

$$\Pi^{monopoly} \equiv \lambda \left(p_H Y - I\right) + \left(1-\lambda\right)\left(p_L Y - I\right) - c + \lambda \left(p_H Y - I\right) \tag{10}$$

Consider now the entry of a competitor, E, on A's market. To focus on A's strategic securitization decision, we assume that E has no monitoring ability,[9] and that switching from E to A in the second period entails no switching costs. The incumbent and entrant profits write, respectively

$$\Pi^A = \mu^A \left[\begin{array}{l} -I + \left(\lambda p_H + \hat{\sigma}_A \tau \left(1-\lambda\right) p_L\right) R_1^A \\ \quad +\sigma_A \left(-c + \bar{\pi}^{i/i} + \left(1-\tau\right)\left(1-\lambda\right) p_L R_1^i\right) + \left(1-\sigma_i\right)\pi^{i/i} \end{array} \right]$$

$$\Pi^E = \mu^E \left[\lambda p_H R_1^E - I\right] + \mu^A \tilde{\pi}^{i/j}\left(\hat{\sigma}_A\right).$$

The latter expression shows that the entrant will drive down its initial rate until its first period profit on a borrower equals the profit it can make by poaching

[8]To see this, note that the monopoly profit with no monitoring ($\sigma = 0$) is given by

$$\Pi^{monopoly} \equiv \lambda \left(p_H Y - I\right) - \left(1-\lambda\right) I + \lambda p_H \left(p_H Y - I\right).$$

Comparing with (10), the value of monitoring is given by $\left(1-\lambda\right) p_L Y + \lambda \left(1-p_H\right)\left(p_H Y - I\right)$, which is always higher than c by ass. (3).

[9]Note that this implies that securitization by E is irrelevant for the equilibrium, and thus can be ignored.

in the second period. In turn, the incumbent will engage in "limit pricing" by setting a rate just below to maximize its market share. We thus have

$$R_1 = \frac{1}{\lambda p_H}\left(I + \tilde{\pi}^{i/j}\left(\hat{\sigma}_A\right)\right) = \frac{1}{\lambda p_H}\left(I + \frac{1}{9}\lambda p_H \bar{s} - \hat{\sigma}_A\left(1-\lambda\right)p_L I\right). \tag{11}$$

In equilibrium, the monitoring decision of the incumbent is given by

$$\sigma^A = \begin{cases} 0 & \text{if } c > \bar{\pi}^{i/i} - \pi^{i/i} + (1-\tau)(1-\lambda)\,p_L R_1, \\ (0,1) & \text{if } c = \bar{\pi}^{i/i} - \pi^{i/i} + (1-\tau)(1-\lambda)\,p_L R_1, \\ 1 & \text{if } c < \bar{\pi}^{i/i} - \pi^{i/i} + (1-\tau)(1-\lambda)\,p_L R_1. \end{cases} \tag{12}$$

It is straightforward to check that together equations (11) and (12) pins down a unique equilibrium. As for the duopoly case, this equilibrium features a monitoring intensity which is decreasing in the level of securitization τ.[10] The softening competition effect of securitization is apparent in the property that the equilibrium (first period) rate is increasing in τ. This softening competition effect opens the possibility for the incumbent to use securitization as a response to entry, as stated in the following result.

Proposition 5. 1. *In the monopoly case, securitization is either irrelevant, or leads to a decrease in monitoring and profits. Hence, securitization is never used.*

2. *When faced with entry, there are cases where the incumbent bank can strictly increase its equilibrium profits by engaging in securitization. A sufficient condition for this is $\bar{\chi}_0 < c < \chi_0$, where*

$$\begin{aligned} \bar{\chi}_0 &= \lambda\left(1-p_H\right)\left(p_H Y - I\right) + \left(1-\lambda\right)p_L \frac{1}{\lambda p_H}\left(I + \frac{1}{9}\lambda p_H \bar{s} - \left(1-\lambda\right)p_L I\right), \\ \chi_0 &= \lambda\left(1-p_H\right)\left(p_H Y - I\right) + \left(1-\lambda\right)p_L \frac{1}{\lambda p_H}\left(I + \frac{1}{9}\lambda p_H \bar{s}\right). \end{aligned}$$

Proof. See Appendix. □

The intuition for proposition 5 is as follows. Involvement in securitization being observed by the entrant, the incumbent can use its securitization decision to signal a low(er) level of monitoring on its clients, and thus an increase in the (future) profit from poaching. This in turn reduces the competitive pressure from the entrant in the first period. Note that proposition 5 does not imply that complete securitization is optimal from the incumbent's viewpoint.

This provide a link between an (exogenous) increase in competition and the development of securitization as a strategic tool to mitigate the consequences of higher competition.[11] Hakenes and Schnabel (2010) also analyze the link

[10] See appendix: proof of proposition 3.

[11] Proposition 5 should not be interpreted as implying that empirically banks that securitize more should be more profitable. The result states that securitization can be used to attenuate the (negative) impact of higher competition on banks' profits.

between competition and securitization. They show that, when banks have limited risk-bearing capacity, a decrease in profits on profitable borrowers brought by intensified competition can lead banks to use securitization to expand their risk-bearing capacity.

4.3. Empirical implications

Our analysis, in particular proposition 3, suggests several testable empirical hypothesis: negative relationship between the level of securitization and monitoring intensity of banks, and positive relationship between the level of securitization and banks' profits. There are several examples of empirical evidence that support the negative relationship between securitization and monitoring intensity. Keys et al. (2010), Mian and Sufi (2009) and Purnanandam (2011) showed that securitization led to an inferior quality of loans, by analyzing US subprime mortgage loans. On the other hand, Berndt and Gupta (2009) and Gaul and Stebunovs (2009) demonstrated similar results on the link between loan sales and the loan performance in the corporate loan market. These empirical studies showed evidence that securitization and loan sales reduce the quality of loans, which can be considered as a proxy of monitoring intensity.

In the last two decades, the landscape of the banking sector has changed dramatically, following the liberalization and deregulation of the financial sector. In the United States, the Riegle-Neal Act of 1994 abolished the geographical barrier to entry between states.

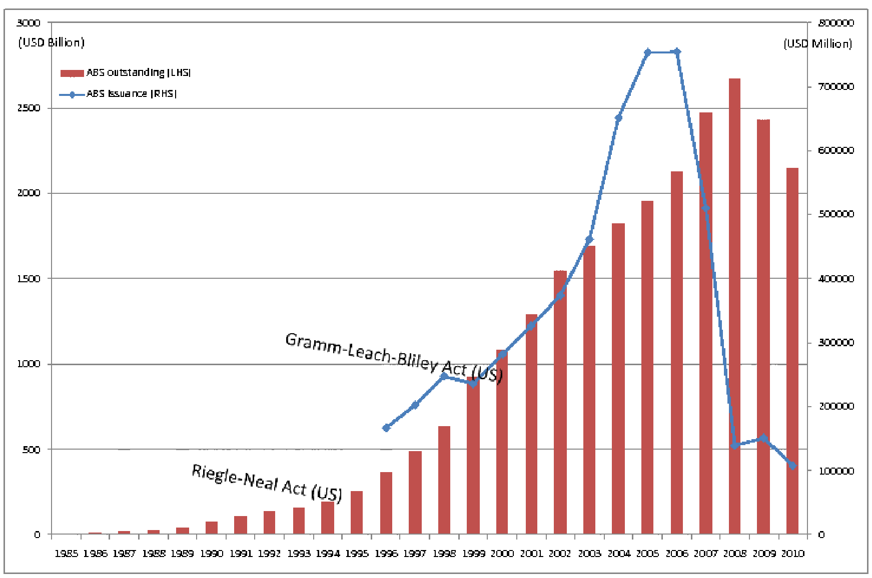

Figure 3: ABS market in the US (*Data: Gorton and Metrick (2011)*)

The Gramm-Leach-Bliley Act of 1999 terminated the separation between commercial banking and investment banking business. The EU area introduced the single banking license in 1993, thus enabling a bank that obtained a banking license in one member country to open branches in another member country

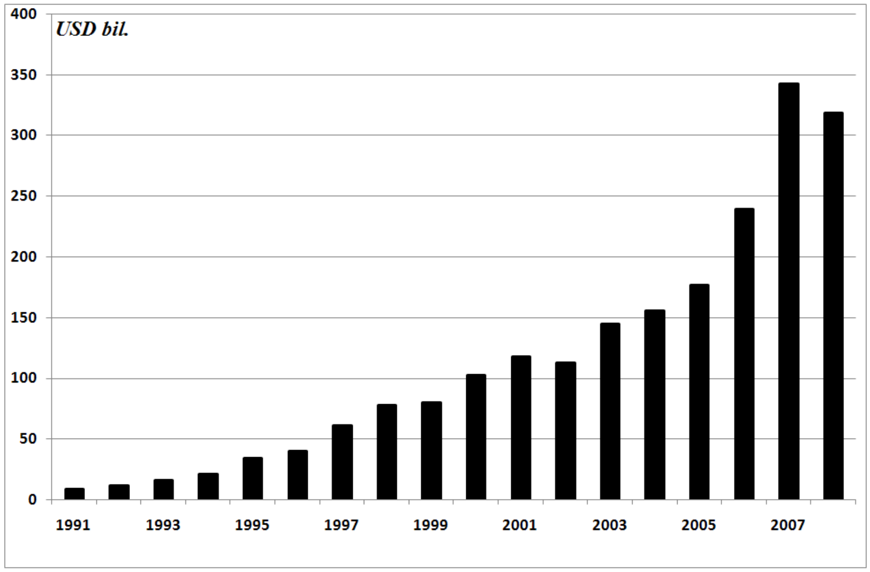

Figure 4: Single name loan sales in the US (*Data: Reuters LPC Traders Survey*)

without further permission. Interbank competition has thus dramatically increased, as several studies have noted. (See, for example, Boot and Schmeits, 2006.) During the same period, secondary markets for loans have increased remarkably in terms of securitization as well as in terms of single name loan sales (Figures 3 and 4. See also BIS (2003; 2008)). This phenomenon is even referred to as a shift in the banks' business model; in other words, from the "originate-to-hold" to the "originate-to-distribute" model (BIS, 2008, Buiter, 2007, Hellwig, 2008). These two parallel increases both in competition and in securitization during the same period fit well with the prediction of our analysis. According our analysis (proposition 5), an increase in securitization can be interpreted as a response by banks to fiercer competition in loan markets.

Our analysis also shed light on the recent crisis triggered from the sub-prime mortgage sector. Several analyses document particular increases in competition in this loan sector during the decade prior to the crisis (see for instance Ashcraft and Schuermann (2008) and Bernanke (2007)) - in part, the saturation of other traditional mortgage markets and the result of excess capacity in the lending industry. One important segment in this sub-prime loan market is the sector for new applicants without credit records, and new home owners who have no previous mortgage loan records (Hull, 2009). In spite of their low quality on average, as characterized by their low income and low wealth, this segment has been considered profitable, owing to the high level of housing prices until the first half of the 2000s. The official maturities of mortgage loans are very long, whereas one of the main practices observed in the sub-prime loan sector is the renegotiation of loan terms after a short period of initial rate, known as the teaser rate. On the other hand, borrowers themselves consider that they will switch their mortgage lender after this teaser rate period, if they find another lender that offers a more attractive loan contract. These observations (competition for borrowers without a credit record, second round competition after a short period) fit well with the environment that we have considered.

According to the prediction of our model, in this environment, securitization and the associated lower level of monitoring can be an equilibrium play. It is more profitable for banks not to monitor their loan applicants than to do so. This is because monitoring worsens the winner's curse effect when poaching the rival's clients after the teaser rate period and will therefore will intensify the competition for initial market share. Our analysis therefore offers an alternative explanation of three seemingly related empirical observations in this sub-prime loan market, and in particular the new loan applicant segment (Dell'Ariccia et al., 2008, Keys et al., 2009): Increasing competition, massive securitization, and a low level of monitoring.

4.4. Conclusion

We have analyzed the effect of the originate-to-hold model on strategic competition between banks. Using a dynamic loan market competition model where borrowers face both exogenous and endogenous costs to switch between banks, we have shown that securitization can lead to a decrease in the intensity of competition. This softening competition effect can explain how securitization can be associated with a decrease in loan market efficiency through reduced monitoring while leading to higher equilibrium profits for banks. This effect is driven by rent extraction in the primary loan market. not by the exploitation of informational asymmetries in the secondary market for loans. The analysis also suggests a link between an (exogenous) increase in competition and the development of securitization as a strategic tool to mitigate the consequences of higher competition.

Appendix A. Appendix: Proofs

Proof of proposition 1

Let $n_{\iota,\kappa}$denote the proportion of bank i's clientele with the first-period result $\kappa \in \{0, Y\}$and i's information on the type $\iota \in \{H, L, \varnothing\}$. Let also R_H, $R_\varnothing$ denote the loan offer to H that succeeded and $\varnothing$that succeeded respectively. We conjecture and verify later that they are same. The respective proportions in the bank i's clientele with i's monitoring intensity σ_i write

$$\begin{aligned} n_{\varnothing,Y} &= (1-\sigma_i)\,\lambda p_H, \\ n_{L,Y} &= \sigma_i\,(1-\lambda)\,p_L, \\ n_{H,Y} &= \sigma_i \lambda p_H, \\ n_{H,0} &= \sigma_i \lambda\,(1-p_H)\,. \end{aligned}$$

The bank i's profit on its clientele in the second period then writes

$$\begin{aligned} \Pi^{i/i} \quad = n_{H,0}\,(p_H Y - I) + \quad & n_{H,Y} \Pr\left[p_H\,(R_H - Q) < s\right](p_H R_H - I) \\ & + n_{\varnothing,Y} \Pr\left[p_H\,(R_\varnothing - Q) < s\right](p_H R_\varnothing - I) \end{aligned}$$

which yields the FOC w.r.t. R_H

$$(p_H R_H - I)\frac{\partial}{\partial R_H}\Pr\left[p_H(R_H - Q) \leq s\right] + p_H \Pr\left[p_H(R_H - Q) \leq s\right] = 0$$

where

$$\Pr\left[p_H(R_H - Q) \leq s\right] = \begin{cases} 1 & \text{if} \quad R_H \leq Q, \\ 1 - \frac{p_H(R_H - Q)}{\bar{s}} & \text{if} \quad Q < R_H < Q + \frac{\bar{s}}{p_H}, \\ 0 & \text{if } Q + \frac{\bar{s}}{p_H} \leq R_H. \end{cases}$$

The FOC thus gives

$$-\frac{p_H}{\bar{s}}(p_H R_H - I) + p_H\left(1 - \frac{p_H(R_H - Q)}{\bar{s}}\right) = 0$$

$$R_H = \frac{1}{2p_H}(I + \bar{s} + p_H Q).$$

Similarly, the FOC w.r.t. $R_\varnothing$ gives

$$-\frac{p_H}{\bar{s}}(p_H R_\varnothing - I) + p_H\left(1 - \frac{p_H(R_\varnothing - Q)}{\bar{s}}\right) = 0$$

The best response of bank i is thus

$$R_\varnothing = R_H = \frac{1}{2p_H}(I + \bar{s} + p_H Q) \qquad \text{(Appendix A.1)}$$

The competitor j's profit writes

$$\begin{aligned} \Pi^{j/i} &= n_{H,Y}\Pr\left[p_H(R_H - Q) > s\right](p_H Q - I) \\ &\quad + n_{\varnothing,Y}\Pr\left[p_H(R_\varnothing - Q) > s\right](p_H Q - I) - n_{L,Y} I \end{aligned}$$

Using $R_H = R_\varnothing$, this reduces to

$$\Pi^{j/i} = \left[n_{H,Y} + n_{\varnothing,Y}\right]\Pr\left[p_H(R - Q) > s\right](p_H Q - I) - n_{L,Y} I$$

which yields the FOC

$$\begin{aligned} \frac{\partial \Pi^{j/i}}{\partial Q} &= (p_H Q - I)\frac{\partial}{\partial Q}\frac{p_H(R - Q)}{\bar{s}} + p_H\frac{p_H(R - Q)}{\bar{s}} \\ &= -\frac{p_H}{\bar{s}}(p_H Q - I) + p_H\frac{p_H(R - Q)}{\bar{s}} \\ &= \frac{p_H}{\bar{s}}(I + p_H R - 2p_H Q) \end{aligned}$$

The FOC w.r.t Q thus writes

$$\frac{p_H}{\bar{s}}(I + p_H R - 2p_H Q) = 0$$

which implies that j's best response to i that offers R to i's clients,

$$Q = \frac{1}{2p_H}\left(p_H R + I\right) \qquad \text{(Appendix A.2)}$$

Using (Appendix A.1) and (Appendix A.2), equilibrium rates are given by

$$p_H R_2^* = I + \frac{2}{3}\bar{s},$$
$$p_H Q_2^* = I + \frac{1}{3}\bar{s}.$$

And equilibrium profits are given by

$$\begin{aligned}
\tilde{\pi}^{i/i}\left(\sigma_i\right) &= n_{H,0}\left(p_H Y - I\right) + \left[n_{H,Y} + n_{\varnothing,Y}\right]\Pr\left[p_H\left(R_2^* - Q_2^*\right) < s\right]\left(p_H R_2^* - I\right) \\
&= n_{H,0}\left(p_H Y - I\right) + \left[n_{H,Y} + n_{\varnothing,Y}\right]\frac{4}{9}\bar{s} \\
&= \sigma_i \lambda\left(1 - p_H\right)\left(p_H Y - I\right) + \lambda p_H \frac{4}{9}\bar{s}
\end{aligned}$$

$$\begin{aligned}
\tilde{\pi}^{j/i}\left(\sigma_i^e\right) &= \left[n_{H,Y} + n_{\varnothing,Y}\right]\Pr\left[p_H\left(R_H - Q\right) > s\right]\left(p_H Q - I\right) - n_{L,Y} I \\
&= \left[\sigma_i \lambda p_H + \left(1 - \sigma_i\right)\lambda p_H\right]\frac{1}{9}\bar{s} - \sigma_i\left(1 - \lambda\right) p_L I \\
&= \lambda p_H \frac{1}{9}\bar{s} - \sigma_i\left(1 - \lambda\right)\bar{p}_L I
\end{aligned}$$

Proof of proposition 2

Overall profits (8) can be written as

$$\Pi^i = \mu^i \left[\begin{array}{l} -I + \left(\lambda p_H + \sigma_i^e \tau\left(1 - \lambda\right) p_L\right) R_1^i + \\ +\sigma_i\left(-c + \bar{\pi}^{i/i} + \left(1 - \tau\right)\left(1 - \lambda\right) p_L R_1^i\right) + \left(1 - \sigma_i\right)\pi^{i/i} \end{array}\right] + \mu^j \tilde{\pi}^{i/j}\left(\sigma_j^e\right)$$

Define

$$\begin{aligned}
\rho^i \equiv\ & \left(\lambda p_H + \sigma_i^e \tau\left(1 - \lambda\right) p_L\right) R_1^i - I + \pi^{i/i} - \tilde{\pi}^{i/j}\left(\sigma_j^e\right) \\
& + \sigma_i\left(-c + \bar{\pi}^{i/i} - \pi^{i/i} + \left(1 - \tau\right)\left(1 - \lambda\right) p_L R_1^i\right)
\end{aligned}$$

Then equilibrium profits can be expressed as

$$\begin{aligned}
\Pi^A &= \mu^A \rho^A + \tilde{\pi}^{i/j}\left(\sigma^B\right), \\
\Pi^B &= \mu^B \rho^B + \tilde{\pi}^{i/j}\left(\sigma^A\right).
\end{aligned}$$

We first consider equilibria in which $\mu^A, \mu^B > 0$. Given borrowers' behavior, this requires that $R_1^A = R_1^B$. We thus have three subcases to distinguish, depending on whether

$$c \gtreqless \bar{\pi}^{i/i} - \pi^{i/i} + \left(1 - \tau\right)\left(1 - \lambda\right) p_L R_1^i.$$

Define $\hat{R}_1$ by

$$c = \bar{\pi}^{i/i} - \pi^{i/i} + (1-\tau)(1-\lambda) p_L \hat{R}_1.$$
$$\hat{R}_1 = \frac{1}{1-\tau} \frac{c - \lambda (1-p_H)(p_H Y - I)}{(1-\lambda) p_L}.$$

Subcase $R_1^* < \hat{R}_1$. Given the monitoring incentive constraint, $\sigma^A = \sigma^B = 0$, and this is perfectly expected by investors. Hence,

$$\rho^A = \rho^B = \lambda p_H R_1^* - I + \pi^{i/i} - \pi^{i/j}.$$

This must be equal to zero, otherwise one bank would make higher equilibrium profits by undercutting (raise its profit by $\frac{1}{2}\rho^i$).

$$\begin{aligned}
\lambda p_H R_1^* &= I - \pi^{i/i} + \pi^{i/j} \\
&= I - \lambda p_H \frac{4}{9}\bar{s} + \lambda p_H \frac{1}{9}\bar{s} \\
&= I - \lambda p_H \frac{1}{3}\bar{s}
\end{aligned}$$

$$R_1^* = \frac{I - \lambda p_H \frac{1}{3}\bar{s}}{\lambda p_H}$$

This is an equilibrium iff $R_1^* < \hat{R}_1$, that is...

$$\frac{I - \lambda p_H \frac{1}{3}\bar{s}}{\lambda p_H} < \frac{1}{1-\tau} \frac{c - \lambda (1-p_H)(p_H Y - I)}{(1-\lambda) p_L}$$

$$c > c_\tau \equiv \lambda (1-p_H)(p_H Y - I) + (1-\tau)(1-\lambda) p_L \frac{1 - \lambda p_H \frac{1}{3}\bar{s}}{\lambda p_H}$$

Subcase $R_1^* > \hat{R}_1$. Given the monitoring incentive constraint, $\sigma^A = \sigma^B = 1$, and this is perfectly expected by investors. Hence,

$$\rho^A = \rho^B = (\lambda p_H + \sigma_i^e \tau (1-\lambda) p_L) R_1^* - I + \bar{\pi}^{i/i} - \bar{\pi}^{i/j} - c = 0$$

This must be equal to zero, otherwise one bank would make higher equilibrium profits by undercutting (raise its profit by $\frac{1}{2}\rho^i$).

$$\begin{aligned}
(\lambda p_H + (1-\lambda) p_L) R_1^* &= I - \bar{\pi}^{i/i} + \bar{\pi}^{i/j} + c \\
&= I - \lambda p_H \frac{1}{3}\bar{s} \\
&\quad - \lambda (1-p_H)(p_H Y - I) - (1-\lambda) p_L I + c
\end{aligned}$$

$$R_1^* = \frac{I - \lambda p_H \frac{1}{3}\bar{s} - \lambda (1-p_H)(p_H Y - I) - (1-\lambda) p_L I + c}{\lambda p_H + (1-\lambda) p_L}$$

This is an equilibrium iff $R_1^* > \hat{R}_1$, that is

$$R_1^* > \frac{1}{1-\tau} \frac{c - \lambda (1-p_H)(p_H Y - I)}{(1-\lambda) p_L}$$

$$c < \bar{c}_\tau \equiv \lambda\left(1-p_H\right)\left(p_H Y - I\right) + \left(1-\tau\right)\left(1-\lambda\right)p_L \frac{I - \lambda p_H \frac{1}{3}\bar{s} - \left(1-\lambda\right)p_L I}{\lambda p_H + \tau\left(1-\lambda\right)p_L}$$

Subcase $R_1^* = \hat{R}_1$. Both banks have interior, possibly different monitoring intensities. Plugging $\hat{R}_1$ into R_1^*,

$$\begin{aligned}
\rho^A &= \left(\lambda p_H + \sigma_A^e \tau\left(1-\lambda\right)p_L\right)\hat{R}_1 - I + \pi^{i/i} - \tilde{\pi}^{i/j}\left(\sigma_B^e\right), \\
\rho^B &= \left(\lambda p_H + \sigma_B^e \tau\left(1-\lambda\right)p_L\right)\hat{R}_1 - I + \pi^{i/i} - \tilde{\pi}^{i/j}\left(\sigma_A^e\right).
\end{aligned}$$

The undercutting argument also implies that $\rho^A = \rho^B = 0$. (*i.e.*, the bank with $\rho^i > 0$ would make a strictly higher profits by undercutting). Now, this implies that

$$\left(\sigma_A^e - \sigma_B^e\right)\tau\left(1-\lambda\right)p_L\hat{R}_1 = \tilde{\pi}^{i/j}\left(\sigma_B^e\right) - \tilde{\pi}^{i/j}\left(\sigma_A^e\right)$$

In equilibrium $\sigma^e = \sigma = \sigma^*$.

$$\left(\sigma_A - \sigma_B\right)\left(1-\lambda\right)\tau p_L\hat{R}_1 = \left(\sigma_A - \sigma_B\right)\left(1-\lambda\right)p_L I$$

In general, $\left(1-\lambda\right)\tau p_L\hat{R}_1 \neq \left(1-\lambda\right)p_L I$. Hence $\sigma_A = \sigma_B$. Now, the equilibrium strategy is characterized by $\rho\left(\sigma^*, \hat{R}_1\right) = 0$.

$$\left(\lambda p_H + \sigma^*\tau\left(1-\lambda\right)p_L\right)\hat{R}_1 - I + \pi^{i/i} - \tilde{\pi}^{i/j}\left(\sigma^*\right) = 0$$

$$\lambda\left(1-p_H\right)\left(p_H Y - I\right) + \left(1-\tau\right)\left(1-\lambda\right)p_L \frac{I - \lambda p_H\frac{1}{3}\bar{s} - \sigma^*\left(1-\lambda\right)p_L I}{\lambda p_H + \sigma^*\tau\left(1-\lambda\right)p_L} = c$$

which gives a unique σ^*

$$\sigma^* = \frac{\left(1-\tau\right)\left(1-\lambda\right)p_L\left(I - \lambda p_H\frac{1}{3}\bar{s}\right) - \left(c - \lambda\left(1-p_H\right)\left(p_H Y - I\right)\right)\lambda p_H}{\left(1-\lambda\right)p_L\left[\left(1-\tau\right)\left(1-\lambda\right)p_L + \tau\left(c - \lambda\left(1-p_H\right)\left(p_H Y - I\right)\right)\right]}$$

$\sigma^* \in [0,1]$ iff $\rho\left(\sigma = 1\right) > 0$ and $\rho\left(\sigma = 1\right) < 0$. That is

$$\left(\lambda p_H + \left(1-\lambda\right)p_L\right)\hat{R}_1 - I + \lambda p_H\frac{1}{3}\bar{s} + \lambda\left(1-p_H\right)\left(p_H Y - I\right) + \left(1-\lambda\right)p_L I - c > 0$$

and

$$\lambda p_H\hat{R}_1 - I + \lambda p_H\frac{1}{3}\bar{s} < 0$$

Substituting $\hat{R}_1$, these conditions gives the same upper and lower threshold on c, in other words $c \in [\bar{c}_\tau, c_\tau]$.

Proof of proposition 3

Case 1: $\bar{c}_\tau \leq c < c_\tau$.

Proof $\frac{\partial\sigma^*}{\partial\tau} < 0$. Let D denote the denominator of σ^* and put $K = c - \lambda\left(1-p_H\right)\left(p_H Y - I\right)$.

$$\frac{\partial\sigma^*}{\partial\tau} = -\frac{\lambda p_H\left(1-\lambda\right)p_L}{D^2}\left[\lambda\left(1-p_H\right)\left(p_H Y - I\right) + \frac{I - \lambda p_H\frac{1}{3}s}{\lambda p_H} + 1 - c\right]$$

$\frac{\partial \sigma^*}{\partial \tau} < 0$ as far as $c < \lambda (1 - p_H)(p_H Y - I) + \frac{I - \lambda p_H \frac{1}{3} s}{\lambda p_H} + 1 \equiv \hat{c}$. As we can check easily $c_{\tau=0} < \hat{c}$, $\frac{\partial \sigma^*}{\partial \tau} < 0$ for all $c \in [\bar{c}_\tau, c_\tau]$.

Proof $\frac{\partial R_1^*}{\partial \tau} > 0$.

$$\begin{aligned}
\frac{\partial R_1^*}{\partial \tau} &= \frac{\partial R_1^*}{\partial \sigma^*} \frac{\partial \sigma^*}{\partial \tau} \\
&= -\left[\lambda (1 - p_H)(p_H Y - I) + (1 - \lambda) p_L I - c\right] \frac{\partial \sigma^*}{\partial \tau}
\end{aligned}$$

This is positive for all $c \in [\bar{c}_\tau, c_\tau]$ because $\lambda (1 - p_H)(p_H Y - I) + (1 - \lambda) p_L I - c > 0$ by the condition (3) and $\frac{\partial \sigma^*}{\partial \tau} < 0$.

Proof $\frac{\partial \Pi^*}{\partial \tau} > 0$.

$$\begin{aligned}
\frac{\partial \Pi^*}{\partial \tau} &= \frac{\partial \Pi^*}{\partial \sigma^*} \frac{\partial \sigma^*}{\partial \tau} \\
&= -(1 - \lambda) p_L I \frac{\partial \sigma^*}{\partial \tau}
\end{aligned}$$

This is positive for all $c \in [\bar{c}_\tau, c_\tau]$ because $\frac{\partial \sigma^*}{\partial \tau} < 0$.

Case 2: $c < \bar{c}_\tau$. $\bar{c}_\tau$ is decreasing in τ. Let $\tau' (< \tau)$ denote new level of securitization. A decrease in the level of securitization from τ to τ' leads to a decrease in $\bar{c}_\tau$ to $\bar{c}_{\tau'}$. When $c > \bar{c}_{\tau'}$, it becomes the same case as the case 1 and there will be a decrease in $\sigma^*$and an increase in R_1^*, Π^*. When $c \leq \bar{c}_{\tau'}$, the equilibrium level of monitoring intensity remains unchanged in 1. A decrease in the level of securitization has no effect on equilibrium interest rate in the first period nor overall profits.

Case 3: $c \geq c_\tau$. $c > c_{\tau'}$ because $c_{\tau'} < c_\tau$. The equilibrium intensity level of monitoring σ^*remains 0. A decrease in the level of securitization has no effect.

Proof of proposition 5

We first discuss the property of the solution (σ, R) to the system (11) and (12). Plugging the expression (11) for R into (12) shows that there is a unique equilibrium, which is characterized by:

- $\sigma^* = 0$ if $c > \bar{\pi}^{i/i} - \pi^{i/i} + (1 - \tau)(1 - \lambda) p_L \frac{1}{\lambda p_H} \left(I + \frac{1}{9} \lambda p_H \bar{s}\right) \equiv \chi_0$,
- $\sigma^* = 1$ if
$$c < \bar{\pi}^{i/i} - \pi^{i/i} + (1 - \tau)(1 - \lambda) p_L \frac{1}{\lambda p_H} \left(I + \frac{1}{9} \lambda p_H \bar{s} - (1 - \lambda) p_L I\right) \equiv \bar{\chi}_0,$$
- and, for intermediate values of c, σ^* is the unique solution to
$$c = \bar{\pi} - \pi^{i/i} + (1 - \tau)(1 - \lambda) p_L \frac{1}{\lambda p_H} \left(I + \frac{1}{9} \lambda p_H \bar{s} - \sigma (1 - \lambda) p_L I\right).$$

It is straightforward to see from this that σ^* is non increasing in τ, and decreasing in the intermediate case.

To prove proposition 5, it is sufficient to show that A can obtain with some $\tau > 0$ a profit which is strictly higher than what with $\tau = 0$. From (12), under the condition $\bar{\chi}_0 < c < \chi_0$, the equilibrium monitoring in the absence of securitization ($\tau = 0$) is characterized by $0 < \sigma_{\tau=0} < 1$. Now, for the intermediate case, the incumbent profit writes

$$\Pi^A = \ -I + (\lambda p_H + \sigma_A \tau (1-\lambda) p_L) R_1^A + \pi^{i/i} \ .$$

The incumbent's profits for $\tau = 0$ is thus simply

$$\Pi^A_{\tau=0} = \ -I + \lambda p_H R_1 (\sigma_{\tau=0}) + \pi^{i/i} \ .$$

Consider now a strictly positive securitization level, $\bar{\tau} > 0$. The associated equilibrium monitoring is such that $\sigma_{\bar{\tau}} < \sigma_{\tau=0}$. Using the expression for the incumbent's profit and the optimal monitoring choice (12), one can find a lower bound for

$$\begin{aligned}\Pi^A_{\bar{\tau}} &\geq \quad -I + (\lambda p_H + \sigma_{\bar{\tau}} \bar{\tau} (1-\lambda) p_L) R_1^A (\sigma_{\bar{\tau}}) + \pi^{i/i} \ , \\ &\geq \ \sigma_{\bar{\tau}} \bar{\tau} (1-\lambda) p_L R_1^A (\sigma_{\bar{\tau}}) + \lambda p_H \left(R_1^A (\sigma_{\bar{\tau}}) - R_1 (\sigma_{\tau=0}) \right) + \Pi^A_{\tau=0}.\end{aligned}$$

But, using $\sigma_{\bar{\tau}} < \sigma_{\tau=0}$ and the fact that $R_1(\sigma)$ is a strictly decreasing function of σ, this implies that $\Pi^A_{\bar{\tau}} > \Pi^A_{\tau=0}$.

References

Acharya, Viral, Philipp Schnabl and Gustavo Suarez (2010), Securitization without risk transfer. Working parper, NewYork University.

Allen, F. and E. Carletti (2006), 'Credit risk transfer and contagion', *Journal of Monetary Economics* **53**(1), 89–111.

American Securitization Forum, Securities Industry and Financial Markets Association, Australian Securitisation Forum and European Securitisation Forum (2008), Restoring confidence in the securitisation markets.

Ashcraft, Adam B. and Til Schuermann (2008), Understanding the securitization of subprime mortgage credit, Staff Reports 318, Federal Reserve Bank of New York.

Barone, Guglielmo, Roberto Felici and Marcello Pagnini (2011), 'Switching costs in local credit markets', *International Journal of Industrial Organization* **29**(6), 694 – 704.

Bernanke, Ben (2007), The subprime mortgage market, Speech at the Federal Reserve Bank of Chicago's 43rd Annual Conference on Bank Structure and Competition (Chicago, Illinois). Available at http://www.federalreserve.gov/newsevents/speech/bernanke20070517a.htm.

Berndt, Antje and Anurag Gupta (2009), 'Moral hazard and adverse selection in the originate-to-distribute model of bank credit', *Journal of Monetary Economics* **56**(5), 725–743.

Bhattacharya, S. and A. V. Thakor (1993), 'Contemporary banking theory', *Journal of Financial Intermediation* **3**(1), 2–50.

BIS (2003), Credit risk transfer, Report, Basel Committee on the Global Financial System.

BIS (2008), Credit risk transfer: Developments from 2005 to 2007, Joint forum report, Basel Committee on Banking Supervision.

Boot, A. and A. Schmeits (2006), 'The competitive challenge in banking', *in L. Renneboog ed., Advances in Corporate Finance and Asset Pricing* pp. 133–160.

Boot, A. and A. Thakor (2000), 'Can relationship banking survive competition', *Journal of Finance* **55**(2), 679–713.

Bouckaert, J. and H. Degryse (2004), 'Softening competition by inducing switching in credit markets', *Journal of Industrial Economics* **52**(1), 27–52.

Buiter, W. (2007), 'Lessons from the 2007 financial crisis', *CEPR Policy Insight* (18).

Calomiris, C. and J. Mason (2004), 'Credit card securitization and regulatory arbitrage', *Journal of Financial Services Research* **26**, 5–28.

Carlstrom, C. and K. Samolyk (1995), 'Loan sales as a response to market-based capital constraints', *Journal of Banking and Finance* **19**(3-4), 627–646.

Dell'Ariccia, Giovanni, Deniz Igan and Luc Laeven (2008), Credit booms and lending standards: Evidence from the subprime mortgage market, Discussion Papers 6683, C.E.P.R.

Duffee, G. and C. Zhou (2001), 'Credit derivatives in banking: Useful tools for managing risk?', *Journal of Monetary Economics* **48**(1), 25–54.

ECB (2008), The incentive structure of the 'originate and distribute' model.

European Parliament (2009), Report on the proposal for a directive of the European Parliament and of the Council amending Directives 2006/48/ec. Session document A6-0139/2009.

Franke, G. and J. P. Krahnen (2008), The future of securitization, Working papers 2008/31, CFS.

Gaul, L. and V. Stebunovs (2009), Ownership and asymmetric information problems in the corporate loan market: Evidence from a heteroskedastic regression. OCC Economics Working Paper 2009-1, Office of the Comptroller of the Currency.

Gehrig, T. and R. Stenbacka (2007), 'Information sharing and lending market competition with switching costs and poaching', *European Economic Review* **51**, 77–99.

Gorton, G and A. Metrick (2011), Securitization. mimeo.

Gorton, G. and G. Pennacchi (1995), 'Banks and loan sales: Marketing nonmarketable assets', *Journal of Monetary Economics* **35**(3), 389–411.

Hakenes, H. and I. Schnabel (2010), 'Credit risk transfer and bank competition', *Journal of Financial Intermediation* **19**(3), 308–332.

Hauswald, R. and R. Marquez (2006), 'Competition and strategic information acquisition in credit markets', *Review of Financial Studies* **19**(3), 967–1000.

Hellwig, M. (2008), Systemic risk in the financial sector: An analysis of the subprime-mortgage financial crisis, Preprints 2008/43, the Max Planck Institute for Research on Collective Goods Bonn. available at http://www.coll.mpg.de/pdf_dat/2008_43online.pdf.

Holmstrom, B. and J. Tirole (1997), 'Financial intermediation, loanable funds, and the real sector', *The Quarterly Journal of Economics* **112**(3), 663–691.

Hull, John (2009), *Risk Management and Financial Institutions*, 2nd edn, Pearson.

Keys, B., T. Mukherjee, A. Seru and V. Vig (2009), 'Financial regulation and securitization: evidence from subprime loans', *Journal of Monetary Economics* **56**(5), 700–720.

Keys, B., T. Mukherjee, A. Seru and V. Vig (2010), 'Did securitization lead to lax screening? evidence from subprime loans', *Quarterly Journal of Economics* **125**(1), 307–362.

Kim, M., D. Kliger and B. Vale (2003), 'Estimating switching costs and oligopolistic behavior', *Journal of Financial Intermediation* **12**(1), 25–56.

Mian, Atif and Amir Sufi (2009), 'The consequences of mortgage credit expansion: Evidence from the 2007 mortgage default crisis', *Quarterly Journal of Economics* **124**(4), 1449–1496.

Morrison, A. (2005), 'Credit derivatives, disintermediation, and investment decisions', *The Journal of Business* **78**(2), 621–648.

Nicolo, A. and L. Pelizzon (2008), 'Credit derivatives, capital requirements and opaque OTC markets', *Journal of Financial Intermediation* **17**(4), 444–463.

Parlour, C. and G. Plantin (2008), 'Loan sales and relationship banking', *Journal of Finance* **63**(3), 1291–1314.

Parlour, Christine and Andrew Winton (2008), Laying off credit risk: Loan sales versus credit default swaps. mimeo.

Peterson, M. and R. Rajan (1995), 'The effect of credit market competition on lending relationships', *The Quarterly Journal of Economics* **110**(2), 407–443.

Purnanandam, A. K. (2011), 'Originate-to-distribute model and the sub-prime mortgage crisis', *Review of Financial Studies* **24**(6), 1881–1915.

Stango, V. (2002), 'Pricing with consumer switching costs: Evidence from the credit card market', *Journal of Industrial Economics* **50**(4), 475–492.

Wagner, G. and I. Marsh (2006), 'Credit risk transfer and financial sector stability', *Journal of Financial Stability* **2**(2), 173–193.