Securitization and Bank Efficiency

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Abstract

We examine whether loan securitization has an impact on bank efficiency. Using a sample of large US commercial banks from 2002 to 2012, we find that bank loan securitization has a significant and positive impact on bank efficiency, and this relationship is stronger for banks with higher capital ratios, higher default risk, and lower level of liquidity and diversification. Our results are robust to Heckman self-selection correction and difference-in-difference (DID) analysis. In addition, these results are found mainly in non-mortgage loan securitizations but not in mortgage loan securitizations. Finally, we show that loan sales also have a positive impact on bank efficiency.

Keywords

- Securitization
- Bank efficiency
- Heckman self-selection
- Difference-in-difference
- Liquidity and diversification

- Loan sales
- Financial crisis

Citation

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1 Introduction

In the last two decades, securitization has dramatically changed the way banks provide liquidity. While it is still debatable on the role of securitization in contribution to the risk of financial markets, it is a general belief that loans have become more liquid and the efficiency of the whole financial market has increased because the credit supply relies less on banks' financial conditions (Loutskina & Strahan, 2009). It is less clear, however, that this change of the special role of banks through securitization has any positive impact on a bank's efficiency.

The effect of bank securitization on bank economic outcomes is ambiguous. On the one hand, the perceived benefits of bank securitization have been widely documented, which include risk sharing (Benveniste & Berger, 1987; Berger, Herring, & Szego, 1995), reducing banks' cost of capital (Pennacchi, 1988) and liquidity increase (Loutskina, 2011). In addition, a bank can use loan securitization to achieve optimal assets and geographic diversification (Berger & DeYoung, 2001; Hughes, Lang, Mester, & Moon, 1999). These channels provide banks with better risk-management tools so that banks are in turn less restricted to traditional sources of funds (Billet & Garfinkel, 2004). Bank efficiency is thus increased with the increased use of securitization. This argument is also consistent with the recent empirical findings that securitization decreases bank risk (Cebenoyan & Strahan, 2004, B) and increases bank profitability (Casu, Clare, Sarkisyan, & Thomas, 2013; Jiang, Nelson, & Vytlacil, 2014).

On the other hand, however, securitization may have negative impact on a bank's efficiency. The initiation of a securitization process requires substantial upfront costs such as legal fees and agent commissions, and additional financial burden has been proved to be inefficient by Lozano-Vivas and Pasiouras (2010). Meanwhile, securitization increases the information transparency between originators and investors, which allows originating banks to take advantage of private information to reduce their efforts in screening borrowers and monitoring loans (Keys, Mukherjee, Seru, & Vig, 2010). Although issuers are in turn able to hide potential risk and securitize bad assets as good ones, a bank's efficiency can be jeopardized by the increased financing costs due to the consistent mispricing of securities in the market (Pagano & Volpin, 2012). Brown, Carlin, and Lobo (2010) model also reveals that such assets with higher degrees of information asymmetry will suffer difficulties in liquidation, which can prevent securitizers from efficient performance. See also Bhardwaj (2021) and Bhardwaj, John, and Mukherjee (2021).

It is unclear that the result of these competing forces can be efficiency gain or lose for a securitizing bank. Given the theoretical ambiguity, the effect of bank securitization on efficiency remains an open question that we investigate in this chapter.

We study the impact of loan securitization on bank efficiency using the dataset including large commercial banks in the United States during the period from 2002 to 2012. We find the involvement of securitization increases bank's efficiency, as measured by the data envelopment analysis (DEA) model. The economic impact is also meaningful. A one-standard-deviation increase of total securitization is associated with a 9.23% increase in the standard deviation of bank's efficiency scores.

To identify the casual impact of securitization on bank efficiency, we first employ the Heckman self-selection model to address the possible self-selection problem, i.e., more efficient banks are more likely to securitize. We employ three exogenous instruments here. The first instrument is the *state-level corporate tax rate*. It is a valid instrument because the corporate tax exemption of securitized assets can increase a bank's securitization incentive (Han, Park, & Pennacchi, 2015). The second instrument is a bank's *peer liquidity index*, which is developed from Loutskina's (2011) *liquidity index*. Since *liquidity index* captures a bank's incentive to securitize assets, the *peer liquidity index* thus can capture a bank's incentive to securitize assets caused by the herd effect (Chari & Kehoe, 2004). We also use the interaction of the first two instruments to capture both a bank-specific securitization incentive and a state-level “average” incentive of securitization.

Second, we use a Difference-in-Difference (DID) approach to explore the association between the changes in securitization ratios and bank's efficiency scores. Following Brunnermeier, Dong, and Palia (2020), we use the bankruptcy of

Lehman Brothers in September 2008 as a source of exogenous variation. The bankruptcy of Lehman Brothers triggered a sudden dried-up of secondary market liquidity, which impacts more significantly on securitized banks (Gorton & Metrick, 2012) relative to nonsecuritized banks. We verify that the differences in bank efficiency between securitized and nonsecuritized banks are reduced in the post Lehman Brothers bankruptcy period.

Our first concern of the DID results is the potential reverse causality problem, that the results are not driven by the exogenous shock but the choice of the shock year. Considering that securitized assets are information sensitive (Manconi, Massa, & Yasuda, 2012), the liquidity dried-up in the securitization market is more likely to be obvious after the announcement of the bankruptcy of Lehman Brothers. Therefore, we conduct a falsification test to falsely assume the exogenous shock to be in 2007 and 2006, respectively. If our results reflect the treatment effect, our results should disappear in the falsification test.

Another concern of the above DID estimation is the impact of the financial shock on securitizers can be dispersed around the event year. Therefore, following Chemmanur, He, and Nandy (2014), we conduct an analysis to reflect the dynamics of securitizers' efficiency changes five years before and five years after the 2008 financial shock. The aim is to capture residual changes in securitizers' efficiency scores in order to reflect the impact of securitization. Our results show that the gap between efficiency scores of securitizers and nonsecuritizers was positive before 2008 and reached the peak in 2007, but this gap was negative after the exogenous shock. Both tests support our main results and the DID regression findings.

We argue that the efficiency improving effects of securitization may be related to the increase of flexibility and diversification. To shed on more light on this argument, we explore cross-variations between securitization ratio and bank-specific characteristics including capital ratio, bank risk, liquidity ratio, and diversification ratio. We find that the impact of loan securitization on bank efficiency is more significant for banks with higher capital ratios, lower Z-scores, lower level of liquidities, and diversification.

We also find a significant impact of nonmortgage securitization ratio on bank efficiency but not for mortgage securitization. These results reflect the fact that mortgage loans are backed by real estates, the values of which are not easily depreciated (Campbell & Cocco, 2015), and are thus expected to be safer compared with nonmortgage loans. Securitizing nonmortgage loans is hence considered as a more efficient risk transferring.

Finally, we find a similar positive impact of loan sales on bank efficiency. In practice, banks may choose loan sales rather than securitization to pursue higher flexibility and diversification. Loan sales involve the totality of an originated loan

(Gorton & Haubrich, 1990) and are affected without recourse (Greenbaum & Thakor, 1987). Thus, loan sales can also reduce banks risk by separating the ownership of riskier assets from their balance sheet (Berger & Udell, 1993).

We conclude that, overall, bank efficiency benefits from loan securitization. This result is especially true for banks with higher capital ratios, higher level of default risk, and lower level of diversification, who are more likely to benefit from the positive impact of bank securitization.

Research on the determinants of bank efficiency has gained interests in recent years. Negative impact of bank risk and the cost of capital on bank efficiency is identified by the theoretical frameworks of Delis, Iosifidi, and Tsionas (2017) and Wanke, Barros, and Emrouznejad (2016). Higher level of flexibility to allocate inputs is found to be positively related to the increase of bank efficiency (Tsionas & Mamatzakis, 2017). Berger and Bouwman (2013) argues that the development of a larger single market for financial services in Europe is not significantly associated with efficiency increase. Our research contributes to the growing literature on bank efficiency by linking such theoretical frameworks to the practical case of securitization.

The results of our paper have also extensive implications for regulators and practitioners. The positive impact of securitization, particularly the impact of nonmortgage loan securitization on bank efficiency, provides evidence on the bright side of securitization. Securitization has been blamed for being one of the main triggers of the 2007–2009 financial crisis because it deteriorates loan quality in the subprime mortgage market (Ghent, 2011; Piskorski, Seru, & Vig, 2010). However, impeding the development of securitization may not be the right strategy to prevent a similar crisis in the future because a less developed securitization market may not be able to supply sufficient credit to the market, and exacerbates real shocks in financial markets (Holmstrom & Tirole, 1997).

In Section 2, we describe our dataset and empirical strategy. Section 3 shows the main results. Section 4 presents additional analysis and Section 5 concludes.

2 Data and Variables

2.1 Data

We start with collecting all annual accounting data from the Reports of Income and Condition for commercial banks (the Call Report) in the period of 2002–2012. Our sample starts from 2002 because US banks are required to provide detailed information on their securitization activities from June 2001. Following Bedendo and Bruno (2012), we drop small banks (with total assets under $1 billion) in the sample because they are rare securitizers due to the substantial upfront costs. Our final sample consists of 863 large commercial banks in the United States, including

150 securitizers and 713 nonsecuritizers, accounting for a total of 5,275 bank-year observations.

2.2 Variables

2.2.1 Bank Efficiency

We use the data envelopment analysis (DEA) model to estimate bank's efficiency scores.[1] The outputs of the banking industry are arguably more likely to be determined by the market (see e.g., Kumbhakar & Tsionas, 2006; Miller & Noulas, 1996; Topuz, Darrat, & Shelor, 2005). We thus apply an input-oriented data envelopment analysis model using the intermediation approach. We assume that banks use three types of inputs: (1) customer deposits and short-term funding; (2) total costs, defined as the sum of interest expenses and noninterest expenses; and (3) equity capital to adequately account for the impact of risk, to produce the following outputs: (1) loans; (2) other earning assets; and (3) noninterest income as a proxy for off-balance sheet activities.[2]

In general, a DEA model estimates efficiency scores from a production set as follows:

(1)

$$P=\{INPUT,OUTPUT\}$$

The technology frontier is therefore defined as:

$$PT=\{(INPUT,OUTPUT)|(INPUT,OUTPUT)\in P,(\sigma INPUT,\sigma-1OUTPUT)\notin P,\forall 0<\sigma<1\}$$

This is then used to estimate a bank's input technical efficiency:

(2)

$$\delta INPUT(INPUTi,OUTPUTi)\equiv inf\{\sigma>0|(\sigma INPUTi,OUTPUTi)\in PT$$

A bank's technical efficiency represents the proportion by which input quantities can feasibly be reduced without reducing output quantities. Bank efficiency scores are measured relative to a common frontier by pooling the data across individuals estimated separately for each year. Bank efficiency scores range from zero to one, with a higher value indicating a higher level of efficiency.

2.2.2 Independent Variables

We use the *securitization ratio* (defined as the ratio of outstanding principal balance of assets securitized over total assets) to represent a bank's securitization activity. The signaling theory suggests providing credit enhancements could improve securitizers' managerial efforts (Downing, Jaffee, & Wallace, 2009). We thus use the *retained interest ratio* to control for bank's credit enhancement

situation. *Retained interest ratio* is defined as the total amount of retained interest divided by the total amount of securitization assets, including the aggregate retained interests into credit enhancements, liquidity provisions, and seller's interest.

We also control for a group of bank-specific characteristics. *Bank size* is measured by the natural logarithm of total assets. The impact of bank size on bank efficiency could be positive, as larger firms are expected to use better technology and be more diversified and better managed. However, a negative effect may be observed in situations where there will be a loss of control resulting from inefficient hierarchical structures in the management of the company. *Diversification ratio*, defined as noninterest income divided by total operating income, controls for a bank's portfolio diversification. Conventional finance theory suggests that risk-adjusted returns are higher for a well-diversified portfolio, which can in turn increase bank efficiency (Rossi, Schwaiger, & Winkler, 2009). *Liquidity ratio*, measured as liquid assets divided by total assets, controls for banks' liquidity situation. Higher liquidity can give banks more flexibility, which can increase efficiency (Jensen, 1986; Myers & Rajan, 1998). *Noninterest expense ratio* is defined as noninterest expenses divided by total assets. Noninterest expenses are usually not associated with targeting customers to deposit funds, which may decrease bank efficiency. *Nonperforming loans ratio* is the total value of loans 90 days past due divided by total assets, reflecting the bank's risk management situation. Berger and DeYoung (1997) provide evidence to show that problem loans significantly reduce bank efficiency. *Local-market power* is the bank-level Herfindahl-Hirschman Index of deposit concentration for local markets in which the bank operates (Berger & Bouwman, 2013). All variable definitions are reported in Appendix 1.

2.3 Descriptive Statistics

Table 1 shows summary statistics (means, medians, and standard deviations (SDs)) on all variables for securitizers and nonsecuritizers. We also report Student's t-test and Wilcoxon rank-sum test for the differences in means and medians between securitizers and nonsecuritizers. Letters of “a” and “b” represent a 1% statistical significance level for means and medians, respectively. Correlation matrix is reported in Appendix 3.

Table 1.

Summary Statistics.

Variables	Securitizers				Non-Securitizers				Differences in Means (1) and Medians (2)		
	Mean	**Median**	**SD**	**Obs.**	**Mean**	**Median**	**SD**	**Obs.**	**(1)**	**(2)**	***t*-test**
Dependent variable											
Efficiency score	0.55	0.50	0.21	658	0.43	0.41	0.13	4,617	0.12	0.00	a, b
Securitization regressor											
Total securitization ratio%	13.74	0.14	37.56	658	–	–	–	–	–	–	–
Bank-specific control variables											
Total retained interest ratio%	7.08	0.00	17.03	658	–	–	–	–	–	–	–
Capital ratio%	11.23	9.60	5.61	658	10.60	9.55	5.61	4,617	0.63	0.00	a
Bank size	15.64	16.15	0.82	658	14.68	14.47	0.74	4,617	0.96	0.62	a
Diversification ratio%	0.44	0.34	0.31	658	0.19	0.16	0.16	4,617	0.25	0.05	a, b
Liquidity ratio%	20.86	19.23	12.29	658	21.59	19.89	12.56	4,617	-0.73	0.59	a, b
Noninterest expense ratio%	3.53	2.90	2.08	658	2.86	2.66	1.33	4,617	0.67	0.00	a, b
Nonperforming loans ratio%	0.36	0.10	0.55	658	0.13	0.02	0.30	4,617	0.23	0.01	a, b
Local-market power	6.47	2.43	8.01	658	1.79	0.22	4.07	4,617	4.69	0.00	a

Note: Table 1 shows the descriptive statistics of the dependent variable (*Efficiency score*), securitization ratios, and control variables used in the regression analysis. We follow Bedendo and Bruno (2012) to include all domestic commercial banks with total assets of more than $1 billion over the time period. Our sample (2002–2012) include 141 banks with securitized loans and 722 without, accounting for a total of 5,275 bank-year observations. Variable definitions are provided in Appendix 1. Descriptive statistics of mean, median, and standard deviation are presented for securitizers and nonsecuritizers, respectively. We also report the differences between securitizers and nonsecuritizers. We use Student's t-test on means and Wilcoxon rank-sum test on medians. Letters of “a” and “b,” in the last column, indicate a significant difference of means and medians at 1% level, respectively.

Source: Authors' original work.

We report a higher average efficiency score for securitizers (0.55) compared with that of nonsecuritizers (0.43). We find both differences in means and medians of efficiency scores between securitizers and nonsecuritizers are statistically significant at 1% level, suggesting that securitized banks are likely to be more

efficient. We also find that, on average, 13.74% of securitizers' total assets have been securitized during 2002–2012. The median of securitization ratio is 0.14 and the SD is 37.56, suggesting that some banks are more active and massive securitizers. The signaling theory suggests that securitizers can use credit enhancements to signal the quality of the assets being securitized (Demiroglu & James, 2012). We find that 7.08% of the securitized assets are backed by credit enhancements. Literature also suggest securitization provides banks with capital relief (Martín-Oliver & Saurina, 2007), diversification (DeMarzo, 2005), and liquidity increase (Loutskina, 2011) benefits. We find that securitizers are more likely to be related to higher capital ratio (11.23% vs. 10.60%), larger in total assets ($6.2 billion vs. $2.4 billion) and lower liquidity (20.86% vs. 21.59%) than nonsecuritizers.[3] Securitization process requires a substantial amount of upfront costs (e.g., consultancy and organizational costs, payments to rating agencies, underwriting fees, and legal expenses). Securitizers are in turn associated with higher operating costs (Gorton & Souleles, 2005). We find the average noninterest expense ratio is higher for securitizers (3.53%) than nonsecuritizers (2.86%). The securitized assets are also required a certain amount of lemon discount by the investor. Larger banks with higher reputation or market powers are more likely to be benefit from a lower lemon discount (Boyd & Prescott, 1986; Campbell & Kracaw, 1980; Diamond, 1984). We find evidence to support that securitizers are likely to be larger (with total assets of $6.4 billion vs. $2.4 billion) with higher market power (6.47 vs. 1.79).

3 Empirical Strategy

Our baseline framework uses the following OLS model to estimate the impact of loan securitization on bank efficiency:

(3)

$$\mathrm{EfficiencyScore}_{it}=\beta_0+\beta_1\mathrm{SecuritizationRatio}_{it}+\beta_2 X_{it}+\alpha_i+\gamma_t+\mu_{it}$$

Where $\mathrm{EfficiencyScore}_{it}$ is the dependent variable calculated from the DEA model, X_{it} is the vector of bank-specific control variables, α_i is the intercept of for each bank, γ_t is the intercept for each year, and μ_{it} is the disturbance term.

We concern the relationship between securitization ratio and bank efficiency score identified by the fixed effects estimator could be endogenous. Banks with higher efficiency are expected to have higher future profits, and thus greater charter value and reputation. Those higher efficiency banks can in turn be benefited with a lower lemon discounts when securitizing assets (Boyd & Prescott, 1986; Campbell & Kracaw, 1980; Diamond, 1984). Therefore, it could be that banks with higher efficiency are naturally more active securitizers. It is also possible that there exist other unobservable factors impacting on both securitization ratios and efficiency scores.

We use two methods to identify the causal effects between securitization and bank efficiency. We first use the Heckman self-selection model to address the potential self-selection bias. We introduce three sets of exogenous instruments in the Heckman model. The first instrument is the annual *state-level corporate tax rate*, where the data are obtained from the US Tax Foundation website. [4] We exploit the state-time variations in corporate tax rates as an instrument for bank securitization because higher corporate tax rate is found to increase bank's incentive to securitize due to the corporate tax exemption of securitized assets (Han et al., 2015).

The second instrument is the *peer liquidity index*, conducted based on Loutskina's (2011) liquidity index which captures banks' incentive to securitize. It is a weighted average of the potential to securitize loans of a given type, based on market-wide averages. Following Loutskina (2011), we break down a bank's loan portfolio into six groups: (1) home mortgages, (2) multifamily residential mortgages, (3) commercial mortgages, (4) agricultural loans, (5) commercial and industrial (C&I) loans, and (6) consumer credit. [5] Liquidity index is defined as:

(4)
$$\text{LiquidityIndex}_{it}=\sum_{j=1}^{6}\left(\frac{\text{EconomyWideSecuritization}_{jt}}{\text{EconomyWideTotalLoans}_{jt}}\right)\times\left(\text{LoanShare}_{j,it}\right)$$

In this equation, $\text{EconomyWideSecuritization}_{jt}$ is the amount of economy-wide securitized loans of type *j* at time *t*, $\text{EconomyWideTotalLoans}_{jt}$ is the economy-wide total loans outstanding of type *j* at time *t*, and $\text{LoanShare}_{j,it}$ is the share of type *j* loans in bank *i* at time *t*.

We then construct bank *i*'s peer liquidity index by calculating the average of the liquidity indexes all of bank *i*'s peers, excluding bank *i* itself. A bank's tendency to securitize loans is arguably related to its industry peers' securitizing behavior because of the herd effect (Chari & Kehoe, 2004). It is unlikely that a bank's industry peers' securitizing behavior can directly affect the bank's efficiency (other than through the channel of securitization).

The *state-level corporate tax rate* does not have a bank-specific component, so it only provides the impact of a state's "average" bank. The *peer liquidity index* provides the impact only based on bank-specific accounting information. We hence use the cross-product of the *state-level corporate tax rate* and the *peer liquidity index* as a third instrument to capture both characteristics (see more empirical research using interaction terms, e.g., Santos and Winton (2008), Leary (2009), Foos, Norden, and Weber (2010), Maskara (2010), Benmelech and Bergman (2011), He, Qian, and Stahan (2012), and Callen and Fang (2013) among others).

Second, we use a DID approach to explore the association between the changes in securitization ratios and bank's efficiency scores. Following Brunnermeier et al.

(2020), we use the bankruptcy of Lehman Brothers in September 2008 as a source of exogenous variation. The bankruptcy of Lehman Brothers triggered a wide withdrawal of short-term repurchase agreements (repos) and led to a securitized banking run (Gorton & Metrick, 2012). The sudden shrink in the securitization market scale could jeopardize bank's efficiency improvement through securitizing assets. We thus expect the efficiency of securitizers to decrease more significantly than nonsecuritizers after the bankruptcy of Lehman Brothers.

We first use a subsample including only matched securitizers and nonsecuritizers to test this hypothesis. We assign propensity scores for each bank using the following bank specific characteristics: *capital ratio, bank size, diversification ratio, liquidity ratio, noninterest expense ratio, nonperforming loans ratio, and local-market power*. We then match each securitizer with the most similar nonsecuritizer using nearest-neighbor matching by imposing a 1% tolerance level on the maximum propensity score distance. [6] Our DID analysis is based on the following model:

(5)
$$EfficiencyScores_{i,t}=\beta 0+\beta 1SecuritizerDummy_{i,t}\times PostLehmanBankruptcy_{i,t}+\beta 2X_{i,t}+\alpha i+\tau t+\varphi_{i,t}$$

$SecuritizerDummy_{i,t}$ is to identify securitized banks (one for securitizers and zero otherwise), $PostLehmanBankruptcy_{i,t}$ is a dummy variable which set to unity after the year of 2008, and zero before 2008, $X_{i,t}$ is the vector of bank specific controls, αi is the intercept of for each bank, τt is the intercept for each year, and $\varphi_{i,t}$ is the error term. The *Post Lehman bankruptcy* dummy and $SecuritizerDummy$ do not appear by itself on the right-hand side of the regression because they would be perfectly collinear with the year and bank fixed effects, respectively.

We also hypothesize that the bankruptcy of Lehman Brothers could impact more significantly on those banks with higher securitization incentives. Following Loutskina (2011), we use the *bank loan portfolio liquidity index* to identify banks' incentives to securitize. We use the 90% distribution threshold of the *bank loan portfolio liquidity index* to define the most affected securitizers. [7] Following Berger and Bouwman (2013), we consider the year of 2005 as the normal period and use *bank loan portfolio liquidity index* values of 2005 to define the size distribution of liquidity index. We then use *Top 10% securitizers* dummy to identify the most active securitizers. *Top 10% securitizers* dummy is set to unity if a securitizer's *bank loan portfolio liquidity index* value is larger than 90% distribution of all securitizers, and zero otherwise. We replace *securitizer dummy* by *Top 10% Securitizers* dummy in Eq. (5) and run the regression using a subsample including only securitized banks.

Our first concern of the above results is the potential reverse causality regarding the choice of shock year. Our DID framework is designed based on the information-sensitivity characteristic of securitized assets (Manconi et al., 2012),

which means the liquidity dried-up in the securitization market is more likely to be severe after the announcement of the bankruptcy of the Lehman Brothers. If our results reflect the treatment effect based on such hypothesis, our results should disappear if the treatment is falsely assumed in other years, e.g., one or two years before 2008. Therefore, our falsification test is to randomize the shock year by replacing the *post Lehman Brother shock* with the *after 2007* and *after 2006* dummies, respectively, and rerun regressions based on Eq. (5).

Another concern of the above DID estimation is the impact of the financial shock on securitizers can be dispersed around the event year. For example, Demyanyk and Van Hemert (2011) argue that problems of subprime mortgages were realized by some originators at least by the end of 2005, which makes it possible for some securitizers to react in advance. Meanwhile, the interconnection among financial institutions has been significantly increased by securitization, which also makes it possible for some securitizers to face real problems later after the interconnected peers suffered from the crisis. Therefore, following Chemmanur et al. (2014), we conduct an analysis to reflect the dynamics of securitizers' efficiency changes five years before and five years after the 2008 financial shock to support the findings from the DID framework. The regression framework follows the specification below:

(6)
$$\text{EfficiencyScore}_{si,t}=\beta 0+\sum_{s=1}^{5}\theta_s \text{SecuritizerDummy}_{i,t}\times \text{Before}_{i,ts}+\sum_{s=1}^{5}\gamma_s \text{SecuritizerDummy}_{i,t}\times \text{After}_{i,ts}+\beta 1 X_{i,t}+\alpha i+\tau t+\varphi_{i,t}$$

In this empirical model, $\text{Before}_{i,ts}$ is the year dummy variable in each year five years before the 2008 financial shock, where s = 1, 2, 3, 4, and 5, while $\text{After}_{i,ts}$ is the year dummy variable in each year five years after the 2008 financial shock, where s = 1, 2, 3, 4, and 5. Therefore, the residual changes in banks' efficiency scores of securitizers compared with nonsecuritizers around 2008 will be captured by θ_s and γ_s . We also replace the $\text{SecuritizerDummy}_{i,t}$ by *Top 10% securitizers* to capture the dynamic patterns of active securitizers around 2008.

4 Empirical Results

4.1 The Impact of Securitization on Bank Efficiency

We start our empirical analysis by summarizing in Table 2 the results of both OLS and Heckman self-selection model. The first-step results of Heckman self-selection model, using instruments of *state-level corporate tax rate*, *peer liquidity index*, and *state-level corporate tax rate* × *peer liquidity index*, are reported in column (2), (4), and (6), respectively. Our key variable is *total securitization ratio*, which captures the extent to which a bank engages in securitization activities. We saturate the model with both bank and year fixed effects.

Table 2.

The Impact of Loan Securitization on Bank Efficiency – OLS and Heckman Analysis.

	Bank Efficiency Scores						
Dependent Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
	OLS	**Heckman Self-Selection**					
		1st Step	**2nd Step**	**1st Step**	**2nd Step**	**1st Step**	**2nd Step**
Total securitization ratio $_{t-1}$	0.080** (0.03)		0.144*** (0.02)		0.151*** (0.02)		0.148*** (0.02)
Total retained interest ratio $_{t-1}$	0.045* (0.03)		0.264** (0.12)		0.233*** (0.09)		0.245*** (0.09)
Capital Ratio $_{t-1}$	−1.260*** (0.24)	−1.351* (0.79)	−2.201*** (0.19)	−1.106* (0.54)	−2.235*** (0.18)	−1.448** (0.56)	−2.329*** (0.19)
Bank size $_{t-1}$	−0.066 (0.05)	0.695*** (0.19)	−0.170** (0.07)	60.26*** (4.35)	−0.176*** (0.06)	60.26*** (4.35)	−0.188*** (0.07)
Diversification ratio $_{t-1}$	2.876 (1.83)	−58.874 (43.59)	13.666* (8.10)	0.915*** (0.15)	11.821 (7.92)	0.879*** (0.15)	12.215 (8.11)
Bank liquidity ratio $_{t-1}$	0.045 (0.05)	0.024 (0.24)	−0.010 (0.08)	−0.276 (0.24)	0.004 (0.08)	−0.259 (0.24)	−0.008 (0.08)
Noninterest expense ratio $_{t-1}$	0.015 (0.02)	2.380*** (0.68)	0.053 (0.03)	12.50*** (1.97)	0.072** (0.03)	12.80*** (1.98)	0.065** (0.03)
Nonperforming loans ratio $_{t-1}$	0.036 (1.08)	20.096*** (7.61)	−0.990 (2.26)	10.11 (6.91)	0.118 (2.12)	9.075 (6.96)	0.383 (2.17)
Local-market power $_{t-1}$	−0.137 (0.14)	6.461*** (0.48)	−0.796*** (0.24)	3.173*** (0.48)	−0.895*** (0.19)	3.271*** (0.47)	−0.898*** (0.19)
Constant	0.555*** (0.03)	−2.422*** (0.17)	1.292*** (0.11)	−2.433*** (0.12)	1.270*** (0.07)	−2.174*** (0.11)	1.297*** (0.07)
State-level corporate tax rate		0.227***(0.05)					
Peer liquidity index				2.014*** (0.19)			
State-level corporate tax rate × Peer liquidity index						0.468*** (0.05)	
Inverse Mills Ratio			−0.277*** (0.05)		−0.273*** (0.03)		−0.279*** (0.03)

Dependent Variable	Bank Efficiency Scores						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	Heckman Self-Selection					
		1st Step	2nd Step	1st Step	2nd Step	1st Step	2nd Step
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,399	4,399	4,399	4,399	4,399	4,399	4,399
Adjusted-R^2/Pseudo-R^2	0.1838	0.2207	0.2401	0.2425	0.2433	0.2433	0.2182

Note: Table 2 presents regression results on the impact of loan securitization on bank efficiency scores using OLS and Heckman self-selection methods. The sample period is 2002–2012. We introduce three instruments in Heckman model: (1) state-level corporate tax rate; (2) peer liquidity index; (3) state-level corporate tax rate × peer liquidity index. The first and second step results are reported in the left and right columns within the instrument groups, respectively. We control for bank and year fixed effects in all regression. Control variables have been lagged for one year. *T*-statistics are based on robust standard errors clustered by banks. *, **, *** denote statistical significance at the 10%, 5%, and 1% levels respectively. All variable definitions are presented in Appendix 1.

Source: Authors' original work.

As expected, we find *total securitization ratio* is significantly (at the 1% statistical significance level) related to the increase of bank efficiency scores, suggesting the involvement of securitization is likely to increase bank efficiency. We report that a one-standard-deviation increase in total securitization ratio leads to an increase of 9.23% of a SD in bank's efficiency scores. Securitization provides securitizers with capital relief and liquidity increase, which in turn increases the flexibility of banks and positively impacts on bank's efficiency.

This finding is also confirmed by the Heckman self-selection analysis, where we report an average 17.04% of SD increase in bank's efficiency score due to a one-standard-deviation increase of total securitization ratio. We show that all instruments are statistically significant in the first step of Heckman self-selection model, suggesting the instruments are all valid.

Results on control variables are largely consistent with previous literature. Retained interest ratios, on average, are found to have a positive impact on bank efficiency. As expected, larger size and higher capital and nonperforming loans ratios are associated with lower bank efficiency scores, while higher diversification and liquidity ratios are related to higher efficiency scores.

We then employ a DID analysis using the bankruptcy of the Lehman Brothers in 2008 as the exogenous shock, and the results are reported in Table 3. As expected, we find the efficiency of securitizers decreased more significantly than nonsecuritizers after the bankruptcy of Lehman Brothers, suggesting the contribution of securitization to bank's efficiency improving decreased significantly after the bankruptcy of Lehman Brothers. We find similar results for banks with the highest securitization incentives and other securitizers. Overall, the DID framework supports our main findings.

Table 3.

The Impact of Loan Securitization on Bank Efficiency – Difference-in-Difference Approach.

Dependent Variable	**Bank Efficiency Scores** $_t$			
Securitizer dummy $_t$ × *Post-Lehman bankruptcy dummy* $_t$	−0.011*** (0.00)	−0.015*** (0.00)		
Top 10% securitizers dummy $_t$ × *Post-Lehman bankruptcy dummy* $_t$			−0.006*** (0.00)	−0.007*** (0.00)
Total retained interest ratio $_t$		0.055** (0.02)		0.055** (0.02)
Capital Ratio $_t$		−1.699*** (0.32)		−1.703*** (0.32)
Bank size $_t$		−0.095 (0.06)		−0.095 (0.06)
Diversification ratio $_t$		7.367** (3.56)		7.436** (3.55)
Bank liquidity ratio $_t$		0.196*** (0.06)		0.195*** (0.06)
Non-interest expense ratio $_t$		0.030 (0.02)		0.031* (0.02)
Non-performing loans ratio $_t$		2.548* (1.49)		2.546* (1.48)
Local-market power $_t$		−0.051 (0.19)		−0.056 (0.19)
Constant	0.658*** (0.01)	0.714*** (0.04)	0.587*** (0.01)	0.714*** (0.04)
Bank fixed effects	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes
Observations	2,174	2,174	1,087	1,087
Adjusted-R^2	0.2465	0.4294	0.1466	0.4310

Note: We consider the bankruptcy filing of Lehman Brothers in 2008 as an exogenous shock (see Brunnermeier et al., 2020 for similar practice). *Post-Lehman bankruptcy* dummy equals to one from the year 2008 onwards, and zero before 2008. We employ a difference-in-difference (DID) approach. We use the DEA

approach to estimate bank's efficiency scores. Column (1) and (2) report the results using a subsample of matched securitizers with nonsecuritizers based on bank-specific variables and constrain the matching to the same year. Securitizers serve as the control group in the matched sample. The sample period is from 2002 to 2012. Column (3) and (4) report the results using a subsample including only securitizers. Banks with higher liquidity and potential to securitize loans are defined as the treatment group, while banks with lower liquidity and potential to securitize loans are the control group. The potential to securitize loans is measured by the liquidity index proposed by Loutskina (2011). *Top 10% securitizers* dummy is set to unity if a securitizer's liquidity index value is larger than 90% distribution of all securitizers, and zero otherwise, based on the value of 2005. Bank and year fixed effects are both included. *, **, *** denote statistical significance at the 10%, 5%, and 1% levels respectively. All variable definitions are presented in Appendix 1.

Source: Authors' original work.

Additionally, we use a split sample analysis to support our DID results by comparing the impact of securitization on bank's efficiency score in precrisis (2002–2006) and postcrisis (2007–2012) periods. Results are reported in Appendix 4. We confirm that securitization ratios are both positively and significantly related to bank's efficiency scores in both periods. We also find a decrease in the economic impact of securitization on bank's efficiency scores. Before 2007, we find a one-standard-deviation increase of total securitization ratio is associated with an increase of 17.82% of a standard deviation in bank's efficiency scores. This impact decreases to 12.49% after the breakout of the 2007–2009 financial crisis.

We then show the results of the falsification test to check whether the results from the DID framework depend on the shock event and associated problems rather than being created by choosing of the shock year in the empirical design. Thus, we change our base year to 2007 and 2006 as the artificial shock years and run the DID regressions. Results are shown in Panel A and B, Table 4 for base year of 2007 and 2006, respectively. Results in both falsification regression show our results disappear for the interaction terms, which in turn supports our main results.

Table 4.

Falsification Test – Use 2007 and 2006 as the Assumed Shock Year.

Dependent Variable	**Bank Efficiency Scores** $_t$			
Panel A				
Securitizer dummy $_t$ × *Post-2007 dummy* $_t$	−0.002 (0.01)	−0.012 (0.01)		
Top 10% securitizers dummy $_t$ × *Post-2007 dummy* $_t$			−0.009 (0.00)	−0.012 (0.00)

Dependent Variable	**Bank Efficiency Scores** $_t$			
Control variables	No	Yes	No	Yes
Bank fixed effects	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes
Observations	2,174	2,174	1,087	1,087
Adjusted-R^2	0.1066	0.2790	0.1395	0.4193
Panel B				
Securitizer dummy $_t$ × *Post-2006 dummy* $_t$	−0.001 (0.00)	−0.011 (0.00)		
Top 10% securitizers dummy $_t$ × *Post-2006 dummy* $_t$			−0.005 (0.00)	−0.009 (0.00)
Control variables	No	Yes	No	Yes
Bank fixed effects	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes
Observations	2,174	2,174	1,087	1,087
Adjusted-R^2	0.1065	0.2788	0.1269	0.4060

Note: We randomize the exogenous shock of bankruptcy filing of Lehman Brothers in 2008 to one and two years before, and results are reported in Panel A and B, respectively. We employ the same difference-in-difference (DID) framework as shown in Eq. (5). Column (1) and (2) report the results using a subsample of matched securitizers with nonsecuritizers based on bank-specific variables and constrain the matching to the same year. Securitizers serve as the control group in the matched sample. The sample period is from 2002 to 2012. Column (3) and (4) report the results using a subsample including only securitizers. Banks with higher liquidity and potential to securitize loans are defined as the treatment group, while banks with lower liquidity and potential to securitize loans are the control group. The potential to securitize loans is measured by the liquidity index proposed by Loutskina (2011). *Top 10% securitizers* dummy is set to unity if a securitizer's liquidity index value is larger than 90% distribution of all securitizers, and zero otherwise, based on the value of 2005. Bank and year fixed effects are both included. *, **, *** denote statistical significance at the 10%, 5%, and 1% levels respectively. All variable definitions are presented in Appendix 1.

Source: Authors' original work.

We finally show the dynamic patterns analysis results in Table 5 and graph the coefficients trends in Fig. 1. Consistent with our hypothesis and the DID results, securitizers are more efficient than nonsecuritizers before the financial shock in 2008, and the efficiency reaches the peak in 2007 right before the breakout of the financial crisis. Securitizers' efficiency scores began to drop after 2008 and most significant decline was witnessed two years after the financial shock. It is in the line with the interconnectedness theory which suggesting that problems will be spread throughout the financial network with securitization.

Table 5.

The Dynamic Patterns Around the 2008 Financial Crisis.

Dependent Variable	**Bank Efficiency Scores** $_t$			
Securitizer dummy $_t$ × *Year dummy 2003* $_t$	0.015 (0.02)	0.035 (0.03)		
Securitizer dummy $_t$ × *Year dummy 2004* $_t$	0.032 (0.02)	0.033 (0.02)		
Securitizer dummy $_t$ × *Year dummy 2005* $_t$	0.002 (0.03)	0.002 (0.03)		
Securitizer dummy $_t$ × *Year dummy 2006* $_t$	0.006 (0.03)	0.027 (0.03)		
Securitizer dummy $_t$ × *Year dummy 2007* $_t$	0.031* (0.02)	0.055** (0.03)		
Securitizer dummy $_t$ × *Year dummy 2009* $_t$	−0.043*** (0.07)	−0.029*** (0.01)		
Securitizer dummy $_t$ × *Year dummy 2010* $_t$	−0.193** (0.08)	−0.141** (0.06)		
Securitizer dummy $_t$ × *Year dummy 2011* $_t$	−0.205*** (0.10)	−0.175*** (0.08)		
Securitizer dummy $_t$ × *Year dummy 2012* $_t$	−0.090*** (0.01)	−0.060*** (0.01)		
Top 10% securitizers dummy $_t$ × *Year dummy 2003* $_t$			0.000 (0.00)	0.004 (0.00)
Top 10% securitizers dummy $_t$ × *Year dummy 2004* $_t$			0.002 (0.00)	0.005 (0.00)
Top 10% securitizers dummy $_t$ × *Year dummy 2005* $_t$			0.002 (0.00)	0.003 (0.00)
Top 10% securitizers dummy $_t$ × *Year dummy 2006* $_t$			0.010* (0.00)	0.006* (0.00)
Top 10% securitizers dummy $_t$ × *Year dummy 2007* $_t$			0.002 (0.00)	0.002 (0.00)
Top 10% securitizers dummy $_t$ × *Year dummy 2009* $_t$			−0.009** (0.00)	−0.011** (0.00)
Top 10% securitizers dummy $_t$ × *Year dummy 2010* $_t$			−0.006*** (0.00)	−0.010*** (0.00)
Top 10% securitizers dummy $_t$ × *Year dummy 2011* $_t$			−0.011*** (0.00)	−0.014*** (0.00)
Top 10% securitizers dummy $_t$ × *Year dummy 2012* $_t$			−0.009** (0.00)	−0.013** (0.00)
Controls	No	Yes	No	Yes
Bank fixed effects	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes
Observations	2,174	2,174	1,087	1,087

Dependent Variable		Bank Efficiency Scores $_t$		
Adjusted-R^2	0.1103	0.2811	0.2918	0.4277

Note: We consider the bankruptcy filing of Lehman Brothers in 2008 as an exogenous shock (see Brunnermeier et al., 2020 for similar practice), and show the dynamic patterns of securitizers' efficiency scores around such shock. The regressions based on the framework of Eq. (6), and coefficients will capture residual changes in securitizers' efficiency scores. In this empirical model, $Before_{i,ts}$ is the year dummy variable in each year five years before the 2008 financial shock, where s = 1, 2, 3, 4, and 5, while $After_{i,ts}$ is the year dummy variable in each year five years after the 2008 financial shock, where s = 1, 2, 3, 4, and 5. Bank and year fixed effects are both included. *, **, *** denote statistical significance at the 10%, 5%, and 1% levels respectively. All variable definitions are presented in Appendix 1. The visual patterns of the coefficients are shown in Fig. 1.

Source: Authors' original work.

Fig. 1.

The Dynamic Patterns of Securitizers' Efficiency Scores Around 2008. *Note*: The horizontal axis identifies the time frame, with 0 is 2008, −1, −2, −3, −4, and −5 are one to five years before the crisis, respectively, while +1, +2, +3, +4, and +5 are one to five years after the crisis, respectively. The vertical axis shows the coefficient of the interaction term which captures the residual changes in Efficiency scores of securitized banks.

The dynamic patterns of active securitizers compared with other securitizers show that the efficiency scores for the former group are higher before the financial shock and the gap between two groups kept growing. However, active securitizers suffered consistent efficiency decline after the financial shock, which suggests the active securitizers are more significantly impacted by the financial shock. Therefore, the dynamic patterns confirm our findings from the DID analysis that securitizers are impacted more significantly than nonsecuritizers.

4.2 Bank Heterogeneity

Our main findings suggest a positive association between securitization ratios and the increase of bank's efficiency scores. In this section, we present regressions to estimate how the relationship between securitization and bank efficiency varies across bank characteristics.

First, securitization provides banks with capital relief benefit which allows securitized banks to hold a lower level of capital buffer. Banks with higher level of regulatory capital ratios are thus able to benefit more from this off-balance-sheet transaction. We thus expect the efficiency scores of banks with higher capital ratios can be more significantly improved by securitization.

Second, securitization allows banks to shift potential risk to security investors through true sales of the underlying assets. Banks with higher balance-sheet risk can in turn benefit more from securitization to decrease the potential risk. We hence expect the efficiency improving impact of securitization to be more significant for banks with higher risk.

Third, securitization allows banks to transfer illiquid assets on the balance sheet into marketable securities (Loutskina, 2011). Banks with insufficient liquidities can in turn benefit more from the extra liquidity provided by securitization and pursue other more profitable projects. We expect the impact of securitization on efficiency scores for banks with lower liquidity levels to be more significant.

Last, securitization increases bank's diversification by allowing securitizers to take advantage of network economies and exploit geographic diversification. Less diversified banks are more likely to be the beneficiaries of securitization to improve efficiency through diversification. We expect the impact of securitization on efficiency for banks with unfavorable level of diversification to be more significant.

We use *capital ratio* to represent bank's capital levels, *LogZ* to represent bank default risk, *liquidity ratio* to represent bank's liquidity position, and the share of noninterest income over total assets (*diversification*) to represent the bank's diversification status. We then interact *securitization ratio* with *capital ratio, LogZ, liquidity ratio*, and *diversification*. All specifications include our standard set of controls as well as time and bank fixed effects.

Overall, results in Table 6 are in the line with our hypotheses and support our argument that the impact of securitization on bank efficiency is stronger for banks with higher capital level, higher default risk, lower liquidity ratio, and lower diversification level since these banks benefit more from the securitization activities.

Table 6.

Co-variations Between Securitization Ratios and Bank-Specific Characteristics.

Dependent Variable	Bank Efficiency Scores			
	(1)	(2)	(3)	(4)
Total securitization ratio × *Capital Ratio* $_t$	0.147*** (0.05)			
Total securitization ratio × *LogZ* $_t$		−0.562*** (0.15)		
Total securitization ratio × *Bank liquidity ratio* $_t$			−1.280*** (0.26)	
Total securitization ratio × *Diversification ratio* $_t$				−0.335** (0.17)
Total securitization ratio $_t$	0.083*** (0.03)	0.099*** (0.03)	0.102*** (0.03)	0.082** (0.03)
Capital Ratio $_t$	−0.012*** (0.00)	−1.254*** (0.25)	−1.346*** (0.24)	−1.263*** (0.25)
LogZ $_t$		0.009** (0.00)		
Bank liquidity ratio $_t$	0.064* (0.04)	0.037** (0.05)	0.063*** (0.02)	0.045** (0.05)
Diversification ratio $_t$	0.309*** (0.04)	0.317*** (0.04)	0.314*** (0.04)	0.028*** (0.01)
Total retained interest ratio $_t$	0.042 (0.03)	0.044* (0.03)	0.044* (0.03)	0.045* (0.03)
Bank size $_t$	−0.093** (0.04)	−0.077 (0.05)	−0.074 (0.05)	−0.067 (0.05)
Non-interest expense ratio $_t$	−0.424 (0.38)	−0.751* (0.51)	−0.752 (0.51)	−0.784** (0.51)
Non-performing loans ratio $_t$	0.176 (1.01)	0.550* (0.99)	0.625* (0.96)	0.122 (1.00)
Local-market power $_t$	−0.238 (0.18)	−0.274 (0.18)	−0.285 (0.18)	−0.251 (0.19)
Constant	0.668*** (0.22)	0.819*** (0.25)	0.815*** (0.25)	0.758*** (0.25)
Bank fixed effects	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes
Observations	4,399	4,399	4,399	4,399
Adjusted-R^2/Pseudo-R^2	0.1268	0.2671	0.2125	0.3770

Note: Table 6 presents regression results on the relationship between cross products of *total securitization ratio* and *capital ratio*, *LogZ*, *liquidity ratio*, and *diversification ratio*, and *bank efficiency scores*. We use the interaction term to explore the possible mechanisms that securitization can impact on bank efficiency scores. We control for both bank and year fixed effects in all regressions. *T*-statistics are based on robust standard errors clustered by banks. *, **, *** denote statistical significance at the 10%, 5%, and 1% levels respectively. All variable definitions are presented in Appendix 1.

Source: Authors' original work.

4.3 The Impact of Mortgage and Nonmortgage Loan Securitization on Bank Efficiency

Results so far suggest the efficiency improving of securitization is likely related to risk transferring. To shed more light on risk transferring, we explore the possible differences between mortgage and nonmortgage securitization. Mortgage loan are backed by real estates which are not easily depreciated (Campbell & Cocco, 2015), and are hence widely considered as safer than nonmortgage loans. Thus, securitizing risky assets (e.g., nonmortgage loans) may be a more efficient method of risk transferring (Minton, Sanders, & Strahan, 2004). We expect nonmortgage securitization to be more significantly related to the increase of bank's efficiency scores. To test the hypothesis, we break down securitization into mortgage and nonmortgage securitizations. Mortgage loans include one to four home mortgages, while nonmortgage loans contain all other types of loans, including home equity lines, credit card receivables, auto loans, commercial and industrial loans, other consumer loans, and all other loans. We replace total securitization ratio with mortgage and nonmortgage securitization ratios in both OLS and Heckman self-selection models and rerun the regressions. Results on mortgage and nonmortgage securitization ratios are reported in Table 7.

Table 7.

The Impact of Mortgage and Nonmortgage Loan Securitization on Bank Efficiency Scores.

Dependent Variable	**Bank Efficiency Scores**							
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
	OLS		**Heckman Self-Selection**					
Instrument			Tax rate	Peer liquidity	Interaction	Tax rate	Peer liquidity	Interaction
Mortgage securitization ratio $_{t-1}$	−0.254 (0.06)		−0.007 (0.09)	−0.035 (0.07)	−0.025 (0.07)			
Nonmortgage securitization ratio $_{t-1}$		0.110*** (0.03)				0.156*** (0.02)	0.166*** (0.02)	0.161*** (0.02)
Mortgage retained interest ratio $_{t-1}$	−0.046* (0.03)		−0.837*** (0.23)	−0.578*** (0.13)	−0.586*** (0.14)			
Nonmortgage retained interest ratio $_{t-1}$		0.009** (0.00)				−0.004 (0.02)	−0.008 (0.02)	−0.010 (0.02)

Dependent Variable	Bank Efficiency Scores							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS		Heckman Self-Selection					
Capital Ratio $_{t-1}$	−1.224*** (0.24)	−1.268*** (0.25)	−2.085*** (0.27)	−1.842*** (0.17)	−2.034*** (0.19)	−2.258*** (0.18)	−2.340*** (0.17)	−2.435*** (0.18)
Bank size $_{t-1}$	−0.065 (0.05)	−0.069 (0.05)	−0.357*** (0.10)	−0.291*** (0.07)	−0.314*** (0.07)	−0.103 (0.06)	−0.124** (0.06)	−0.136** (0.06)
Diversification ratio $_{t-1}$	2.460 (1.99)	2.791 (1.87)	18.687 (12.28)	12.951 (8.60)	13.216 (8.68)	12.366* (7.51)	10.873 (7.60)	11.149 (7.66)
Bank liquidity ratio $_{t-1}$	0.050 (0.05)	0.043 (0.05)	0.013 (0.11)	0.055 (0.08)	0.036 (0.08)	0.025 (0.07)	0.030 (0.07)	0.019 (0.07)
Noninterest expense ratio $_{t-1}$	0.003 (0.01)	0.012 (0.01)	0.000 (0.05)	0.039 (0.03)	0.033 (0.04)	0.075** (0.03)	0.087*** (0.03)	0.081*** (0.03)
Nonperforming loans ratio $_{t-1}$	0.351 (1.05)	0.121 (1.08)	−1.426 (3.80)	4.464** (2.23)	4.663** (2.25)	−2.219 (2.14)	−0.984 (2.05)	−0.657 (2.07)
Local-market power $_{t-1}$	−0.145 (0.15)	−0.131 (0.14)	−1.517*** (0.40)	−1.049*** (0.20)	−1.026*** (0.20)	−0.683*** (0.19)	−0.854*** (0.17)	−0.834*** (0.17)
Constant	0.553*** (0.03)	0.558*** (0.03)	1.646*** (0.18)	1.333*** (0.08)	1.369*** (0.08)	1.225*** (0.08)	1.245*** (0.06)	1.264*** (0.06)
*Inverse Mills Ratio**			0.257*** (0.05)	2.291*** (0.18)	0.536*** (0.04)	0.137*** (0.05)	2.014*** (0.19)	0.473*** (0.04)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,399	4,399	4,399	4,399	4,399	4,399	4,399	4,399
Adjusted-R^2/Pseudo-R^2	0.2075	0.2155	0.3633	0.3736	0.3425	0.2252	0.2821	0.2143

Note: Table 7 presents regression results on the impact of mortgage and non-mortgage loan securitization on bank efficiency scores. We use both fixed effects and Heckman self-selection methods. The sample period is 2002–2012. We introduce three instruments in Heckman model: (1) *state-level corporate tax rate*; (2) *peer liquidity index*; (3) *state-level corporate tax rate* × *peer liquidity index*. We report the second step results are reported in columns (3)–(5) for mortgage securitization, and (6)–(8) for non-mortgage securitization, respectively. The first-step results are reported in Panel B, Appendix 5. We control for both bank and year fixed effects in all regressions. All control variables have been lagged for one year. *T*-statistics are based on robust standard errors clustered by banks. *, **, ***

denote statistical significance at the 10%, 5%, and 1% levels respectively. All variable definitions are presented in Appendix 1.

Note: *Inverse Mills ratios are calculated from the first-step of Heckman self-selection regression, based on different instruments. In column (3) to (8), we use the label "Tax rate," "Peer liquidity," and "Interaction" to represent the instrument of state-level corporate tax rate, *peer liquidity index*, and *state-level corporate tax rate* × *peer liquidity index*, respectively.

Source: Authors' original work.

We find that mortgage securitization ratio is not significantly related to bank's efficiency scores (column (1)), and nonmortgage securitization ratios are significantly associated with the increase of bank's efficiency scores (column (2)). This finding is in the line with our expectation that nonmortgage securitization is likely to be more significant related to bank's efficiency than mortgage securitization. This finding holds after we control for self-selection bias using Heckman self-selection model.

4.4 The Impact of Loan Sale Activities on Efficiency Scores

Finally, we examine the impact of loan sales. In practice, loan sales are related to a lower level of fixed upfront costs (Carlstrom & Samolyk, 1995). Banks that intend to pursue additional flexibility may choose loan sales rather than securitization. Loan sales involve the totality of an originated loan (Gorton & Haubrich, 1990) and are affected without recourse (Greenbaum & Thakor, 1987). Thus, loan sales can also reduce banks risk by separating the ownership of riskier assets from their balance sheet (Berger & Udell, 1993). We expect the impact of loan sale ratios on bank efficiency scores to be positive as securitization ratios. Following Bedendo and Bruno (2012), we define loan sales by the difference between: (1) the outstanding principal balance of assets owned by others with servicing retained by the bank, and (2) the outstanding principal balance of assets sold and securitized by the bank. Loan sales data are collected from the Call Report, and the regression results are reported in Table 8.

Table 8.

The Impact of Loan Sales on Bank Efficiency Scores.

Dependent Variable	Bank Efficiency Scores						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	Heckman Self-Selection					
		1st Step	2nd Step	1st Step	2nd Step	1st Step	2nd Step
Total securitization ratio $_{t-1}$	0.022* (0.01)		0.030** (0.01)		0.037*** (0.01)		0.034*** (0.01)
Capital Ratio $_{t-1}$	−0.656*** (0.14)	−0.537 (0.63)	−1.338*** (0.21)	0.747 (0.49)	−1.417*** (0.18)	−0.266 (0.56)	−1.496*** (0.18)
Bank size $_{t-1}$	−0.051 (0.05)	0.687*** (0.18)	−0.252*** (0.08)	0.486*** (0.18)	−0.264*** (0.07)	0.515*** (0.18)	−0.268*** (0.06)
Diversification ratio $_{t-1}$	2.984 (1.84)	−51.299 (42.56)	15.570 (9.65)	−52.299 (42.60)	12.463 (8.73)	−48.523 (42.63)	12.186 (8.16)
Bank liquidity ratio $_{t-1}$	0.086 (0.05)	0.119 (0.23)	0.017 (0.09)	0.327 (0.23)	0.034 (0.08)	0.304 (0.23)	0.030 (0.08)
Non-interest expense ratio $_{t-1}$	0.011 (0.02)	3.144*** (0.75)	0.037 (0.04)	−3.919*** (0.41)	0.053 (0.04)	−3.186*** (0.37)	0.051 (0.03)
Non-performing loans ratio $_{t-1}$	−0.369 (0.95)	38.289*** (6.87)	−1.011 (3.13)	44.114*** (6.39)	2.525 (2.28)	42.788*** (6.45)	3.227 (2.13)
Local-market power $_{t-1}$	−0.129 (0.15)	6.674*** (0.46)	−1.113*** (0.33)	4.093*** (0.51)	−1.156*** (0.21)	4.784*** (0.50)	−0.979*** (0.19)
Constant	0.471*** (0.03)	−2.561*** (0.16)	1.333*** (0.14)	−2.522*** (0.11)	1.278*** (0.08)	−2.263*** (0.11)	1.243*** (0.07)
State-level corporate tax rate		0.259*** (0.05)					
Peer liquidity index				2.318*** (0.18)			
State-level corporate tax rate × Peer liquidity index						0.540*** (0.04)	
Inverse Mills Ratio			−0.321*** (0.06)		−0.303*** (0.03)		−0.279*** (0.03)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,399	4,399	4,399	4,399	4,399	4,399	4,399
Adjusted-R^2/Pseudo-R^2	0.3051	0.3129	0.3773	0.3704	0.3705	0.3176	0.3696

Note: Table 8 presents regression results on the impact of loan sale ratios on bank efficiency scores. We use both fixed effects and Heckman self-selection methods. The sample period is 2002–2012. We introduce three instruments in Heckman model: (1) *state-level corporate tax rate*; (2) *peer liquidity index*; (3) *state-level corporate tax rate × peer liquidity index*. The first and second step results are reported in the left and right columns within the instrument groups, respectively. We control for both bank and year fixed effects in all regressions. All control variables have been lagged for one year. *T*-statistics are based on robust standard errors clustered by banks. *, **, *** denote statistical significance at the 10%, 5%, and 1% levels respectively. All variable definitions are presented in Appendix 1.

Source: Authors' original work.

We find the impact of loan sales on bank efficiency is positive in all specifications. The coefficients of loan sale ratios are all positive and significant (at least at the 5% level). We find a one-standard-deviation increase of loan sale ratios is associated with an increase of 7.22% and an average of 11.06% in the SD of bank's efficiency scores estimated by OLS and Heckman self-selection models, respectively. All instruments in the first-step of Heckman self-selection models are all statistically significant, suggesting the instruments are all valid. Overall, we show a similar efficiency improving effect of loan sales.

5 Conclusion

In this chapter we empirically examine the impact of securitization on bank efficiency. We apply a two-stage approach using US large commercial bank data during 2002–2012. In the first step, we use a DEA model to calculate bank efficiency scores, and we regress them against securitization ratios and control variables in the second step. We find a positive and significant relationship between securitization ratio and bank's efficiency scores.

To address the endogeneity problem in securitization, we first employ a Heckman self-selection model by introducing three instruments, (1) state-level corporate tax rate; (2) peer liquidity index; (3) state-level corporate tax rate × peer liquidity index; in both analyses. We also use a DID analysis. Results support our main findings.

In the additional analysis, we first examine the co-variations between securitization ratios and several bank-specific characteristics. We show that securitization impacts more significantly on those banks with higher capital ratios, higher bank risks, lower liquidity ratios, and diversification. In the second analysis, we examine the difference between mortgage and nonmortgage securitization. Mortgage loans are considered as safer compared with nonmortgage loans. Securitizing nonmortgage loans are likely to be a more efficient risk transferring, and thus more significantly impacts on bank's efficiency. We find evidence to support this

hypothesis. We last examine the impact of loan sales and find a similar impact of loan sale ratios on bank's efficiency scores.

Stringent capital regulation is implemented mainly to reduce bank risk and risk-taking incentives (John, Saunders, & Senbet, 2000; Kahane, 1977), but bank efficiency can be decreased because of the financial restrictions. Our research suggests that the rapid development of off-balance sheet activities, including securitization and loan sales, provides commercial banks with an alternative way to regain better efficiency. Our research also suggests that simply employing the capital to asset ratio as the measurement of capital regulation is not sufficient, especially if the residual asset quality is not considered. Commercial banks can still take on more risk using securitization. In the presence of capital arbitrage, securitizers can become even riskier and less efficient when facing strict regulation on capital, increasing the likelihood of failure (Koehn & Santomero, 1980).

Notes

1

DEA model does not require the explicit specifications of the functional form of the underlying production relationship, which is popular in banking studies. Berger and Humphrey (1997) provide a comprehensive survey of related efficiency research in banking.

2

Selected descriptive statistics for the inputs and outputs used in the DEA efficiency measurement are presented in Appendix 2.

3

The two numbers stand for securitizers' and nonsecuritizers', respectively.

4

The data are available at: http://www.taxfoundation.org/taxdata/show/230.html.

5

The data used to construct this instrument variable come from the “Financial Accounts of the United States” (Z.1) data release.

6

In the unreported analysis, we also use the matched sample to conduct a Propensity Score Matching analysis. Results show that the average efficiency scores of securitizers is 0.79, which is significantly (at 1% significance level) higher than that of nonsecuritizers (0.57), supporting that securitization is likely to increase bank efficiency.

7

In robustness tests we consider various other bank size thresholds (e.g., 95%, 98%). The results are qualitatively similar.

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Appendix 1: Variable Definition

Variable	Definition
Dependent variable	
Bank Efficiency Score	Bank efficiency scores range from zero to one, derived from a data envelopment analysis (DEAs) model using three inputs and outputs (summary statistics for inputs and outputs are reported in Appendix 2). A higher score indicates a higher level of efficiency, and vice versa.
Independent variables	
Total Securitization Ratio	The outstanding principal balance of the total amount of assets securitized over total assets.
Mortgage Securitization Ratio	The outstanding principal balance of the total amount of mortgage assets securitized over total assets.
Nonmortgage Securitization Ratio	The outstanding principal balance of the total amount of nonmortgage assets securitized over total assets.
Total Retained Interests Ratio	The total dollar amount of credit exposure from all retained interest-only strips, all other credit enhancements, unused commitments to provide liquidity to asset securitized, and, ownership (or sellers)

Variable	Definition
	interests carried as securities or loans on related assets, divided by the total of all securitized assets.
Mortgage Retained Interests Ratio	The total dollar amount of credit exposure from all retained interest-only strips, all other credit enhancements, unused commitments to provide liquidity to asset securitized, and, ownership (or sellers) interests carried as securities or loans on related assets, divided by the total of all securitized mortgage assets.
NonMortgage Retained Interests Ratio	The total dollar amount of credit exposure from all retained interest-only strips, all other credit enhancements, unused commitments to provide liquidity to asset securitized, and, ownership (or sellers) interests carried as securities or loans on related assets, divided by the total of all securitized non-mortgage assets.
Capital Ratio	Capital divided by total assets.
Bank Size	The natural logarithm of total assets.
Diversification Ratio	Noninterest income divided by total operation income.
Liquidity Ratio	Liquid assets divided by total assets.
NonInterests Expenses Ratio	Noninterest expenses divided by total assets.
NonPerforming Loans Ratio	Loans past due 90 days divided by total assets.
Local-Market Power	The sum of the squares of each portfolio in every bank.

Appendix 2: Bank Inputs and Outputs

Variable	All Banks			Securitizers			Nonsecuritizers			Difference in Means	
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	(abs)	*p* Value
Inputs	($ billion)										
Customer deposits and short-term funding	12.76	1.68	70.52	72.64	11.10	186.65	4.22	1.50	11.84	68.42	0.00
Total costs	1.03	0.11	5.40	6.13	1.15	14.08	0.31	0.10	0.97	5.82	0.00
Equity capital	1.97	0.23	10.08	11.19	2.06	2.06	0.66	0.20	1.95	10.53	0.00
Outputs	($ billion)										

Variable	All Banks			Securitizers			Nonsecuritizers			Difference in Means	
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	(abs)	*p* Value
Loans	10.43	1.49	49.36	57.71	11.16	127.38	3.69	1.32	10.48	54.02	0.00
Other earning assets	16.72	2.03	92.95	96.10	17.34	246.06	5.41	1.82	15.06	90.70	0.00
Noninterest income	0.39	0.02	2.15	2.44	0.41	5.58	0.10	0.02	0.43	2.34	0.00

Note: This table reports the summary statistics of inputs and outputs used in the DEA model, in order to calculate bank efficiency scores. Three inputs are considered in the model, including: (1) customer deposits and short-term funding; (2) total costs, defined as the sum of interest expenses and noninterest expenses; and (3) equity capital, to adequately account for the impact of risk (Berger, 2007). Three outputs include: (1) loans; (2) other earning assets; and (3) noninterest income as a proxy for off-balance sheet activities. This table presents descriptive statistics for: (1) all sample banks (863), (2) securitizers (banks with securitized loans) (141), and (3) nonsecuritizers (banks without securitized loans) (722). Mean, Median, and SD stand for mean, median, and standard deviation values of the individual bank time-series observations, respectively. The last two columns report the comparison analysis of variables between securitizers and nonsecuritizers. Difference in means is calculated as the difference between securitizers' and nonsecuritizers' means in absolute (abs) values, with the *p*-values of the *t*-test on the equality of means reported in the last column.

Appendix 3: Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1)	1													
(2)	0.2618***	1												
(3)	0.1818***	0.2976***	1											
(4)	0.2164***	0.9529***	-0.0059	1										
(5)	0.2490***	0.3521***	0.0435***	0.3550***	1									
(6)	0.0809***	0.0304**	0.1084***	−0.0026	0.4596***	1								

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(7)	0.1568***	0.1284***	0.0072	0.1321***	0.2228***	0.0016	1							
(8)	−0.2796***	0.1747***	−0.0245	0.1908***	0.0948***	−0.0268	0.0471***	1						
(9)	0.2845***	0.1685***	0.1899***	0.1162***	0.2119***	0.1128***	0.1057***	0.0677***	1					
(10)	0.4961***	0.3493***	0.2345***	0.2914***	0.3231***	0.1039***	0.1756***	0.1911***	0.4800***	1				
(11)	0.0423***	−0.0503***	0.0102	−0.0559***	−0.0140	0.0325**	−0.0547***	−0.1229***	0.0216	0.0481***	1			
(12)	0.1102***	0.4163***	0.0436***	0.4222***	0.2664***	−0.0136	0.0976***	0.2384***	0.0171	0.4695***	−0.0470***	1		
(13)	0.1777***	0.2839***	0.1206***	0.2591***	0.1979***	0.0412***	0.1687***	0.1346***	0.2252***	0.2592***	−0.1320***	0.2237***	1	
(14)	0.2310***	0.1295***	0.2557***	0.0545***	0.1472***	0.1367***	0.0293**	−0.0131	0.4272***	0.3771***	−0.0036	0.0435***	0.1806***	1

Note: Variables are numbered as follows: (1) Bank efficiency scores, (2) Total securitization ratio; (3) Mortgage securitization ratio; (4) Nonmortgage securitization ratio; (5) Total retained interests; (6) Retained interests on mortgage loans; (7) Retained interests on non-mortgage loans; (8) Capital ratio; (9) Bank size; (10) Diversification ratio; (11) Liquidity ratio; (12) Noninterests expense ratio; (13) Nonperforming loans ratio; (14) Local-market power index.

Appendix 4: The Impact of Loan Securitization on Bank Efficiency – Split Sample Analysis (Referring to the 2007–2009 Financial Crisis)

Dependent Variable	Bank Efficiency Scores							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS		Heckman Self-Selection					
	Before 2007	After 2007	Before 2007			After 2007		
Instrument			Tax rate	Peer liquidity	Interaction	Tax rate	Peer liquidity	Interaction
Total securitization ratio $_{t-1}$	0.146*** (0.04)	0.125*** (0.03)	0.121*** (0.02)	0.132*** (0.02)	0.123*** (0.02)	0.131*** (0.03)	0.135*** (0.03)	0.137*** (0.03)
Total retained interest ratio $_{t-1}$	0.016 (0.03)	0.065 (0.04)	−0.197 (0.13)	−0.154 (0.10)	−0.133 (0.10)	−0.261 (0.17)	−0.218* (0.12)	−0.241* (0.13)

Dependent Variable	Bank Efficiency Scores							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS		Heckman Self-Selection					
	Before 2007	After 2007	Before 2007			After 2007		
Capital Ratio $_{t-1}$	–1.993*** (0.19)	–1.219*** (0.32)	–1.917*** (0.25)	–2.097*** (0.22)	–2.102*** (0.22)	–2.292*** (0.30)	–2.264*** (0.25)	–2.442*** (0.28)
Bank size $_{t-1}$	–0.022 (0.04)	–0.190*** (0.06)	–0.073 (0.08)	–0.063 (0.08)	–0.072 (0.07)	–0.256*** (0.11)	–0.269*** (0.09)	–0.277*** (0.10)
Diversification ratio $_{t-1}$	1.104 (0.86)	2.285 (3.70)	13.561 (8.27)	11.903 (7.69)	11.598 (7.25)	12.070 (17.35)	12.744 (17.86)	14.796 (18.88)
Bank liquidity ratio $_{t-1}$	–0.003 (0.06)	–0.025 (0.07)	0.083 (0.10)	0.094 (0.09)	0.077 (0.09)	–0.007 (0.11)	–0.029 (0.11)	–0.038 (0.11)
Noninterest expense ratio $_{t-1}$	0.462 (0.32)	0.004 (0.02)	0.641* (0.36)	0.701** (0.32)	0.711** (0.30)	0.052 (0.04)	0.070** (0.03)	0.063* (0.04)
Nonperforming loans ratio $_{t-1}$	4.219*** (1.59)	–0.476 (1.08)	–0.007 (4.43)	2.591 (3.84)	3.788 (3.65)	–3.322 (2.94)	–1.159 (2.56)	–1.308 (2.71)
Local-market power $_{t-1}$	0.160 (0.31)	–0.033 (0.14)	–0.715*** (0.28)	–0.704*** (0.23)	–0.616*** (0.21)	–0.745** (0.36)	–0.816*** (0.26)	–0.863*** (0.28)
Constant	0.680*** (0.03)	0.591*** (0.04)	1.124*** (0.10)	1.098*** (0.08)	1.082*** (0.07)	1.358*** (0.19)	1.313*** (0.11)	1.366*** (0.13)
*Inverse Mills Ratio**			–0.236*** (0.05)	–0.222*** (0.04)	–0.209*** (0.03)	–0.290*** (0.07)	–0.271*** (0.04)	–0.286*** (0.05)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,611	2,788	1,611	1,611	1,611	2,788	2,788	2,788
Adjusted-R^2/Pseudo-R^2	0.1838	0.1838	0.2207	0.2401	0.2425	0.2433	0.2433	0.2182

Note: Appendix 4 presents the results on the impact of securitization on bank efficiency scores with the reference to the 2007–2009 financial crisis. We use both fixed effects and Heckman self-selection methods. We introduce three instruments in Heckman model: (1) *state-level corporate tax rate*; (2) *peer liquidity index*; (3) *state-level corporate tax rate* × *peer liquidity index*. We report the second-step results in columns (3)–(8), and the first-step results in Panel A, Appendix 5. We control for bank and year fixed effects in all regressions. All control variables have been lagged for one year. *T*-statistics are based on robust standard errors clustered by banks. *, **, *** denote statistical significance at the 10%, 5%, and 1% levels respectively. All variable definitions are presented in Appendix 1.

*_Note_: Inverse Mills ratios are calculated from the first-step of Heckman self-selection regression, based on different instruments. In column (3) to (8), we use the label "Tax rate," "Peer liquidity," and "Interaction" to represent the instrument of *state-level corporate tax rate*, *peer liquidity index*, and *state-level corporate tax rate × peer liquidity index*, respectively.

Appendix 5

Panel A Heckman Model First-Step Results (Split Sample)

Dependent Variable	Total Securitization Dummy					
	(1)	(2)	(3)	(4)	(5)	(6)
	Before 2007			After 2007		
Capital Ratio $_{t-1}$	−3.143** (1.27)	−0.707 (0.92)	−2.820*** (1.07)	0.345 (0.89)	0.983 (0.70)	0.281 (0.80)
Bank size $_{t-1}$	0.381 (0.29)	0.177 (0.30)	0.237 (0.30)	0.919*** (0.26)	0.788*** (0.26)	0.814*** (0.26)
Diversification ratio $_{t-1}$	−74.378 (83.10)	−83.947 (87.03)	−76.298 (85.47)	−46.404 (60.99)	−23.253 (71.43)	−23.930 (69.93)
Bank liquidity ratio $_{t-1}$	−0.096 (0.38)	0.164 (0.38)	0.081 (0.38)	0.042 (0.32)	0.216 (0.32)	0.183 (0.32)
Noninterest expense ratio $_{t-1}$	24.401*** (6.27)	−4.604 (5.97)	−5.743 (7.06)	2.283*** (0.67)	−2.493*** (0.49)	−1.878*** (0.45)
Nonperforming loans ratio $_{t-1}$	18.919 (20.44)	54.828*** (19.48)	61.780*** (20.69)	17.042* (8.76)	20.147** (8.45)	19.949** (8.46)
Local-market power $_{t-1}$	7.404*** (0.82)	5.118*** (0.87)	5.794*** (0.84)	5.558*** (0.63)	3.550*** (0.70)	4.121*** (0.67)
State-level corporate tax rate	0.282*** (0.09)			0.166*** (0.06)		
Peer liquidity index		2.869*** (0.44)			1.661*** (0.22)	
State-level corporate tax rate × Peer liquidity index			0.748*** (0.11)			0.375*** (0.05)
Constant	−2.226*** (0.29)	−2.460*** (0.22)	−2.123*** (0.20)	−2.536*** (0.22)	−2.525*** (0.15)	−2.331*** (0.15)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,611	1,611	1,611	2,788	2,788	2,788
Adjusted-R^2/Pseudo-R^2	0.2983	0.2155	0.2124	0.2133	0.2196	0.2431

Panel B Heckman Model First-Step Results (Mortgage and Nonmortgage Securitization)

Dependent Variable	Mortgage Securitization Dummy			Non-Mortgage Securitization Dummy		
	(1)	(2)	(3)	(4)	(5)	(6)
Capital Ratio $_{t-1}$	−2.975** (1.09)	−3.230*** (0.90)	−3.746*** (0.91)	−2.660** (0.83)	−0.471 (0.54)	−1.105 (0.58)
Bank size $_{t-1}$	66.06*** (5.45)	67.22*** (5.45)	67.31*** (5.46)	39.99*** (5.09)	41.05*** (5.12)	40.92*** (5.13)
Diversification ratio $_{t-1}$	0.939*** (0.15)	0.490** (0.17)	0.494** (0.17)	1.317*** (0.16)	0.736*** (0.18)	0.672*** (0.18)
Bank liquidity ratio $_{t-1}$	0.146 (0.27)	0.247 (0.27)	0.231 (0.27)	−1.261*** (0.30)	−1.034*** (0.30)	−0.995** (0.30)
Noninterest expense ratio $_{t-1}$	−6.213* (2.46)	−1.985 (2.53)	−2.101 (2.54)	13.40*** (2.03)	18.21*** (2.10)	18.87*** (2.12)
Nonperforming loans ratio $_{t-1}$	−2.385 (7.75)	−12.18 (8.32)	−12.51 (8.33)	12.68 (7.47)	−1.692 (8.42)	−5.148 (8.66)
Local-market power $_{t-1}$	4.343*** (0.48)	3.707*** (0.50)	3.837*** (0.49)	3.118*** (0.52)	0.804*** (0.59)	1.017 (0.58)
Constant	−11.47*** (0.85)	−11.99*** (0.85)	−11.94*** (0.84)	−9.050*** (0.80)	−8.835*** (0.78)	−8.748*** (0.79)
State-level corporate tax rate	0.782*** (0.07)			0.269*** (0.06)		
Peer liquidity index		0.398*** (0.09)			0.955*** (0.16)	
State-level corporate tax rate × *Peer liquidity index*			0.107*** (0.02)			0.280*** (0.04)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,399	4,399	4,399	4,399	4,399	4,399
Adjusted-R^2/Pseudo-R^2	0.3330	0.3471	0.3633	0.3448	0.3691	0.2065

Note: This table presents regression results on the impact of loan securitization on bank efficiency scores. We use both fixed effects and Heckman self-selection methods. The sample period is 2002–2012. We introduce three instruments in Heckman model: (1) *state-level corporate tax rate*; (2) *peer liquidity index*; (3) *state-level corporate tax rate* × *peer liquidity index*. The first and second step results are reported in the left and right columns within the instrument groups, respectively. To deal with the possible time series issue, all control variables have been lagged for one year. *T*-statistics are based on robust standard errors clustered by banks, where *, **, *** denote statistical significance at the 10%, 5%, and 1% levels respectively. All variable definitions are presented in Appendix 1.

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