

# Exposure to Real Estate in Bank Portfolios

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## Abstract

We implement a three-step procedure to assess the extent of exposure to real estate in commercial banks. First, we investigate the determinants of delinquency on real estate loans. We find the changes in interest rates and income to be the major determinants of aggregate delinquency rate. In the second step, we adopt a stress testing approach to calculate the potential impact on banks' position of any adverse changes in these determinants. These calculations suggest that a 1.3 percentage point increase in mortgage interest rate leads to a 20% decrease in a typical bank's distance to default. Finally, we look at the cross-sectional differences to identify the most vulnerable banks. Banks with rapid loan growth along with high cost-income ratio appear to be the most likely to experience a deterioration in their soundness.

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In 2006, the federal banking agencies issued two guidelines to address their concern that financial institutions have become overexposed to the real estate sector while credit standards and risk management practices in real estate lending have been deteriorating. In particular, the concern was that concentration in commercial real estate loans has reached a level that could lead to undesirable outcomes in the event of a significant downturn. Moreover, expanding use of nontraditional mortgage loans, yet to be tested in a stressed environment, were argued to warrant increased scrutiny.<sup>1</sup>

Such exposure to the real estate sector is a legitimate cause for concern especially when it coincides with increasing property prices giving rise to the financial accelerator effect as demonstrated by Kiyotaki and Moore (1997). Regulators feared a repeat of the widespread commercial real estate failures inciting turmoil in the banking sector in the 1980s and 1990s. Additionally, they urged the lending institutions to maintain strong risk management practices for residential real estate loans as well, reasoning that credit standards tend to deteriorate during the upward phase of economic cycles<sup>2</sup> and certain nontraditional mortgage loans can introduce risks that are unfamiliar to both lenders and borrowers.

Yet, practitioners argued that part of commercial real estate loans (to be specific, multifamily housing) have lower default risk (as traditionally assumed for other

residential real estate loans) and, moreover, commercial real estate loans were much better-secured than they were before, thanks to the developments in mortgage-backed securities markets. Moreover, they worried that a zealous industry-wide attempt to contain risks might choke the lending sector by “slamming the brakes on good loans,” (BNA Daily Report for Executives, Sept. 15, 2006) and lead to the failures that it actually aims to avoid. Instead, practitioners favored a well-measured supervisory response specifically targeted at the institutions with poor risk management practices.

The regulators’ concerns happened to be justified in the summer of 2007 when the news of increasing defaults on subprime mortgage loans hit mortgage-backed securities and triggered what turned out to be one of the most severe financial crises in history. It is an interesting question whether analysis of detailed data on banks and the overall economy could have revealed early warning signs of the problems the banks currently are suffering from.

This paper analyzes the exposure to the real estate sector in commercial banks prior to the financial crisis. We follow a three-step procedure. We first estimate a model of delinquency rates as a function of aggregate variables to identify the factors driving defaults on real estate loans. Then, detailed bank-level data are used to calculate the impact on the soundness of banks of plausible changes in key variables. Finally, we document the distinguishing characteristics of the banks that appear to be the most vulnerable. The novel features of the study, in addition to combining micro and macro data, are the recognition of the two-way causality between credit and real estate cycles and the focus on the impact of widespread real estate loan defaults on bank soundness.

The findings suggest that changes in interest rates and income are the major determinants of aggregate delinquency rate. Residential delinquencies are also affected by unemployment and the availability of credit. The responsiveness to availability of credit conforms with the idea that bank behavior can be excessively aggressive and extend loans to households who, *ex post*, cannot repay their debt. Commercial delinquencies seem to be responsive to a smaller number of variables, but they particularly respond to industry conditions (measured by the vacancy rate) and the debt burden. Stress-testing calculations suggest that a 1.3 percentage point increase in mortgage interest rate leads to a 20% decrease in a typical bank’s distance to default. Finally, based on the analysis of the differences between the most vulnerable banks and the rest of the sample, banks with rapid loan growth along with a high cost-income ratio appear to be the most likely to experience a deterioration in their soundness.

In the light of the events in credit markets that started in the summer of 2007, the findings reported here point to an important regulatory issue. Namely, indicators traditionally used by supervisors do not appear to be the only relevant ones in today’s markets. Real estate exposure and its coverage through usual capital requirements have not given any early warning signs, yet it was the exposures concentrated in off-balance sheet items that triggered problems. Moreover, the

“shadow banking system,” not the commercial banks, constitutes the realm of the turmoil. Having said that, the characteristics of vulnerable banks point to particular issues that regulators and supervisors could have paid more attention to. Hence, there is a need to reconsider the list of relevant indicators and the overall regulatory framework. This paper makes a case for this need in a formal empirical framework.

The rest of the paper is organized as follows. We first recap the related literature on delinquencies on real estate loans. Then we discuss our empirical approach in detail. After introducing the data, we summarize our main findings and discuss their implications.

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### Related Literature

The literature on real estate markets and real estate-related lending is vast, yet there appears to be a divide between studies based on micro and macro data in terms of their focus. Many of the micro-oriented studies using detailed data on individual loans and borrower characteristics concentrate on default probabilities and, to the best of our knowledge, do not consider the impact of defaults on the potential failure of banks. For instance, Quigley, Van Order, and Deng (2000) conclude that, while trigger events such as divorce directly affect the probability of default on residential mortgages, the probability of negative equity is the main time-varying covariate influencing mortgage holders' default decision. Researchers reach contradictory results regarding purely residential (single-family) and commercial (multifamily) mortgages. On one hand, Avery, Bostic, Calem, and Canner (1996) establish the link between loan-to-value ratio and the borrower's credit history as the major determinants of single-family mortgage defaults. Archer, Elmer, Harrison, and Ling (1998), on the other hand, examine defaults on multifamily mortgages and find that origination loan-to-value ratio is a poor indicator of future default while the spread between the loan and market interest rates empirically reflect default risk. For commercial mortgage defaults in general, Vandell, Barnes, Hartzell, Kraft, and Wendt (1993) find that the contemporaneous market loan-to-value ratio to be significant in explaining foreclosures; however, the original debt service coverage ratio (a proxy for short-term cash flow situation) is insignificant. Yet, factors that can explain aggregate default rates and implications for systemic failure of changes in these factors remain more or less not explored. Exceptionally, Elmer and Seelig (1999) look at foreclosures on single-family homes and argue that shocks to house prices and income are the two variables most closely related to the foreclosure rates. But, their analysis employs a meticulously constructed series for foreclosures rather than the readily available delinquency rates, limiting its practical use, and does not consider aggregate rate of commercial mortgage defaults. Moreover, most micro studies rely on cross-sectional dimension of the data more than the time dimension. This raises doubts on the accuracy of the estimates when the impact of macroeconomic variables is in question because of little, if any, variation in the macro variables used.

Macro-oriented studies of real estate markets instead focus on the patterns of movement in prices and activity, as well as their links to the overall economy. Real estate markets, due to certain distinctive features (e.g., rigid supply, infrequent trades, opaqueness, short-term financing for construction together with long-term financing for occupancy), are intrinsically prone to boom-bust cycles. For example, Ball, Morrison, and Wood (1996) and Ball and Wood (1999) find evidence of significant and long period cycles in commercial and residential real estate, respectively.

Against this backdrop, the relation between credit and real estate is an intriguing one. Use of real estate as collateral lets businesses and consumers borrow more during real estate booms, which generally coincides with benign macroeconomic environment (e.g., low inflation and high income growth). As they borrow more, demand for real estate increases, pushing prices even higher and banks keep on lending. But, when the cycle starts turning (generally coinciding with slowing income growth), banks find themselves with nonperforming loans and credit rationing sets in. This is why regulation in real estate lending especially during real estate booms attracts so much attention.

Exhibit 1 illustrates these relations between the business, credit, and real estate cycles by plotting the year-on-year changes in GDP, bank credit to the private sector, and house prices in real terms. Two observations are particularly interesting. First, the real estate cycle moves more closely with the credit cycle than it does with the business cycle. Second, real estate prices appear to have become less correlated with the other cycles since the mid-1990s.<sup>3</sup> All cycles started their downturn in 2006, indicating that the unwinding in the banks' position was to start soon.<sup>4</sup>

Policy-oriented literature has recognized this two-way relationship in which real estate and credit cycles feedback into each other and documented the coincidence between the two cycles (e.g., IMF, 2000; and BIS, 2001). Formal empirical research, however, has been limited, and almost nonexistent in studying the response of aggregate default rates to these cycles and the potential impact on the vulnerability of the banking sector or financial markets in general.

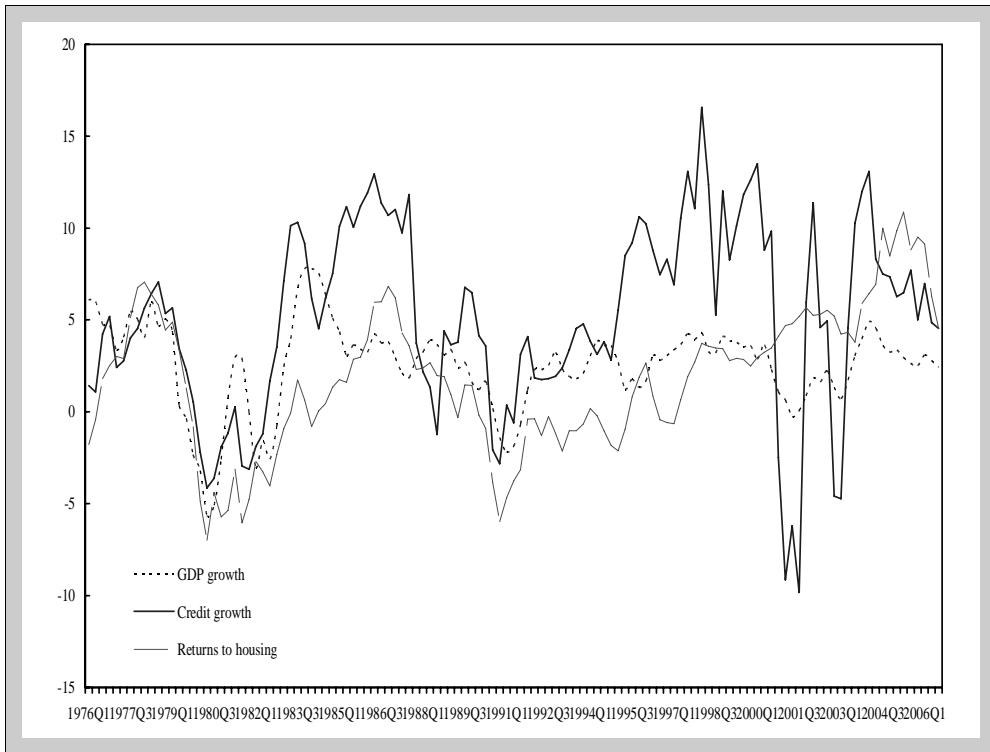
This paper puts micro and macro components together to form a full picture of the exposure to real estate in banks. Following a brief examination of the time trends in real estate-related bank activity, we proceed to find out the extent of exposure and discuss the recent regulations under the light of these findings.

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## Empirical Approach

The objective of this paper is two-fold, seeking answers to the questions: (1) What is the extent of banks' exposure to the real estate sector?; and (2) What are the potential implications of the proposed regulations?

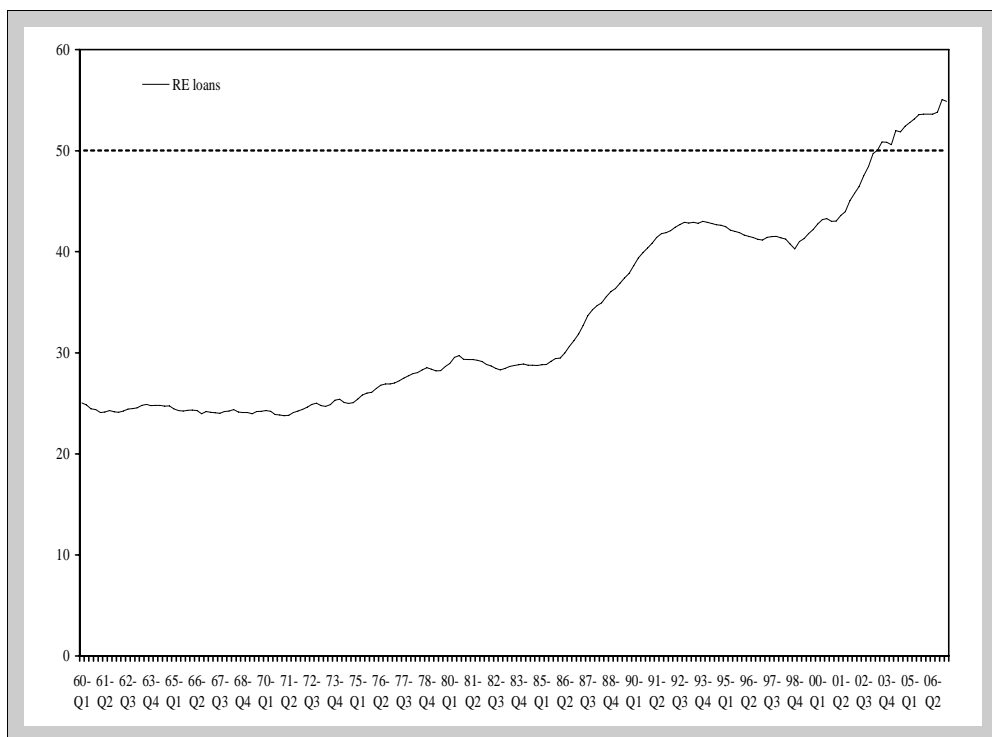
To answer the first of these questions, we examine several indicators to assess the position of the banking sector at the end of 2006 with respect to its exposure to

**Exhibit 1** | Business, Credit, and Real Estate Cycles: 1976–2006

Sources: IMF *International Financial Statistics*, Office of Federal Housing Enterprise Oversight.

the real estate sector. Commercial banks are the largest holders of mortgage debt outstanding. We start with the time-series patterns of real estate-related activity in the commercial banks' balance sheets. Exhibit 2 shows that the weight in commercial banks' loan portfolio of loans secured by real estate has increased. This fact, taken alone, could imply that the real estate exposure of banks is at historically high levels. Actually, the weight of real estate-related loans has steadily increased since the 1960s, but never has reached the levels observed at the end of 2006 even before or during the crisis of early 1990s.

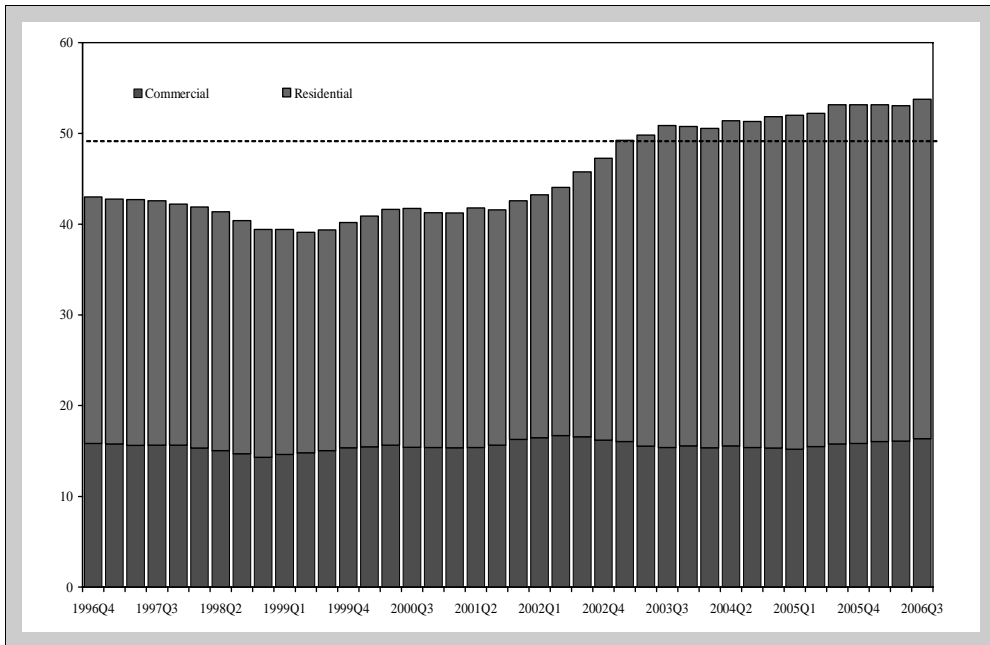
It is, however, interesting to notice that the increase in exposure is actually driven by residential mortgage and home equity loans: the share of commercial real estate loans has been pretty stable (Exhibit 3). Commercial real estate loans are generally considered to be riskier than loans for residential purposes, not only because the primary source of repayment is cash flows from the real estate collateral but also because commercial real estate prices have historically shown more volatility (Exhibit 4).<sup>5</sup> The fact that it is the residential real estate loans that are expanding more rapidly could be comforting if the historical characteristics are assumed to prevail. This, however, might be a rather stringent assumption considering that

**Exhibit 2** | Share of All Real Estate-Related Loans in Banks' Portfolios: 1960–2006

Source: Haver Analytics.

many reports show that the growth in the residential mortgage market has been driven by the “subprime” segment.<sup>6</sup> Also, the proportion of nontraditional loan products that allow borrowers to defer repayment of principal and, sometimes, interest has grown.<sup>7</sup> According to Federal Housing Finance Board’s Monthly Interest Rate Survey, the share of adjustable-rate mortgages grew from 12% in 1998 to 22% in 2006, peaking at 35% in 2004. Ultimately, it was problems in these segments that triggered the current crisis.

These facts relate to an important point: one needs to consider the specific risk characteristics of the assets held and the risk management practices in place to assess the extent of exposure. Although not direct, other measures of real estate exposure, defined relative to the banks’ asset and equity positions, can help demonstrate this point. Exhibit 5 plots the ratio of loans secured by real estate plus the market value of mortgage-backed securities (excluding those issued or guaranteed by U.S. government agencies and enterprises) to total assets, as well as to equity capital. In the upper left-hand panel, one can observe that banks’ exposure to real estate—in loans and securities as a whole—as a percentage

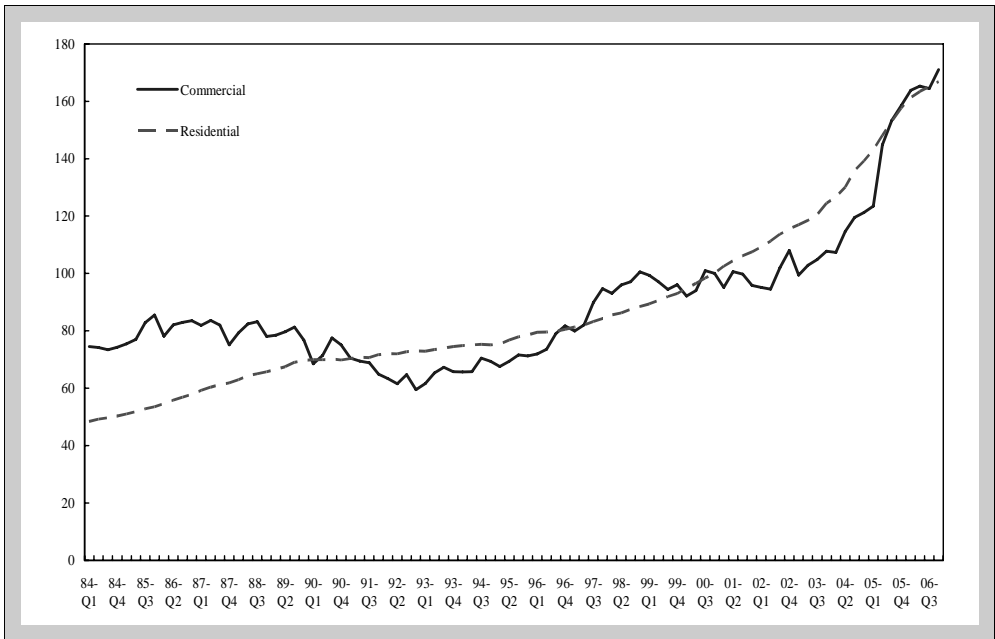
**Exhibit 3** | Share of Real Estate Loans in Banks' Portfolio: 1996–2006

Source: Haver Analytics.

of total assets increased considerably during 2000–2006. Nevertheless, there has been a corresponding increase in equity capital ratio. So, the relative increase in real estate exposure seems to be less pronounced. A similar pattern is visible in the middle panel when one looks at the untapped lines of credit for real estate as a measure of exposure.

Although not wise in retrospect, one could have found comfort in the fact that banks were better capitalized. Nevertheless, why they chose to do so is an important question. The reason might be simply that effective supervision and prudential motives lead banks to build up the cushion against possible losses. Yet, it might also be to compensate for the higher levels of risk in their real estate portfolios or other assets. If this is the case, as it turned out to be, increased scrutiny over banks' lending standards, portfolio performance, and risk management practices would be justified.

In addition to the time-series aspect, it is interesting to explore the variation among banks in their exposure. Identifying the characteristics of the banks that are more vulnerable to deteriorating circumstances is an important tool for efficient and effective supervision. For this purpose, the analysis is composed of three steps. First, controlling for microeconomic reasons of default, we look into the responses

**Exhibit 4** | Real Estate Price Indices: 1984–2006

Source: Haver Analytics.

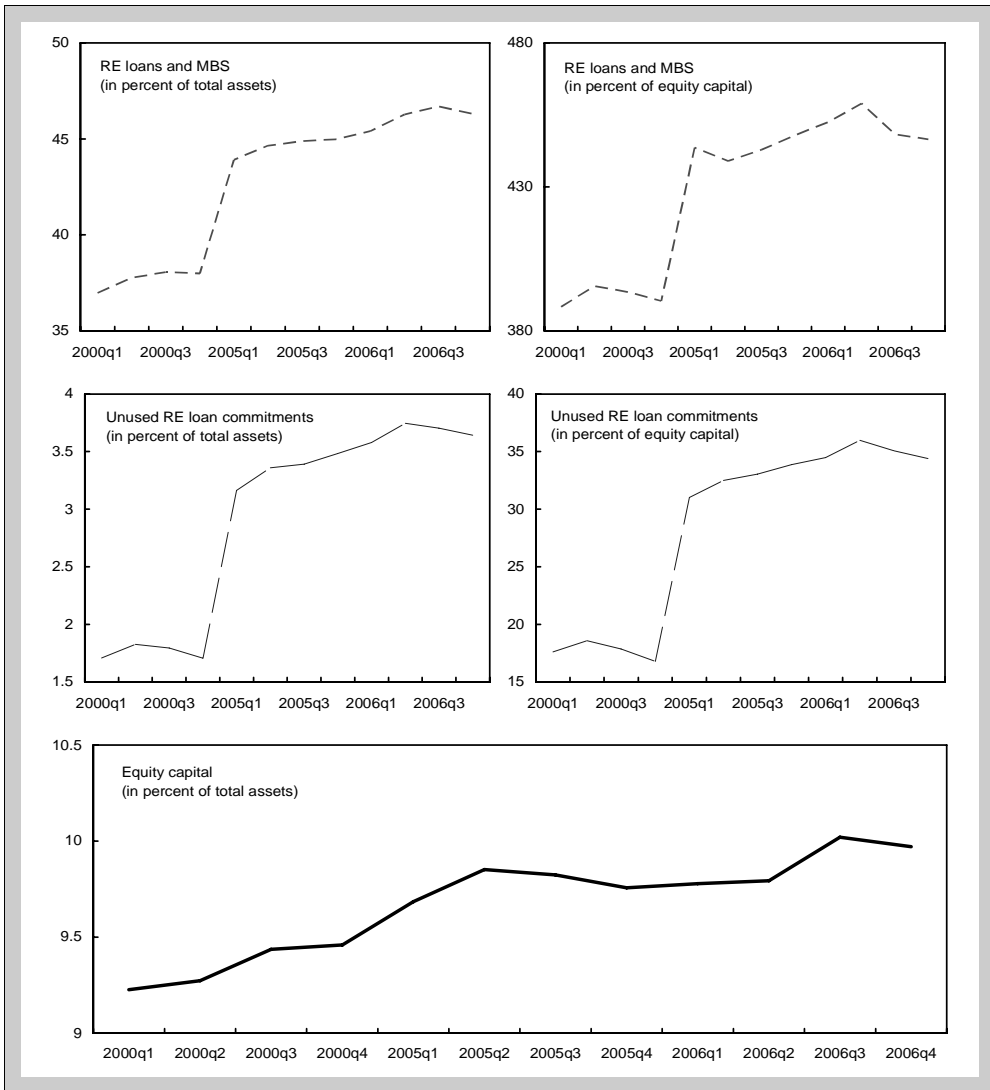
of the aggregate delinquency rates to system-wide shocks. Then, the impact of adverse shocks in key macroeconomic factors on individual banks is calculated. Finally, properties of the banks with the largest exposures are summarized.

### Modeling the Determinants of Delinquencies

Why does a borrower default on a debt? The literature offers two answers to this question. According to the ability-to-pay hypothesis, the borrower will default on the loan when he faces an income shock or an unfavorable change in loan terms makes it implausible to keep up with his payments. While shocks related to the borrower's personal circumstances (divorce, emergency medical care, etc.) tend to lead to default here and there, it is the macro shocks such as rising interest rates or sluggish economic activity that are likely to have a stronger relation with defaults at the aggregate level. More interestingly, the increase in interest rates does not have to stem from movements in the term structure: many adjustable-rate mortgages include an initial period with lower interest rates ("teaser" rates), which reset to the market rate at the end of this initial period. Hence, establishing the relation between interest rates and defaults would enable one to analyze the effect of these special loan products on the borrower's ability to pay.



**Exhibit 5** | Real Estate Exposure: Median Bank: 2000–2006



Source: Federal Reserve Report of Condition and Income database.

Strategic-default hypothesis, alternatively, argues that the borrower will default when the value of the loan is greater than the value of the asset, after taking transaction and reputation costs into account. Especially with collateralized loans, incentives to exercise the option to default will depend on the movements in the underlying asset value. Depressed house prices, for instance, could trigger defaults on residential mortgage loans.

Guided by these hypotheses, we model the aggregated delinquency rate as a function of interest rates, income, debt burden on the borrowers, and the variables that indicate the position on the housing, credit, and business cycles. It is important to repeat the analysis on delinquency rates for residential and commercial real estate loans separately. As Exhibit 6 suggests, residential and commercial real estate markets are likely not only to react differently to the same variables but also to react to different variables.

Using aggregate data, we first estimate the following model of delinquency rate:

$$DR = f(r_L, r_M, \Delta GDP, U, \Delta RPI, L, \Delta C), \quad (1)$$

where  $DR$  is the delinquency rate on real estate loans,  $r_L$  is the bank loan rate,  $r_M$  is the mortgage interest rate,  $\Delta GDP$  is the growth rate of GDP,  $U$  is the unemployment rate,  $\Delta RPI$  is the change in real estate prices,  $L$  is the outstanding real estate loans (accounting for the “burden” on the borrowers), and  $\Delta C$  is the mortgage credit growth between periods  $t-1$  and  $t$ . For residential and commercial real estate delinquencies, we estimate the following equations separately:

$$DR_R = f(r_L, r_M, \Delta DPI, U, \Delta HPI, L_R, \Delta C), \text{ and} \quad (2)$$

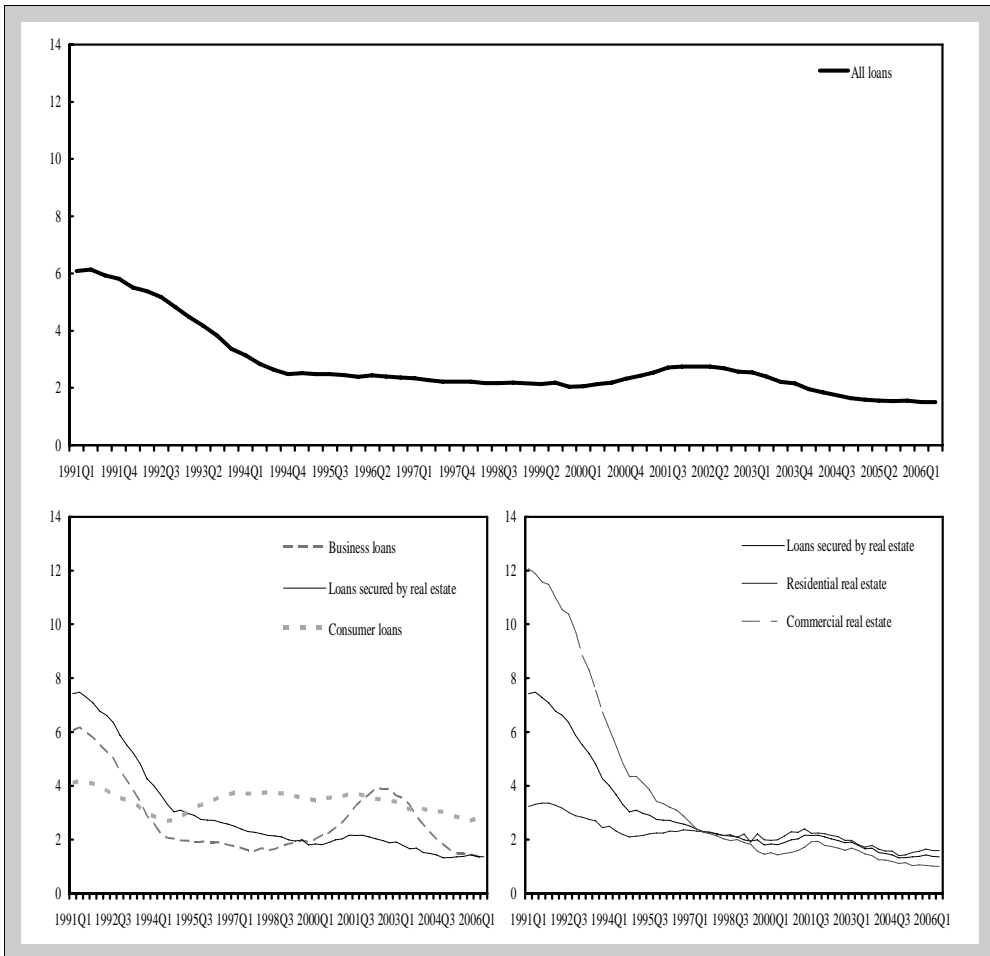
$$DR_C = f(r_L, r_M, \Delta GDP, V, \Delta CREPI, L_C, \Delta C), \quad (3)$$

where  $DR_R$  is the delinquency rate on residential real estate loans and  $DR_C$  is the delinquency rate on commercial real estate loans.  $\Delta DPI$  is the change in disposable personal income,  $V$  is the vacancy rate,  $\Delta HPI$  is the change in house prices,  $\Delta CREPI$  is the change in commercial property prices (including apartments, offices, and industrial and retail space),  $L_R$  is the outstanding residential real estate loans, and  $L_C$  is the outstanding commercial real estate loans. The rest of the variables are as defined above.

### Stress testing<sup>8</sup>

As a proxy for banks’ vulnerability, we use a derivative of distance-to-default ( $DD$ ).  $DD \equiv (k + \mu) / \sigma$ , where  $k$  is the equity capital as percentage of assets,  $\mu$  is the average return on assets, and  $\sigma$  is the standard deviation of return on assets. Deriving on the option pricing formula, typically, market data are combined with accounting data to calculate the market value and volatility of assets. In our simpler version, also known as the  $z$ -score, we calculate  $DD$  based only on balance sheet and income statement data. A larger value of  $DD$  indicates a lower probability of insolvency.

**Exhibit 6** | Delinquency Rate: 1991–2006



Source: Federal Reserve.

To assess banks’ vulnerability, first, predicted aggregate delinquency rates under plausible scenarios are mapped into banks. The main assumption is that the distribution of delinquencies across banks remains unchanged. An example could help illustrate this point. Suppose there are two banks in the system, A and B, where bank A has 5 delinquent loans out of 50 and bank B has 20 delinquent loans out of 100. Hence, bank A and B have 10% and 20% delinquency rates, respectively, and the aggregate delinquency rate is 16.6% (25/150). If the aggregate delinquency rate was to increase to 20%, the delinquency rate in bank A would increase to 12% and that in bank B would become 24%, keeping the ratio of delinquencies in bank A to those in bank B at its original level (1 to 2).

Once the mapping is completed, we recalculate  $DD$  assuming that the increase in delinquencies would decrease income from loans proportionately. The change in  $DD$  indicates how much closer the bank is to insolvency as a consequence of the increase in the delinquency rate. This allows us to split the banks into several categories depending on their response to specific macro shocks, allowing us to determine which banks are more at risk.

### Determinants of Vulnerability

The final part in our approach builds on the last idea discussed in step 2 (i.e., pinpointing which characteristics are more important to determine exposure to risk). This part is more concerned with policy implications and looks into how the change in distance to default depends on bank characteristics, such as size, geographic location, and other exposures. Hence, we look at the following regression equation using bank-level data:

$$ADD_i = g(S_i, CI_i, NIM_i, LD_i, LOC_i, RE_i), \quad (4)$$

where  $S$  is the bank size (measured as log of total assets),  $CI$  is the cost-to-income ratio,  $NIM$  is the net interest margin,  $LD$  is the loan-to-deposit ratio,  $LOC$  is the location (to capture state-specific shocks), and  $RE$  is the percentage of loans that are related to real estate. This is a cross-section analysis where the dependent variable is the estimated change in distance to default (from step 2) and the independent variables are historical averages.

Finally, we also use a panel data model to enhance our understanding of the determinants of the delinquency rate in real estate loans,  $DR$ , defined as  $(RealEstateNonperformingLoans + RealEstateNonaccruals) / (TotalRealEstateLoans)$ , at the bank level. This analysis uses  $DR$  as its dependent variable and the same independent variables as the cross-section analysis described above, but now we use both year-to-year and cross-sectional variation and we introduce a time-fixed-effect and a measure of individual banks' credit growth. Hence, the regression equation to be estimated using panel data is:

$$DR_{it} = h(S_{it}, CI_{i,t-1}, NIM_{i,t-1}, LD_{i,t-1}, RE_{i,t-1}, LOC_i, CG_{it}, TFE_t), \quad (5)$$

where  $TFE$  is the time-fixed-effect (to capture common movements),  $CG$  is the credit growth in bank  $i$  from period  $t - 1$  to  $t$  and other variables are essentially as defined above (keeping in mind that we no longer use averages).

These models allow us to understand where regulation should be directed (i.e., what the main determinants of exposure to real estate risk are and what type

of regulations could be more effective). Thus, they enable us to provide an assessment of the proposed regulations.

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## Data

We utilize both macro and micro data at quarterly frequency. In the first and second steps, aggregate data compiled by federal agencies are used. The macroeconomic data for the analysis come from IMF International Financial Statistics database. These steps examine the relationship between aggregate delinquency rates and major economic factors during 1987–2006. The final step of the study relies on detailed bank accounting data to examine the loan composition and structure for U.S. banks from 1986 to 2006. The main data source is the Report of Condition and Income database (Call Report Files) that provides the balance sheets and income statements for all banks regulated by the Federal Reserve System. Breakdowns of loans in non-accrual status and information on nonperforming loans are used to compute the delinquency rate at the bank level.

Following the discussion in the previous section, we model the decision to go delinquent on a loan as a function of interest rates, income, real estate prices, and credit conditions. Here, interest rates, income, and outstanding loans, proxying for debt burden, represent the factors affecting the borrower's ability to pay. Inclusion of bank credit pertains to another aspect of payment capacity, namely, the ease of credit in the financial system, which is important when refinancing is offered as an option to delinquency. Real estate prices reflect the possibility of strategic default. As mentioned earlier, residential and commercial real estate loans are analyzed separately and factors that are likely to be more relevant for each type are employed as explanatory variables. For instance, while unemployment is linked to delinquencies in residential real estate loans, vacancy rate is a better proxy for economic activity related to delinquencies in commercial real estate loans. As for the bank-level analysis in step 3, we use CAMEL measures as determinants of bank soundness and control for bank characteristics such as size, growth, and exposure to real estate.<sup>9</sup> Exhibit 7 explains the variables used in the analysis while Exhibit 8 presents the summary statistics.

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## Results

### What Leads to Delinquencies?

To find out which factors have the largest impact on aggregate delinquency rates while taking the feedback effect between the credit and real estate cycles into account, we use a vector error correction framework.<sup>10</sup> Exhibit 9 presents the estimates for aggregate delinquency rates on all real estate loans while Exhibits 10 and 11 show the results for residential and commercial real estate loans separately.

**Exhibit 7** | Definition and Source of Variables

Variable	Definition	Source
Aggregate Delinquency rate	Loans secured by real estate that are past due thirty days or more and still accruing interest as well as those in nonaccrual status, expressed as a percentage of end-of-period loans (available separately for residential and commercial real estate)	FFIEC
Mortgage interest rate	Contract interest rate on commitments for fixed-rate first mortgages	FHLMC
Bank loan rate	Rate posted by a majority of top 25 (by assets in domestic offices) insured U.S.-chartered commercial banks	FED
Disposable personal income	Personal income less personal current taxes	BEA
GDP	Gross domestic product	IFS
Unemployment	Unemployment rate	IFS
Vacancy rate	Proportion of real estate inventory which is vacant for industrial, office, or residential rental use	BC
Bank credit to the private sector	Loans extended to private corporations and individuals by commercial banks	IFS
Outstanding real estate loans	Stock of real estate-related loans (available separately for residential and commercial real estate)	FED
Real estate price index	Transaction-based prices of real estate properties (available separately for residential and commercial real estate)	OFHEO <sup>a</sup>
Bank Level Distance to default	Sum of equity capital and return on assets divided by return volatility, calculated on a rolling basis	FED <sup>b</sup>
Size	Logarithm of total bank assets	FED <sup>b</sup>
Net interest margin	Difference between interest expense and interest income, expressed as a percentage of average earning assets	FED <sup>b</sup>
Cost-income ratio	Total costs divided by total income	FED <sup>b</sup>
Loan-deposit ratio	Total loans divided by total deposits	FED <sup>b</sup>
Share of real estate in loan portfolio	Loans secured by real estate divided by total loans (available separately for residential and commercial real estate)	FED <sup>b</sup>
Credit growth	Growth rate of total real estate loans (available separately for residential and commercial real estate)	FED <sup>b</sup>

*Notes:* Abbreviations: FFIEC; Federal Financial Institutions Examination Council; FHLMC: Federal Home Loan Mortgage Corporation; FED: Federal Reserve Board; BEA: Bureau of Economic Analysis; IFS: IMF International Financial Statistics; BC: Bureau of the Census; OFHEO: Office of Federal Housing Enterprise Oversight.

**Exhibit 7** | (continued)

## Definition and Source of Variables

<sup>a</sup>Authors' calculations using the single-family home price index by OFHEO and commercial real estate transaction-based price index constructed by MIT Center for Real Estate

<sup>b</sup>Authors' calculations using the Report of Condition and Income database maintained by Chicago FED.

**Exhibit 8** | Summary Statistics

Variable	Mean	Std. Dev.
Aggregate		
Delinquency rate on all real estate loans	3.58	0.24
Delinquency rate on residential real estate loans	2.85	0.25
Delinquency rate on commercial real estate loans	2.73	0.48
Mortgage interest rate	2.05	0.19
Bank loan rate	1.99	0.28
Disposable personal income	8.68	0.30
GDP	9.07	0.14
Unemployment	1.70	0.17
Vacancy rate	2.29	0.12
Bank credit to the private sector	9.43	0.32
Outstanding real estate loans	7.07	0.50
Outstanding residential real estate loans	6.44	0.57
Outstanding commercial real estate loans	6.20	0.45
Real estate price index	5.05	0.24
Residential real estate price index	5.37	0.28
Commercial real estate price index	4.73	0.22
Bank Level		
Distance to default	33.63	16.30
Size	11.69	1.45
Net interest margin	2.31	1.20
Cost-income ratio	130.51	21.78
Loan-deposit ratio	78.69	20.46
Share of real estate in loan portfolio	62.40	22.09
Share of residential real estate in loan portfolio	28.88	19.38
Share of commercial real estate in loan portfolio	21.80	15.93
Credit growth in real estate loans	3.40	8.89
Credit growth in residential real estate loans	2.67	10.10
Credit growth in commercial real estate loans	4.30	12.00

Note: All aggregate data series are seasonally adjusted and are in logs.

**Exhibit 9** | VEC Estimation Results: Delinquency Rate on Real Estate Loans

	Estimation Period: 1987–2006	
	Coeff.	t-Stat.
Delinquency Rate		
(L1)	-0.20*	-1.61
(L2)	-0.07	-0.60
Bank Loan Rate		
(L1)	-0.03	-0.34
(L2)	0.07	0.81
Mortgage Interest Rate		
(L1)	-0.04	-0.36
(L2)	-0.001	-0.01
GDP		
(L1)	-0.34	-0.87
(L2)	-0.39	-0.95
Real Estate Price Index		
(L1)	-0.01	-0.08
(L2)	0.30**	2.63
Outstanding Real Estate Loans		
(L1)	0.16	0.63
(L2)	0.03	0.14
Bank Credit to the Private Sector		
(L1)	-0.17*	-1.94
(L2)	-0.08	-0.91
Constant	-0.002	0.31

Based on these estimation results, we plot the impulse response functions demonstrating the accumulated impact of a one standard deviation change in the variable of interest on the delinquency rate. Exhibit 12 shows that real estate loan delinquencies are most likely to be driven by changes in the mortgage interest rate and real estate prices, in line with Elmer and Seelig (1999). Overall delinquency rates on real estate loans respond strongly to changes in mortgage interest rates, yet, as expected, delinquency behavior for residential real estate and commercial real estate loans differ considerably. In particular, residential real estate loans are more sensitive to interest rate changes, as well as to changes in household income and unemployment rates, reflecting the arguments set forth in the ability to pay hypothesis. While rising mortgage interest rates lead to an increase in delinquencies as more borrowers find it harder to make their payments, an increasing house price also appears to be linked to a higher delinquency rate. Looking at residential and commercial delinquency rates separately, however,



**Exhibit 10** | VEC Estimation Results: Delinquency Rate on Residential Real Estate Loans

	Estimation Period: 1987–2006	
	Coeff.	t-Stat.
Delinquency Rate		
(L1)	-0.39**	-3.41
(L2)	-0.16*	-1.42
Bank Loan Rate		
(L1)	-0.45**	-3.66
(L2)	0.02	0.15
Mortgage Interest Rate		
(L1)	-0.09	-0.80
(L2)	-0.06	-0.38
Disposable Personal Income		
(L1)	-0.60*	-1.73
(L2)	-0.83**	-2.67
Unemployment		
(L1)	-0.41***	-6.44
(L2)	-0.24***	-4.69
Residential Real Estate Price Index		
(L1)	0.59*	1.58
(L2)	0.22	0.57
Outstanding Residential Real Estate Loans		
(L1)	0.10	0.48
(L2)	-0.02	-0.12
Bank Credit to the Private Sector		
(L1)	-0.34***	-3.50
(L2)	-0.19*	-1.62
Constant	0.01*	1.46

reveals that rising property prices are negatively related to delinquencies on commercial real estate loans (Exhibits 13 and 14). Commercial real estate loans also appear to come under pressure on the face of increased debt burden and movements in the business cycle, as demonstrated in the delinquency rate's response to GDP and vacancy rates. These results suggest that the delinquencies on commercial real estate loans can be better explained by strategic behavior, as suggested by Vandell, Barnes, Hartzell, Kraft, and Wendt (1993), whereas the positive relation between (residential) house prices and delinquency rate is inconsistent with the strategic default hypothesis, in contrast to Quigley, Van Order, and Deng (2000). A potential explanation for this, nevertheless, could be households borrowing beyond their means.

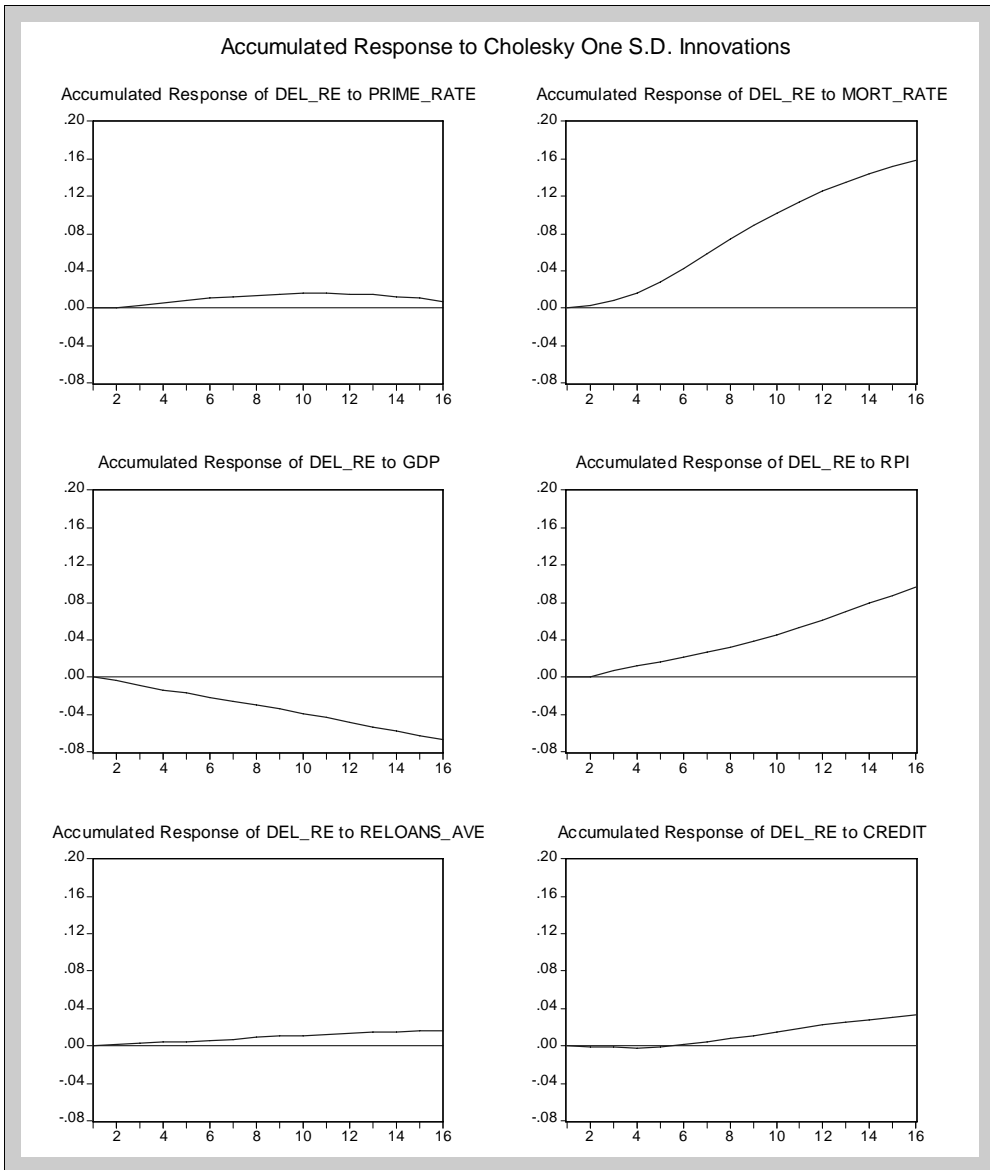
**Exhibit 11** | VEC Estimation Results: Delinquency Rate on Commercial Real Estate Loans

	Estimation Period: 1987–2006	
	Coeff.	t-Stat.
Delinquency Rate		
(L1)	−0.50**	−2.77
(L2)	−0.14	−0.81
Bank Loan Rate		
(L1)	0.21	0.98
(L2)	0.10	0.57
Mortgage Interest Rate		
(L1)	−0.28*	−1.55
(L2)	−0.35*	−1.78
GDP		
(L1)	2.72**	2.76
(L2)	2.15**	2.20
Vacancy Rate		
(L1)	0.10	0.25
(L2)	0.97**	2.52
Commercial Real Estate Price Index		
(L1)	0.06	0.46
(L2)	0.05	0.38
Outstanding Commercial Real Estate Loans		
(L1)	0.60	1.04
(L2)	0.44	0.76
Bank Credit to the Private Sector		
(L1)	−0.11	−0.56
(L2)	−0.30*	−1.66
Constant	−0.06**	−2.93

### *Can the Banking Sector Survive an Economic Downturn?*

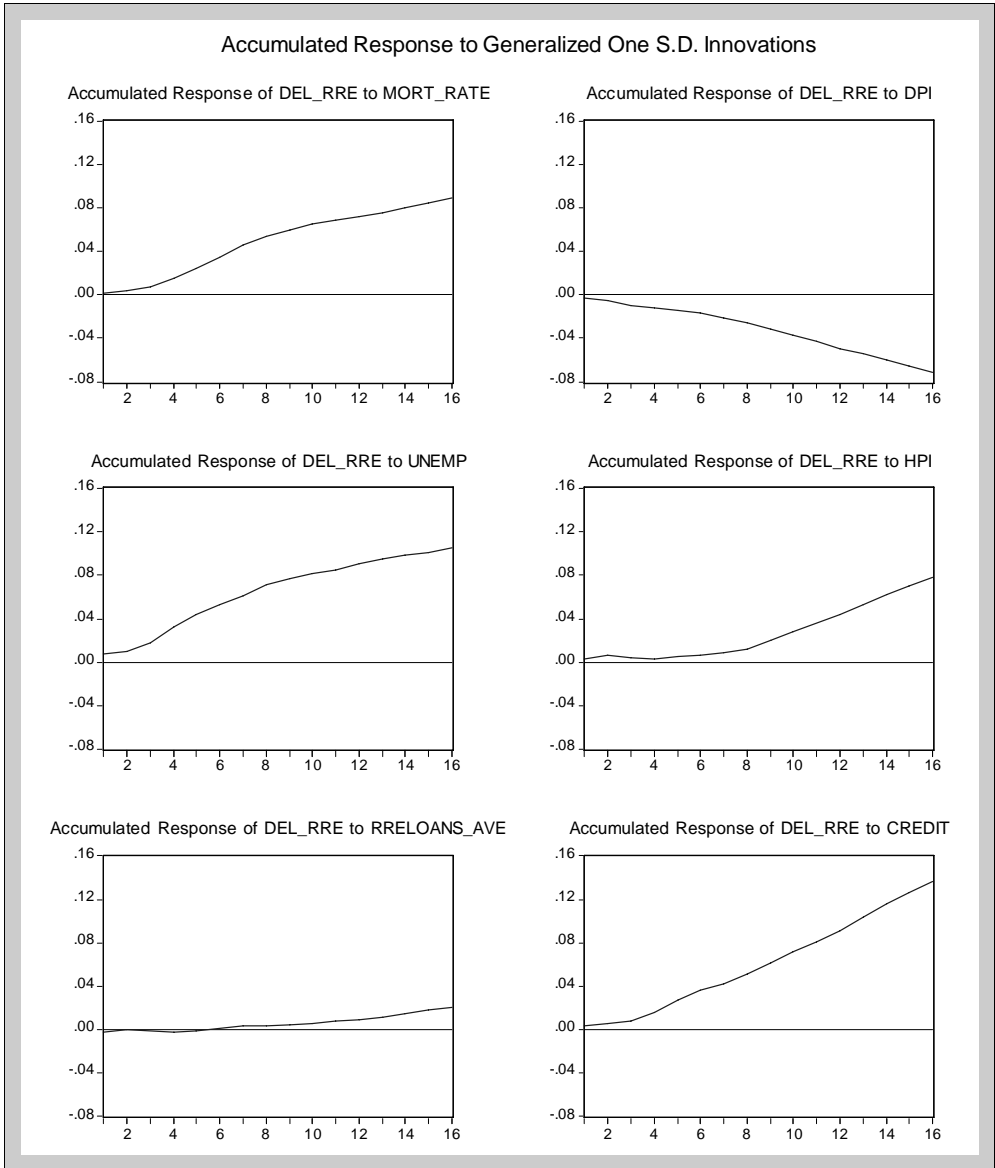
Findings from the first step of our analysis suggest that mortgage interest rates are important in determining delinquency rates on real estate loans. Specifically, a one standard deviation increase in the mortgage interest rate could trigger a 1.1 percentage point accumulated increase in the real estate loan delinquency rate over four years. Since interest rates can be taken as an indicator of other changes in the economy, we treat an increase in interest rates as the sign of economically hard times and calculate the impact on the average real estate loan portfolio.<sup>11</sup> Increase in interest rates might curb demand for home purchase loans and initiate a slowdown in house price appreciation; hence, looking at the impact of higher interest rates could shed light on the consequences of a glum real estate market.

**Exhibit 12** | Delinquency Rate on Real Estate Loans to Major Determinants



This stress-testing exercise also encompasses the potential effects of resetting interest rates on adjustable-rate mortgages.

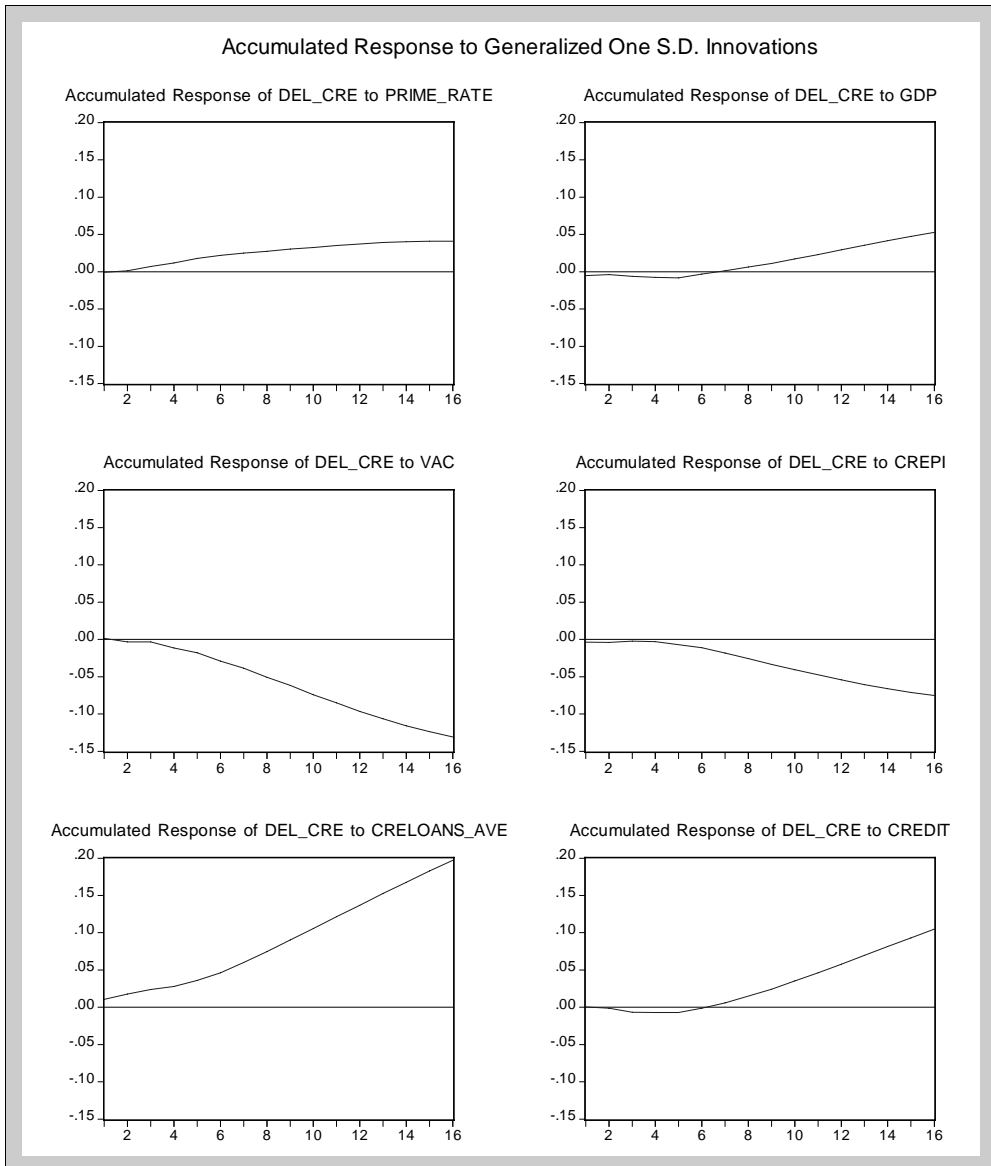
A typical bank in 2006, with a delinquency rate of 2.0% and real estate share of 66.6% in its loan portfolio, would suffer an interest income drop equal to 10.3% were the delinquency rate to experience a 1.1 percentage point increase and rise

**Exhibit 13** | Response of Delinquency Rate on Residential Real Estate Loans to Major Determinants

to 3.1%. This would correspond to a 20% decrease in the bank's distance to default, indicating an increased likelihood of solvency problems.

One could interpret these average figures as justification for a widespread regulatory move on commercial banks' real estate lending activities. On a bank-by-bank basis, however, less than 1% of the banks carry the risk of becoming

**Exhibit 14** | Response of Delinquency Rate on Commercial Real Estate Loans to Major Determinants



insolvent (i.e., distance to default measure entering the negative territory). Four-fifths of these banks have exposure to real estate in their loan portfolios in excess of the sample average of 66.6% and three-fourths of them have exposure exceeding the median value of 70.84%. These indicate a high degree of asymmetry between vulnerable and sound banks in terms of their exposure to real estate.<sup>12</sup> To explore these issues further and evaluate the merits of an industry-wide

regulation, we look into the differences across banks depending on the estimated response of the distance to default measure to the change in interest rates.

### Who are the Vulnerable Banks?

Exhibit 15 shows the summary statistics for the least and most vulnerable banks, where the least and most vulnerable banks are defined by the top and bottom quintiles with respect to the change in the distance to default measure. It appears to be the case that banks with high loan-deposit ratios and large share of real estate loans in their lending activities are more likely to be among the most vulnerable. Next, we investigate whether these characterizations remain valid in the regression analysis. Exhibit 16 shows the results of estimating the cross-sectional equation:

$$\begin{aligned} \Delta DD_i = & \alpha + \beta_1 S_i + \beta_2 CI_i + \beta_3 NIM_i + \beta_4 LD_i + \beta_5 RE_i \\ & + \beta_6 LOC_i + \varepsilon_i, \end{aligned} \quad (6)$$

while Exhibit 17 presents the results of estimating the panel data equation:

$$\begin{aligned} DR_{it} = & \alpha + \beta_1 S_{it} + \beta_2 CI_{i,t-1} + \beta_3 NIM_{i,t-1} + \beta_4 LD_{i,t-1} \\ & + \beta_5 RE_{i,t-1} + \beta_6 CG_{it} + \gamma_1 LOC_i + \gamma_2 TFE_t + \varepsilon_{it}, \end{aligned} \quad (7)$$

**Exhibit 15** | Summary Statistics by Vulnerability

	Least Vulnerable		Most Vulnerable	
	Mean	Std. Dev.	Mean	Std. Dev.
Distance to default	30.89	16.85	39.28	17.82
Default rate on real estate loans	1.62	4.47	3.08	2.83
Size	11.86	2.06	11.69	1.16
Net interest margin	2.18	1.33	2.33	1.16
Cost-income ratio	130.21	29.75	128.08	17.54
Loan-deposit ratio	75.80	23.77	83.12	18.87
Share of real estate in loan portfolio	53.41	29.40	72.31	16.58
Credit growth	3.95	11.55	2.22	5.77

**Exhibit 16** | Characteristics of Vulnerable Banks: Cross-Section Analysis

	Coeff.	t-Stat.
Size	-0.086***	-5.99
Net interest margin	-0.218***	-7.65
Cost-income ratio	-0.003***	-2.91
Loan-deposit ratio	-0.002	-0.76
Share of real estate in loan portfolio	0.007***	5.72
Constant	3.851***	19.90

Note: The dependent variable is Change in DD.

**Exhibit 17** | Characteristics of Vulnerable Banks: Panel Data Analysis

	Coeff.	t-Stat.
Size	-0.093***	-7.24
Net interest margin	0.044***	4.79
Cost-income ratio	-0.001***	-5.94
Loan-deposit ratio	-0.003	-0.19
Share of real estate in loan portfolio	-0.018***	-6.25
Credit growth	-0.004***	-2.84
Constant	-0.246***	-8.03

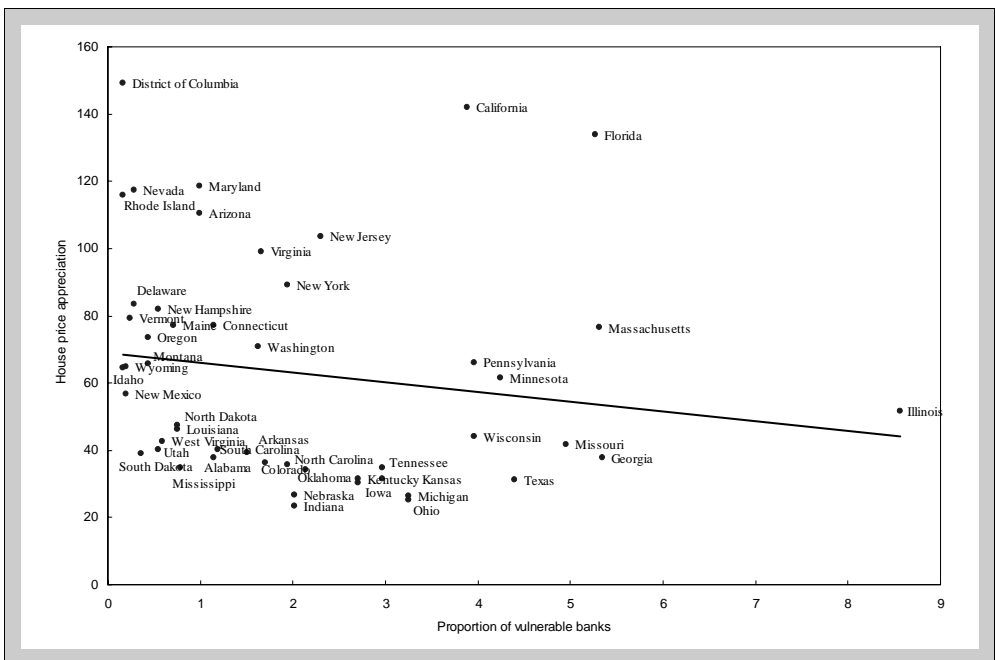
Note: The dependent variable is DR.

where coefficients on location and time dummies are suppressed for sake of brevity.

These regression results partially confirm the picture that emerges from examining the summary statistics. The small difference between the average size of least and most vulnerable banks is apparently not statistically significant. Actually, larger banks have a higher likelihood of facing troubles in the event of an economic downturn, which is somewhat puzzling at first sight because they tend to have lower delinquency rates on their real estate loans. Yet, further investigation of the relation between size and delinquency rates reveal that delinquency rates increase more in the case of an economic downturn in larger banks. In the cross-sectional regressions, banks with high net interest margins, although profitable, appear to

be more vulnerable to shocks brought about by changes in the interest rates both through the direct impact and through the indirect impact of increased delinquency rates triggered by the higher interest rates. Panel data regressions suggest that this could be because these banks take on riskier loans as they tend to have relatively more delinquent real estate loans. Less efficient banks, as indicated by the coefficient on cost-income ratio in Exhibit 17, would experience a sharper drop in their distance to default although they do not necessarily have higher rates of delinquent loans in their real estate portfolios, as seen in Exhibit 18. This points out the importance of management quality and the associated enhanced efficiency. Banks that have high shares of real estate loans in their portfolio, probably because they tend to have a relatively lower proportion of nonperforming real estate loans, do not appear to be more vulnerable. One potential explanation for this seemingly puzzling finding is that these banks have relatively more income from other activities that could offset the downfall in income from their real estate loan portfolios. Alternatively, one could argue that these banks choose to “specialize” in real estate lending because they have an ability to make better loans in this market, and hence, a lower rate of delinquency. If they are also good at managing the associated risks, then they will not appear to be any more vulnerable than banks that do not specialize in real estate lending. Finally, banks that extend credit faster tend to have higher real estate loan delinquency rates, which points out to aggressive lending practices during phases of rapid credit expansion.

**Exhibit 18** | Bank Vulnerability and House Price Appreciation between 2000 and 2006





Location also could be an important factor as real estate loans are particularly sensitive to local housing market conditions. Exhibit 18 gives a list of the top ten states in the distribution of the most vulnerable banks across states.<sup>13</sup> It is interesting to notice that some of these states, such as Florida and California, have been among the places experiencing stronger real estate price booms than others in the past few years. Exhibit 19 illustrates this insight further. Hence, the event of downturn in the housing cycle might have a higher probability of happening in these states where house price appreciation has been higher, making the borrowers and the lenders more vulnerable.

### What is the Likely Impact of Recent Regulations?

Supervisory and regulatory policy discussions at the end of 2006 and the beginning of 2007 focused on commercial real estate exposure and the potential risks associated with nontraditional mortgage loans. Looking at the composition of real estate loans in banks' portfolios, it is hard to argue that concentration in commercial real estate loans poses an immediate concern. Relative share of commercial real estate loans has been stable while the increase in banks' exposure to real estate has been driven by an increased share of residential real estate loans. Moreover, the gap between commercial and residential real estate loans in terms of level and volatility of delinquency rates has narrowed in the past decade. Hence, given the increasing concentration in residential real estate loans, along with the converging risk profile of this type of loans, the concern on the use of nontraditional mortgage products to expand residential real estate loan portfolios appear to be quite relevant.

That said, our analysis also reveals that there is considerable variation in the extent of exposure among banks. Therefore, more refined measures such as the intensified

**Exhibit 19** | Most Vulnerable Banks: Distribution by State

State	%
Illinois	8.56
Georgia	5.35
Massachusetts	5.31
Florida	5.27
Missouri	4.95
Texas	4.40
Minnesota	4.24
Pennsylvania	3.96
Wisconsin	3.96
California	3.88

supervision of most vulnerable banks and guidance targeted on specific risk factors would be preferable. In particular, given the importance of mortgage interest rates and the expanding use of adjustable-rate mortgages in riskier segments of the borrower pool, supervisors should encourage sound risk management practices regarding such products and closely monitor the status of those institutions that use such products more frequently.<sup>14</sup>

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## Conclusion

In the five years to March 2007, house prices grew at an annual rate of 8% while outstanding mortgage debt almost doubled. In residential versus commercial comparison, it was the residential real estate prices and real estate loans contributing more to the overall growth. Share of real estate-related loans in the same period increased from 42.6% to 56.5% where subprime lending at nontraditional terms was the fastest growing segment of the residential mortgage market. The analysis conducted here using information on commercial banks' balance sheets right before the financial crisis of 2007–08 stormed the economy suggests that not all banks had the capacity to absorb the consequences of potential adverse movements in interest rates and house prices. Vulnerable banks tend to expand loans rapidly, have poor efficiency records and high real estate lending activity levels, and include those located in a number of states some of which had experienced a house price boom. While it may come as no surprise that inefficient banks are more likely to run into trouble, we identify another generally-overlooked characteristic, namely, the rate of loan growth, as an indicator of vulnerability. In the light of the events that took down some institutions in 2007 and 2008, it appears to be the case that there were some vulnerability pockets that could have been detected back in 2006.

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## Endnotes

- <sup>1</sup> See “Interagency Guidance on Nontraditional Mortgage Product Risks,” dated September 29, 2006, and “Concentrations in Commercial Real Estate Lending, Sound Risk Management Practices,” dated December 9, 2006, available at <http://www.federalreserve.gov/boarddocs/press/bcreg/2006>.
- <sup>2</sup> See Ruckes (2004), and references therein, for theoretical frameworks explaining cyclical variation in credit standards. Asea and Blomberg (1998) provide evidence on lax lending during the expansionary phase of the business cycle. Jimenez and Saurina (2006) present similar evidence for Spain.
- <sup>3</sup> Indeed, the correlation between credit movements and house prices was 0.74 between 1976 and 1990, but dropped to 0.13 between 1991 and 2006. Similarly, the correlation between income changes and house prices was 0.53 between 1976 and 1990, but dropped to 0.13 between 1991 and 2006.
- <sup>4</sup> At the time of the writing of the first version of this paper, the unwinding had not started, yet it is obvious now that the banking system is under distress as predicted.

- <sup>5</sup> In the period shown, for instance, the annualized volatility of commercial real estate price index was 3.44 percentage points while that of the residential real estate price index was 1.77 percentage points.
- <sup>6</sup> Subprime mortgages are defined as those loans offered to borrowers with higher risk profiles. According to *Inside Mortgage Finance*, the share of subprime lending increased from 9% in 2000 to 20% in 2006. In absolute terms, the change was from \$120 billion to \$600 billion.
- <sup>7</sup> These include interest-only mortgages, where the borrower does not pay any loan principal during the first few years of the loan, and payment-option adjustable-rate mortgages, where the borrower has flexibility over the amount he pays with the potential for negative amortization.
- <sup>8</sup> It should be noted that the stress testing exercise assumes that banks do not respond to changing market conditions, and hence, does not consider the dynamic nature of risk management practices. The implication is that the results of the stress testing exercise represent a worst case scenario of bank probabilities of encountering financial distress. Responsive managers can mitigate the problems by imposing stricter underwriting standards and enhanced scrutiny of loan applications.
- <sup>9</sup> CAMEL is a rating system used widely by bank supervisors. The main idea is assigning a score to each bank based on five factors: capital adequacy, asset quality, management, earnings, and liquidity. Lately, a sixth factor, sensitivity to market risk, was added, changing the acronym to CAMELS. For more information on CAMEL(S), see, among others, Lopez (1999).
- <sup>10</sup> Before proceeding with the regression analysis, we check if the data series we are using are stationary. All series are found to be I(1) at high levels of significance, with the slight exception of outstanding commercial real estate loans, for which the null hypothesis of the first difference of having a unit root is rejected at the 10% significance level. Then, we determine the number of cointegrating relationships. The test statistics support the existence of two cointegrating relationships for real estate loans at the 5% significance level. For residential and commercial real estate loans, the number of cointegrating relationships is one and three, respectively. Tables summarizing the unit root and Johansen cointegration tests are available on request.
- <sup>11</sup> Higher interest rates here imply a decreased ability to make payments because the cost of borrowing is higher. This might occur, for instance, as economic activity reaches its peak and monetary stance tightens.
- <sup>12</sup> Summary statistics also point to a great degree of skewness in the distribution of key variables across banks. For instance, while the median delinquency rate stands at 2%, the mean is closer to 4%. Hence, it is possible that a small number of banks find themselves in serious distress, potentially spreading the problems elsewhere in the financial system through cross holdings.
- <sup>13</sup> For banks operating in multiple states, the data are rearranged at the state level. For example, Wachovia appears as several entities in the database as Wachovia California and Wachovia Arizona. Therefore, the location variable reflects the situation associated with the location of the loan activity and/or property.
- <sup>14</sup> An equally important development in mortgage markets has been the increased degree of securitization. The analysis here focuses on the traditional measures of exposure while supervisors should also watch the exposure through asset-backed security holdings.

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