Availability of Credit and Loan Default: A Look at the Commercial Mortgage Supply Cycle

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Abstract. **This study uses a structural equation approach to assess the presence of a credit supply effect in the commercial mortgage market and the lenders' ability to incorporate expectations about this effect into their lending policies. A credit supply effect is defined as the effect of mortgage supply on the level of loan defaults. The empirical analysis shows two important results. First, changes in loan defaults appear to be preceded by changes in commercial mortgage supply with a lag of approximately four to five years. Second, lenders tend to behave myopically, failing to incorporate expectations about the credit supply effect into their lending policies. Additionally, a simulation suggests that adequate timing of the mortgage supply cycle is crucial in limiting the incidence of mortgage default.**

Introduction

This study uses a structural equation approach to assess the presence of a credit supply effect in the commercial mortgage market and the ability of commercial mortgage lenders to incorporate expectations about this effect into their lending supply strategies. For the purpose of the discussion, a credit supply effect is defined as the effect of mortgage supply on the level of loan defaults.

A credit supply effect arises from the interaction between the real estate capital and space markets. As Mueller (1995) explains, the interaction between these two markets is such that fluctuations in the real estate capital cycle are related to fluctuations in the real estate space cycle, and viceversa. The implication is clear: changes in the supply of capital may lead to changes in the supply of space and, consequently, to changes in vacancies and rents. In the highly leveraged commercial real estate market, the suggestion is that changes in the supply of mortgages may affect not only the projects' rents but also the likelihood that borrowers repay their loans. Under this argument, the more willing lenders are to undertake a liberal lending policy the less likely projects are to succeed and the more inclined borrowers are to default, holding space demand and other factors constant.[1]

This being the case, lenders must aim to design loan supply policies that account for the cyclical link between mortgage supply and loan defaults. For various reasons,

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however, they may fail to do so. First, as Born and Pyhrr (1994) and Pyhrr, Born, Robinson and Lucas (1996) show, lenders may inappropriately rely on trend-based analyses, which assume that current market conditions continue to hold in the future. As a result, lenders may form property return expectations that are extremely high at the peak of the cycle and extremely low at the trough of the cycle. That is, lenders may undertake extremely liberal lending policies at the peak of the cycle and extremely conservative lending policies at the trough of the cycle. Second, lenders may rely too much on the views of developers. Developers tend to be optimistic about their plans and such optimism could lead lenders to unusually liberal lending policies. This argument is supported by Gardner (1993), who identifies the optimism of developers as a factor in the formation of construction cycles. Finally, lenders may be influenced by regulatory measures, as pointed by DeGennaro, Lang and Thomson (1993).

Some believe that the presence of a credit supply effect and the lenders' inability to predict this effect were critical to the commercial mortgage market crisis of the late 1980s and early 1990s. Hendershott and Kane (1992) argue that excess mortgage supply was an important factor in the market downturn. They refer to the liberal increase in the financing of commercial real estate as a "lending frenzy" that led to disproportionate space supply, low property returns and high levels of default. In their view, regulatory legislation introduced in the early 1980s was a reason for the lenders' decision to increase financing at the expense of risk control.[2] Follain, Hendershott and Ling (1992) describe such a liberal lending as the greatest disturbance to commercial real estate markets in the 1980s, emphasizing how excess mortgage supply led to increasing space supply and decreasing profitability.

Others, however, think that the presence of a credit supply effect and the lenders' inability to predict this effect were not crucial. Cole and Fenn (1994), for example, indicate that although the liberal mortgage supply of the mid- and late-1980s could have helped increase bank failures, it was not the underlying factor. They study the relation between real estate lending and bank failures and show that moral hazard factors, including management's risk preferences, could have been more important. Vandell (1992), in turn, suggests that the credit supply effect may not have been significant. This conclusion is based on a forecasting model of commercial foreclosure rates, which in his view fails to support the belief that the commercial mortgage crisis was caused by the volume of lending of the mid-1980s.

This article reconsiders the issue by modeling the commercial mortgage lending decision with lags and loan default expectations. The analysis offers an alternative view of the commercial mortgage lending decision and extends the limited research devoted to the commercial mortgage market. The results can be summarized as follows. First, the empirical analysis suggests that the effect of mortgage supply on future loan defaults is significant. The results support the argument that a liberal supply of commercial mortgage credit can make property investors more likely to default if the flow of space associated with the flow of mortgages is not adequately absorbed. Second, the results do not support the hypothesis that lenders incorporate loan default expectations into their lending supply decisions. In this regard, the results indicate that the myopic lending supply behavior is not solely a characteristic of the mid- and late-1980s, a period of extensive regulatory changes. Third, the results suggest some form of forward-looking credit spread decisions. Interestingly, during periods other than the 1982–1989 liberal lending period, lenders seem to incorporate very short-term projections of loan defaults into their credit spread decisions. Conversely, during the 1982–1989 liberal lending period, lenders do not appear to adopt any type of forward-looking expectations. During this period, lenders fail to increase the credit spread even as mortgage delinquency rates increase. Fourth, a simulation shows that correct timing of the mortgage supply cycle would have been helpful in maintaining a successful lending supply strategy during the mid- and late-1980s. The simulation illustrates how a decrease in the flow of mortgages during this period would have kept mortgage delinquencies within reasonable levels. These results are important for commercial mortgage lenders, investors, developers and regulators subject to the risks associated with an oversupplied mortgage market.

This article is organized as follows. The next section looks at the interaction between mortgage supply and loan defaults throughout the commercial mortgage cycle. The following section presents the empirical analysis of commercial mortgage lending and includes discussions about the empirical framework, data and model. Next, a simulation is used to examine the lenders' ability to time the commercial mortgage supply cycle. The final section is the conclusion.

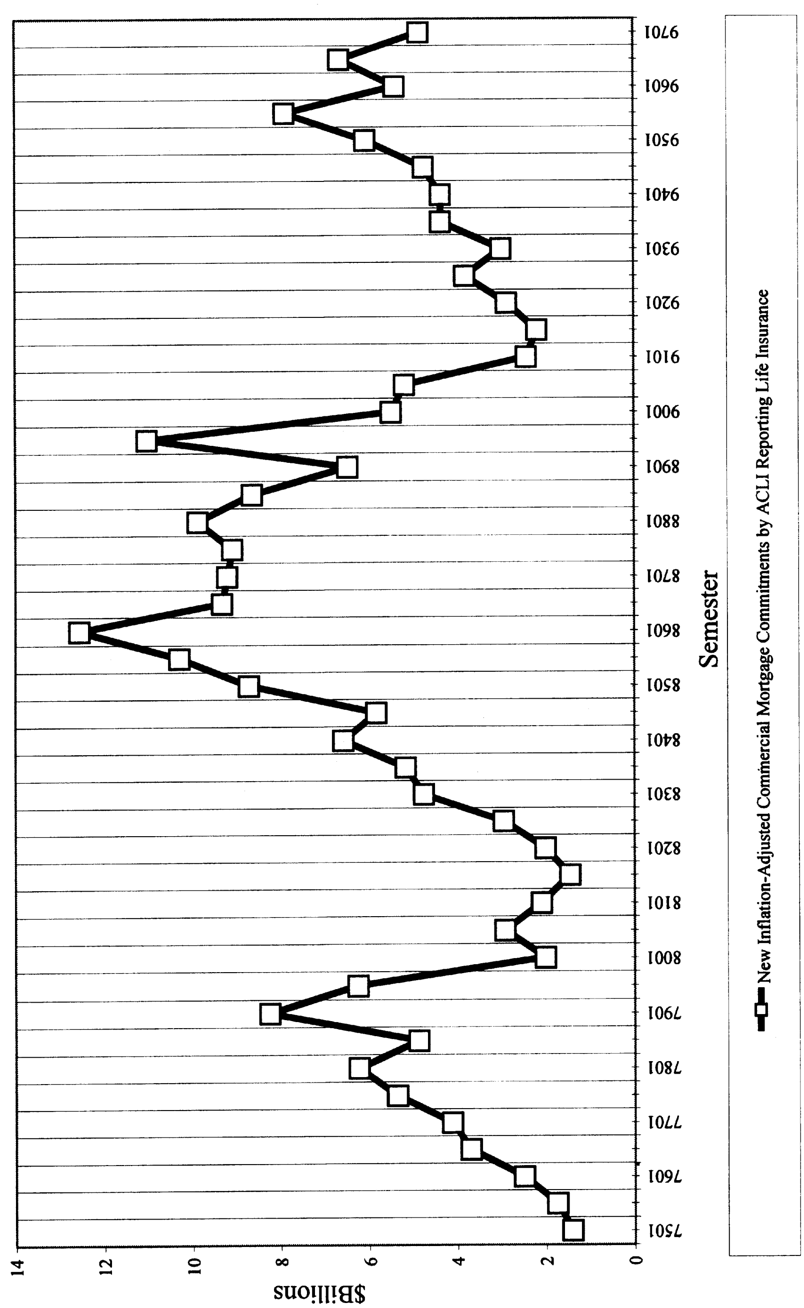
Commercial Mortgage Supply and Loan Defaults

This section anecdotally describes the interaction between mortgage supply and loan defaults. The analysis uses semiannual data on new mortgage commitments and loan delinquencies from the American Council of Life Insurance (ACLI).[3] The data cover the 1975–1997 period. This section explores the presence of a credit supply effect by focusing on the correlation between lagged mortgage supply and loan defaults.

The semiannual flow of new mortgage commitments by ACLI reporting life insurance companies has fluctuated significantly over the last couple of decades (see Exhibit 1). The series first presents an increasing trend between 1975 and 1979. Then, because of the recessions of the early 1980s, the supply of funds decreases. The series goes from about $8 billion at the end of 1979 to less than $2 billion at the end of 1981. With the economy recovering, the series begins an upward trend that extends from the first semester of 1982 to the second semester of 1986. The flow of credit remains in the $6–$12 billion range between 1987 and late 1989. At that point, lending is reduced and the series decreases to almost $2 billion in the second half of 1991, when a new upward trend begins.

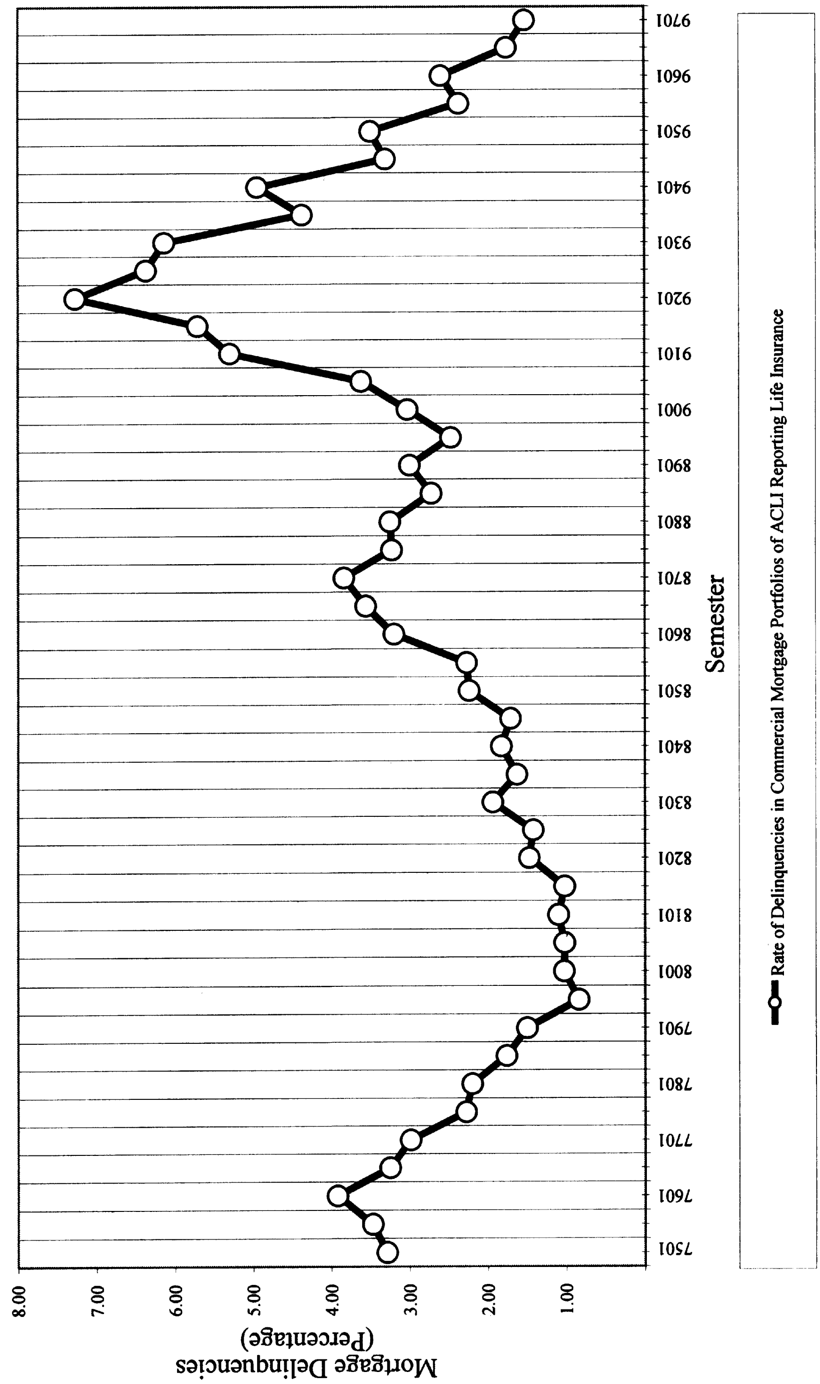
The rate of loan delinquencies that the ACLI report appears to react to changes in mortgage supply (see Exhibit 2). This rate is in the 4% range during the mid–1970s and then decreases to the 1% range, accompanying the restrictive lending period of the early 1980s. As the economy recovers, the series takes an upward trend that reaches the highest point in 1992 at more than 7%. This level of default appears associated with the increased flow of credit that accompanied the deregulation of the

Exhibit 1
Semiannual Flow of Commercial Mortgage Commitments by ACLI Reporting Companies, 1975:1–1997:1



Source: American Council of Life Insurance, 1975-1997 Surveys.

Exhibit 2
Commercial Mortgage Delinquencies
Portfolios of ACLI Reporting Companies, 1975:1–1997:1



Source: American Council of Life Insurance, 1975-1997 Surveys.

banking industry. Only after lenders reduce the supply of credit does the mortgage delinquency rate begin to decrease, falling in the 1%–2% range in 1997.

Correlations between lagged mortgage commitments and loan delinquencies (for lags between one and ten years) are presented in Exhibit 3. The correlation increases as the lag between mortgage supply and mortgage delinquency increases. At lags of zero, one and two years, the correlation is not significant at the 0.05 level, with values of −0.128, −0.056 and 0.162, respectively. At lags of four to seven years, however, the correlation is positive and significant at the 0.05 level. The correlation increases from 0.388 at a lag of three years and 0.535 at a lag of four years to 0.626 at a lag of five years and 0.658 at a lag of six years. The correlation then decreases to 0.518 at a lag of seven years. Finally, at lags of eight, nine and ten years, the correlation is not significant at the 0.05 level, with values of 0.328, −0.053 and −0.457, respectively.

The positive and significant correlations at lags of four to seven years are consistent with the presence of a credit supply effect. The results support previous findings by Snyderman (1991, 1994) and Ciochetti (1997), who reveal that levels of foreclosure rise rapidly from mortgage origination, peak at approximately five years from origination, and then decline, with most foreclosures occurring within eleven years since origination. Note that the analysis uses new mortgage commitments as a proxy for mortgage supply and that there is a period, usually between six months and one year, between the commitment and the actual mortgage disbursement. As a result, the correlation between mortgage commitment and mortgage delinquencies at a lag of n periods implies that the effect between mortgage disbursement and mortgage delinquencies actually occurs with a lag of approximately $n - 1$ periods. The presence of a credit supply effect becomes particularly apparent during the liberal lending period of the mid- and late-1980s. During this period, excess financing of income-producing real estate apparently led to disproportionate space supply, low property returns and significant default losses.

Empirical Analysis: Credit Supply Effect and Lending Decisions

The purpose of the empirical analysis is to assess the presence of a credit supply effect in the commercial mortgage market and the ability of commercial mortgage lenders to incorporate expectations about this effect into their lending supply strategies. This discussion is presented in three parts. The first describes the empirical framework and data. The second presents summary statistics. Finally, the third discusses the empirical model.

Empirical Framework and Data

The empirical analysis is based on a structural equation approach with lags and loan default expectations. The proposed behavioral model includes three equations with three endogenous variables: mortgage supply (represented by the flow of commercial mortgages), loan default (represented by the rate of commercial mortgage

Exhibit 3
Correlation between Commercial Mortgage Delinquencies and Lagged Commercial Mortgage Supply, 1975:1–1997:1

	Commercial Mortgage Supply (Lag by Year)										
	0	1	2	3	4	5	6	7	8	9	10
Rate of Delinquencies	−0.128 (0.402)	−0.056 (0.720)	0.162 (0.313)	0.388 (0.015)	0.535 (0.001)	0.626 (0.000)	0.658 (0.000)	0.518 (0.003)	0.328 (0.083)	−0.053 (0.794)	−0.457 (0.022)

Note: Number in parentheses represent *p*-values.
Source: ACLI, 1975–1997 Surveys.

delinquencies) and credit spread (represented by the difference between the average commercial mortgage lending rate and the 10-year Treasury rate). The loan default equation provides information about the significance of the credit supply effect. Similarly, the mortgage supply and credit spread equations provide information about the lenders' ability to incorporate loan default expectations into their lending supply policies. Data for the analysis have been obtained from ACLI's Survey of Mortgage Commitments, ACLI's Mortgage Delinquency Reports and the Citibase Database.

Equation (1) defines commercial mortgage supply as a function of expected loan defaults, while controlling for the lending rate and a set of exogenous factors. The equation has the form:

$$S_t = f({}_tp^e{}_{t+n}|i_t(r_t, d_t), Z_{st}), \qquad (1)$$

where S_t represents commercial mortgage supply at time t and ${}_tp^e_{t+n}$ represents expectations formed at time t about loan defaults at time $t + n$. For the purpose of the empirical analysis, the variable ${}_tp^e_{t+n}$ is specified as the actual value of loan defaults at time $t + n$. Since S_t is lagged with respect to ${}_tp^e_{t+n}$, this specification is consistent with the need to test the lenders' ability to forecast actual future loan defaults, controlling for other variables in the model. Additionally, i_t is the lending rate at time t, r_t is the 10-year Treasury rate at time t, d_t represent the endogenous credit spread at time t and Z_{st} is a vector of exogenous factors that affect lending supply decisions. The vector Z_{st}, is represented by the inflation rate at time t, referred to as inf_t, which controls for inflationary trends that affect capital allocation decisions.

Equation (2) defines future loan defaults as a function of the lagged mortgage supply, while controlling for the lagged lending rate and a set of lagged exogenous factors. The lending rate consists of the 10-year Treasury rate and the credit spread. The equation is expressed as:

$$p_{t+n} = f(S_t|i_t(r_t, d_t), Z_{pt}), \qquad (2)$$

where S_t, i_t, r_t and d_t stand as defined earlier, while p_{t+n} measures loan defaults at time $t + n$, and Z_{pt} represents a set of economy- and loan-related exogenous factors that affect property performance. The vector Z_{pt} includes the unemployment rate at time t, referred to as $unem_t$, which control for fluctuations in the economy that affect loan defaults, as well as the loan-to-value ratio at time t, ltv_t, and the debt coverage ratio at time t, dcr_t.

Equation (3) endogenously defines the credit spread as a function of expected loan defaults, while controlling for the Treasury rate and a set of exogenous factors. This equation takes the form:

$$d_t = f({}_tp^e_{t+n}|r_t, Z_{dt}), \tag{3}$$

where d_t, as defined earlier, represents the endogenous credit spread at time t, while ${}_tp^e_{t+n}$ represents expectations formed at time t about loan defaults at time $t + n$ and r_t is the treasury rate at time t. Again, ${}_tp^e_{t+n}$ is specified as the actual value of loan defaults at time $t + n$. As noted, this specification is consistent with the need to test the lenders' ability to forecast actual future loan defaults, controlling for other variables in the model. Additionally, Z_{dt} represents a set of exogenous underwriting factors that determine the credit spread decision. The set includes factors that influence the lenders' credit spread decision. They are the size of the loan at time t, $loan_t$, the term of the loan at time t, $term_t$, the loan-to-value ratio at time t, $ltvr_t$, and the debt coverage ratio at time t, dcr_t.[4]

Data for the estimation of these equations are obtained from three sources. First, commercial mortgage supply data, represented by commercial mortgage commitments, are obtained from the ACLI Survey of Mortgage Commitments. Data on commercial mortgage rates, mortgage terms, loan size, debt coverage ratios and loan-to-value ratios are also obtained from this survey. Second, loan default data are obtained from the ACLI Mortgage Delinquency Reports. Loan default data are represented by the reported rate of ACLI mortgage delinquency.[5] Finally, data on 10-year Treasury rates as well as inflation and unemployment rates are obtained from the Citibase Database. Commercial mortgage rates from the ACLI Survey of Mortgage Commitments are combined with 10-year Treasury rates from the Citibase Database to calculate the credit spreads. Also, all dollar amounts are adjusted for inflation using a CPI measure.[6]

In sum, the simultaneous equation model is specified as:

$$\begin{aligned} S_t &= a_0 + a_1\,{}_tp^e_{t+n} + a_2\,(d_t + r_t) + a_3 inf_t + e_s, \\ p_{t+n} &= b_0 + b_1 S_t + b_2\,(d_t + r_t) + b_3 unem_t + b_4\, ltvr_t + b_5\, dcr_t + e_p, \\ d_t &= c_0 + c_1\,{}_tp^e_{t+n} + c_2 r_t + c_3 loan_t + c_4\, term_t + c_5\, ltvr_t + c_6\, dcr_t + e_d, \end{aligned} \tag{4}$$

where all variables stand as defined earlier, while a, b and c represent parameters and e is the error term.[7] The behavioral model shown in Equation (4) captures several relations implied in the literature. The use of the interest rate, loan default expectations and inflation as explanatory variables in the mortgage supply equation partially reflects the characteristics of the mortgage supply equation of Martin and Smyth (1991). The relation between mortgage supply and underwriting standards such as the loan-to-value ratio and the debt coverage ratio, as suggested by Ambrose, Benjamin and Chinloy (1996), enters the mortgage supply equation via the endogenous credit spread variable. Finally, the relation between loan defaults and loan characteristics such as the loan-to-value ratio and debt coverage ratio follows the intuition behind Vandell (1992) and Vandell, Barnes, Hartzell, Kraft and Wendt (1993)'s models.[8] As specified, Equation (4) complies with the order and rank conditions required for proper identification of the model.

Summary Statistics

Selected statistics for the ACLI data are presented in Exhibit 4. The data set, which covers the 1975:1–1997:1 period, is semiannual (although most data are available on a quarterly basis, the ACLI delinquency data are semiannual in some periods). The semiannual inflation-adjusted flow of new commercial mortgage commitments by the ACLI reporting life insurance companies shows an average annual flow of $2.93 billion. A minimum value of $480 million was reached around the 1981 recession and a maximum value of $7.10 billion reached in 1986 during the period of liberal lending that preceded the most recent commercial mortgage crisis. The mortgage delinquency series shows an average level of 2.9%. The lowest level of delinquencies is 0.8%, reached at the close of the 1970s, while the highest level is 7.3%, reached in 1992 at the bottom of the commercial mortgage downturn. The commercial mortgage rate has a mean value of 10.3%, ranging between 7.5% and 15.2%. Other variables are also reported in Exhibit 4. The mortgage term has an average of 12.4 years, with a low of 6.6 years and a high of 22.3 years. The reported inflation-adjusted dollar amount per individual loan shows an average of $8.4 million, with a minimum of $4.69 million and a maximum of $37.65 million. The debt coverage and loan-to-value ratios show average values of 1.33 and 71.3%, respectively. The debt coverage ratio ranges between 1.22 and 1.56, while the loan-to-value ratio ranges between 65.9% and 77.5%.

Exhibit 4
Selected Statistics for ACLI Commercial Mortgage Market Data, 1975:1–1997:1

	Mortgage Commitments ($bil.)	Rate of Delinquencies (%)	Interest Rate (%)	Mortgage Term (Years)	Average per Loan ($mil.)	LTV Ratio (%)	Debt Coverage Ratio
Mean	2.93	2.9	10.3	12.5	8.36	71.4	1.33
Std. Dev.	1.56	1.5	2.0	5.5	4.88	2.7	0.09
Min.	0.48	0.8	7.5	6.6	4.69	65.9	1.22
Max.	7.10	7.3	15.2	22.3	37.65	77.5	1.56

Source: ACLI, 1975–1997 surveys.

Empirical Model

The three-equation structural model is estimated in a first difference form to avoid the impact of autocorrelated errors. The first difference form is specified with no intercept term.[9] The estimation is based on a three-stage least square method that controls the problems associated with simultaneous equation bias, while accounting for correlation of errors across equations.[10] The estimated model is:

$$\begin{aligned} \Delta S_t &= a_{11}\,\Delta_t p^e_{t+n} + a_{12}\,(D_p * \Delta_t p^e_{t+n}) + a_2\,\Delta(d_t + r_t) + a_3 \Delta inf_t + e_s, \\ \Delta p_{t+n} &= b_1 \Delta S_t + b_2\,\Delta d_t + b_3\,\Delta unem_t + b_4 \Delta ltvr_t + b_5\,\Delta dcr_t + e_p, \\ \Delta d_t &= c_{11}\,\Delta_t p^e_{t+n} + c_{12}\,(D_p * \Delta_t p^e_{t+n}) + c_2\,\Delta r_t + c_3 \Delta loan_t \\ &\quad + c_4\,\Delta term_t + c_5 \Delta ltvr_t + c_6\,\Delta dcr_t + e_d, \end{aligned} \quad (5)$$

where Δ is a first difference operator, S_t, i_t, d_t, r_t, ${}_tp^e_{t+n}$, $unem_t$, inf, $loan_t$, $term_t$, $ltvr_t$ and dcr_t stand as defined earlier, while a, b and c represent parameters and e is the error term.

As shown in Equation (5), the model also includes a slope dummy variable that accounts for the peculiarities of the 1982–1989 period of liberal lending. The slope dummy variable is motivated by the argument that the lending behavior of the mid– and late–1980s was not typical. During this time, lending decisions may have been associated with regulatory factors that affected the lenders' forecasting ability.[11] The multiplicative dummy variable, D_p, is 1 for the 1982–1989 liberal lending period and 0 for the rest of the series. Accordingly, the resulting ($D_p * \Delta_t p^e_{t+n}$) interactive variable is $\Delta_t p^e_{t+n}$ for the 1982-1989 period and 0 for the rest of the series. The variable ($D_p * \Delta_t p^e_{t+n}$) shows changes in the slope of $\Delta_t p^e_{t+n}$, namely changes in the lenders' ability to predict changes in loan defaults from one period to the other.

Estimates of Equation (5) are presented in Exhibit 5. Following the timeframe of the preliminary correlation analysis, the estimates are presented for annual lags, n, between one and ten years. The columns in Exhibit 5 show estimates (for each lag) for the three equations, while the rows show the explanatory variables. The exhibit also shows, for each equation, the root mean squared error (RMSE) and the Durbin Watson (DW) Statistic. In interpreting the results, two issues are important. First, is the nature of the credit supply effect, as inferred from the relation between loan defaults at time $t + n$, p_{t+n}, and the supply of mortgages at time t, S_t. This relation is shown under the loan default equation columns in Row 2. Second, is the lenders' ability to incorporate loan default expectations into their lending supply strategies, as inferred from the significance of the expectation variable, ${}_tp^e_{t+n}$, in the mortgage supply and credit spread equations. This relation is shown under the mortgage supply and credit spread equation columns in Row 2.

Credit supply effect. This part of the analysis focuses on the relation between loan defaults at time $t + n$, p_{t+n}, and the supply of mortgages at time t, S_t . The objective is to determine the extent to which current mortgage supply affects future loan

Exhibit 5
Simultaneous Equation Estimates

Independent Variables	One Year Lag S_t	P_{t+n}	d_t	Two Year Lag S_t	P_{t+n}	d_t	Three Year Lag S_t	P_{t+n}	d_t	Four Year Lag S_t	P_{t+n}	d_t	Five Year Lag S_t	P_{t+n}	d_t
S_t		1.061			0.979			0.509			0.125			0.315	
		(1.36)			(0.87)			(2.38)			(1.04)			(2.34)	
${}_tp^e_{t+n}$	0.127		1.039	0.458		1.343	1.004		−0.221	2.217		−4.482	2.851		−1.021
	(0.22)		(1.98)	(0.67)		(1.22)	(1.19)		(−0.15)	(1.83)		(−1.57)	(2.19)		(−0.97)
$D_p{}^*\Delta_t p^e_{t+n}$	1.501		−2.485	0.855		−2.747	0.997		−0.480	0.674		0.372	−0.123		0.613
	(0.89)		(−1.80)	(0.55)		(−1.22)	(0.50)		(−0.22)	(0.31)		(0.19)	(−0.01)		(0.48)
i_t	−1.473	1.357		−1.396	1.318		−0.950	0.621		−1.235	0.203		−0.544	0.108	
	(3.21)	(1.21)		(−2.70)	(0.95)		(−1.49)	(1.55)		(−1.43)	(0.76)		(−0.61)	(0.32)	
inf_t	0.138			0.064			−0.060			−0.006			−0.012		
	(1.06)			(0.61)			(−0.35)			(−0.02)			(−0.08)		
$unem_t$		0.384			0.129			−0.076			−0.118			−0.029	
		(0.80)			(0.21)			(−0.47)			(0.74)			(−0.28)	
r_t			−0.589			−0.610			−0.626			−0.342			−0.728
			(−4.43)			(−3.39)			(−3.14)			(−0.70)			(−4.09)
$term_t$			−0.177			−0.195			−0.154			−0.134			−0.069
			(−1.86)			(−1.52)			(−1.45)			(−0.77)			(−0.60)
$loan_t$			0.023			0.033			−0.021			0.051			0.014
			(1.02)			(0.89)			(0.76)			(1.02)			(0.79)
$ltvr_t$		−0.098	0.065		−0.014	−0.019		0.056	−0.013		−0.009	−0.034		0.006	0.001
		(−0.98)	(0.77)		(−0.17)	(−2.00)		(0.90)	(−0.10)		(−0.15)	(−0.19)		(0.12)	(0.01)
dcr_t		−2.176	2.170		−2.042	3.416		−1.565	−1.185		−1.805	−1.132		−0.151	−1.112
		(−0.53)	(0.67)		(−0.44)	(0.64)		(0.72)	(−0.22)		(−0.76)	(−1.07)		(−0.11)	(0.30)
RMSE	1.62	2.05	0.94	1.76	1.94	1.16	1.99	1.18	0.72	2.63	0.82	3.39	3.09	1.07	0.99
DW	2.43	2.43	2.15	2.53	2.59	2.28	2.70	2.69	2.71	2.64	2.28	2.15	2.64	2.60	2.31

Exhibit 5 (continued)
Simultaneous Equation Estimates

Independent Variables	Six Year Lag			Seven Year Lag			Eight Year Lag			Nine Year Lag			Ten Year Lag		
	S_t	P_{t+n}	d_t	S_t	P_{t+n}	d_t	S_t	P_{t+n}	d_t	S_t	P_{t+n}	d_t	S_t	P_{t+n}	d_t
S_t		0.461			0.372			0.540			0.768			0.740	
		(1.76)			(1.50)			(2.00)			(2.22)			(2.27)	
${}_tp^e_{t+n}$	1.190		−1.020	1.391		0.801	1.674		−1.220	0.729		0.180	1.718		0.197
	(1.00)		(−0.98)	(1.92)		(0.28)	(2.91)		(−1.12)	(1.19)		(0.49)	(1.52)		(0.54)
$D_p{}^*\Delta_t p^e_{t+n}$	1.600		1.627	0.581		0.357	0.299		0.908	0.075		−0.706	0.399		−1.264
	(0.73)		(1.02)	(0.30)		(0.14)	(0.19)		(0.54)	(0.04)		(−0.51)	(0.07)		(−0.39)
i_t	−1.020	0.274		−1.322	0.874		−0.826	0.509		−1.341	1.145		−2.592	1.002	
	(−1.28)	(0.58)		(−1.95)	(2.27)		(−1.49)	(1.19)		(−2.12)	(2.05)		(−1.73)	(2.01)	
inf_t	−0.075			−0.085			−0.048			0.047			0.502		
	(−0.41)			(−0.32)			(−0.28)			(0.19)			(1.07)		
$unem_t$		−0.088			0.007			−0.023			0.474			0.577	
		(−0.41)			(0.03)			(−0.11)			(1.46)			(1.98)	
r_t			−0.803			−0.828			−0.553			−0.714			−0.729
			(−4.17)			(−1.53)			(−2.82)			(−4.54)			(−3.67)
$term_t$			−0.071			−0.092			−0.029			−0.192			−0.141
			(−0.60)			(−0.52)			(−0.18)			(−1.53)			(−0.94)
$loan_t$			0.018			0.002			0.039			0.008			0.005
			(0.67)			(0.02)			(0.95)			(0.30)			(0.22)
$ltvr_t$		0.021	0.030		0.080	−0.119		0.013	−0.091		0.170	−0.073		−0.145	−0.077
		(0.24)	(0.24)		(0.94)	(−0.35)		(0.13)	(−0.69)		(0.74)	(−0.36)		(−0.74)	(0.46)
dcr_t		0.869	1.193		−0.393	0.689		−0.340	−7.25		5.633	−0.675		4.085	−2.908
		(0.25)	(0.22)		(−0.10)	(0.09)		(−0.09)	(−0.93)		(0.82)	(−0.12)		(0.62)	(0.5)
RMSE	2.14	1.17	0.91	1.83	0.87	1.02	1.66	0.94	1.02	1.46	1.14	0.84	1.72	0.98	0.88
DW	2.63	2.71	2.13	2.67	2.44	2.33	1.94	1.93	2.18	1.87	1.64	2.49	1.82	1.73	2.32

Numbers in parentheses are *t*-Statistics.

defaults, while controlling for the other variables. The null hypothesis that the coefficient of the lagged mortgage supply variable, S_t, in the loan default equation is less than or equal to zero is tested against the alternative hypothesis that the coefficient is positive. Under the alternative hypothesis, increases in commercial mortgage supply at a given time lead to increases in future mortgage delinquencies, holding the lending rate, the unemployment rate, the loan-to-value ratio and the debt coverage ratio constant.

As Exhibit 5 shows across Row 1, the relation between p_{t+n} and S_t is significant at a 0.05 level (using a one-tail test), at lags of three and five years, and remains significant at most lags between 6 and 10 years. In all cases, the relation exhibits positive coefficients. The coefficient of the S_t variable in the loan default equation with a lag of five years has the highest level of significance, with a t-Statistic of 2.3. This equation also has the best fit relative to the significance of the S_t coefficient, with a RMSE of 1.1%.[12] In this equation, the estimated coefficient of the S_t variable is 0.3% and its approximated standard error is 0.1%. This coefficient can be interpreted as the average percentage change in mortgage delinquencies associated with a change of $1 billion in the flow of mortgages, about 5 years earlier, when other factors are held constant. This result corroborates the presence of a credit supply effect that appears to peak at a lag of approximately four to five years. As noted, the analysis uses new mortgage commitments as a proxy for mortgage supply. Because of the period between the commitment and the actual mortgage disbursement, the correlation between mortgage commitment and mortgage delinquencies at a lag of five years implies that the effect between mortgage disbursement and mortgage delinquencies actually occurs with a lag of approximately four to five years.

Incorporating loan default expectations into lending supply strategies. The lenders' ability to incorporate expectations about future loan defaults into their lending decisions is measured by the significance of the expectation variable, ${}_tp^e_{t+n}$, in the mortgage supply and credit spread equations. The null hypothesis that the coefficient of ${}_tp^e_{t+n}$ in the mortgage supply equation is greater than or equal to zero is tested against the alternative hypothesis that this coefficient is negative. Similarly, the null hypothesis that the coefficient of the expectation term, ${}_tp^e_{t+n}$, in the credit spread equation is less than or equal to zero is tested against the alternative hypothesis that this coefficient is positive. If the null hypotheses were rejected, the results would imply forward-looking lending policies. Otherwise, they would imply myopic lending behavior.

The results can be observed in Exhibit 5, Row 2. On the one hand, the null hypothesis that the coefficient of the loan default expectation variable at time $t + n$, ${}_tp^e_{t+n}$, in the mortgage supply equation is negative cannot be rejected. In other words, the hypothesis that lenders behave myopically when making decisions about mortgage supply is not rejected. Although the relation between S_t and ${}_tp^e_{t+n}$ in the mortgage supply equation has p-values under 0.05 level (using a one-tail test) at lags of four, five, seven and eight years, the coefficients do not have the expected negative sign. On the other hand, the relation between credit spread at time t, d_t, and the loan default expectation variable, ${}_tp^e_{t+n}$, in the credit spread equation is significant at a 0.05 level (using a one-tail test) at a lag of one year. The coefficient of the ${}_{t}p^{e}_{t+n}$ variable is 1.0% and its approximated standard error is 0.5%. This coefficient can be interpreted as the average percentage change in credit spread as a result of a 1% change in expected mortgage delinquencies (one year ahead), when other factors are held constant. In short, the results do not support the argument that lenders incorporate loan default expectations into their lending supply decisions. However, they imply some form of short-term forward-looking behavior associated with credit spread decisions.

The last portion of the analysis focuses on the coefficient of the interactive variable ($D_p * \Delta_{t}p^{e}_{t+n}$). Exhibit 5, Row 3, shows that this variable is not significant at any lag in the mortgage supply equation. This result implies that the lenders' inability to incorporate expectations about loan defaults into their lending supply decisions is exhibited in all periods, including the 1982–1989 liberal lending period. Conversely, the multiplicative dummy variable is significant at the 0.07 level (using a two-tail test) in the credit spread equation at a lag of one year. The result suggests that the slope of ${}_{t}p^{e}_{t+n}$ changes from positive to negative during the 1982–1989 liberal lending period, implying that in the 1982–1989 period the hypothesis of forward-looking credit spread behavior does not hold.

Summary of results. The empirical analysis shows three fundamental results. First, the analysis supports the argument that a liberal supply of commercial mortgage credit can make property investors more likely to default if the space supply associated with the flow of mortgages is excessive. That is, they support the existence of a credit supply effect. Second, the observations fail to support the argument that lenders look forward when making lending supply decisions. In this regard, the results suggest that the myopic lending supply behavior is not solely a characteristic of the 1980s, a period of extensive regulatory changes. Finally, the results suggest some form of forward-looking credit spread decisions. Interestingly, during periods other than the 1982–1989 liberal lending period, lenders seem to incorporate very short-term expectations of loan defaults into their credit spread decisions. Conversely, the forward looking expectation hypothesis does not hold between 1982 and 1989, a period characterized by decreasing credit spreads and increasing loan delinquencies. These results are important in two ways. First, the limited forward-looking lending behavior implies that borrowers usually compensate lenders for past lending mistakes. If so, the analysis provides a partial explanation for the increasing demand of alternative lending vehicles, such as mortgage securitization or real estate investment trusts (REITs). Second, the results show that lenders fail to increase the credit spread even as default rates increase. This observation corroborates the argument that the regulatory measures of the early 1980s encouraged lenders to increase their level of lending regardless of the risk consequences.

Two additional issues deserve attention. On the one side, the interest rate variable, ($d_t + r_t$), is significant in the mortgage supply equation, with a negative sign. This result is consistent with the notion that lenders restrain the supply of mortgages at high levels of interest rates, in part because of the possibility of an adverse selection effect. This argument can also explain the increasing mortgage supply of the mid– and late–1980s, when interest rates decreased significantly, compared to the levels of the late

1970s and early 1980s. On the other side, the 10-year Treasury rate appears significant, with a negative sign, in the credit-spread equation. This result is inconsistent with the argument that the low risk associated with a low interest rate should translate, holding other things constant, into a lower credit spread. This observation may have to do with the incoherence that characterized the lending policies of the mid– and late–1980s.[13]

Timing the Cycle: Actual vs. Normative Mortgage Supply

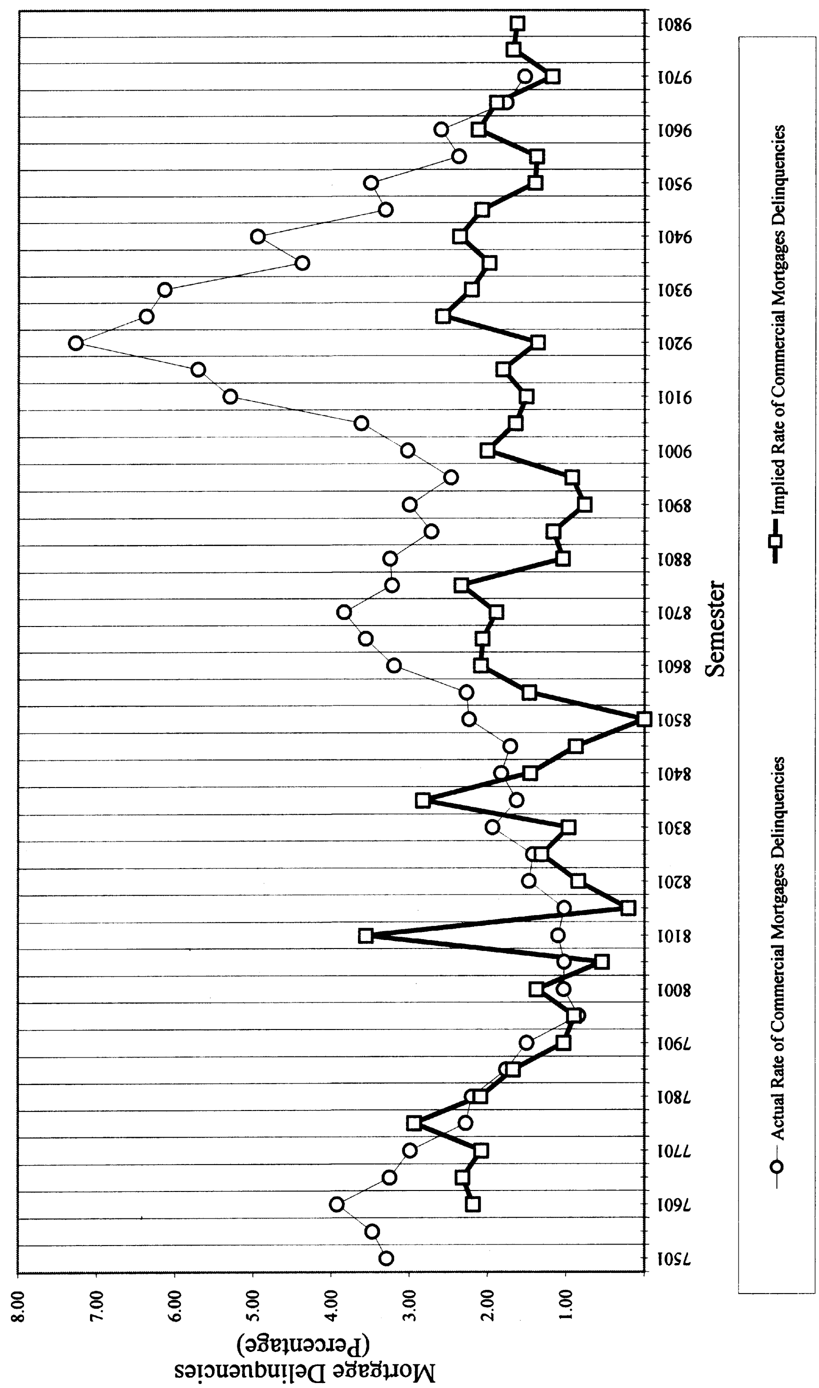
The empirical analysis suggests that the tremendous increase in mortgage delinquencies in the 1982–1989 liberal lending period is associated with a credit supply effect and the lenders' inability to predict future loan defaults. A simulation is conducted to illustrate the extent to which adequate timing of the mortgage supply cycle would have limited the incidence of mortgage delinquencies. The structural equation model is simulated to estimate the level of supply that would have been consistent with the expected level of mortgage delinquencies implied in the actual credit spreads.

The implied level of delinquencies is derived using estimates from the credit spread equation, for a lag of one year. This equation is solved for the ${}_tp^e_{t+n}$ variable, given actual credit spreads and other estimates in the model. The actual and implied delinquency rates are presented in Exhibit 6. The two series coincide before the 1982–1989 period, which is consistent with the idea that before the regulations of the early 1980s lenders were more cautious about how to set the credit spread. Conversely, the two series diverge during the 1982–1989 liberal lending period and through 1996. This result corroborates that during the 1982–1989 period lenders failed to increase the credit spread even as default rates increased, in part because of the regulatory incentives of the early 1980s.[14]

A simulation is conducted to estimate the level of supply that would have been consistent with the implied delinquency rates. This simulation is based on estimates from the loan default equation, for a lag of five years.[15] The simulated mortgage supply series, which provide a normative representation of the mortgage supply cycle, is presented in Exhibit 7. The plot of the actual and normative mortgage supply series confirms that achieving the implied mortgage delinquencies would have required a reduced level of mortgage supply. The normative mortgage supply series ranges from approximately $9 billion in 1977 to zero or negative lending in 1980, 1981 and 1985.[16] The series is above $7 billion in 1983, slows down for about two years and then increases to reach $6 billion in 1986 and 1987. At that point, the normative series slows down again, increasing again to approximately $5 billion in 1990 and 1991.

The simulation suggests that adequate timing of the mortgage supply cycle would have limited the incidence of mortgage delinquencies observed during the 1982–1989 liberal lending period. The gap between the actual and the normative series represents the excess flow of funds injected into the market. This gap shows that lenders fail to assess the effect of mortgage supply on future loan defaults. The result is consistent with the assessment that lenders rely excessively on trend-based, rather than cycle-

Exhibit 6
Actual vs. Implied Rate of Commercial Mortgage Delinquencies in Portfolios of ACLI Reporting Companies, 1975:1–1997:1



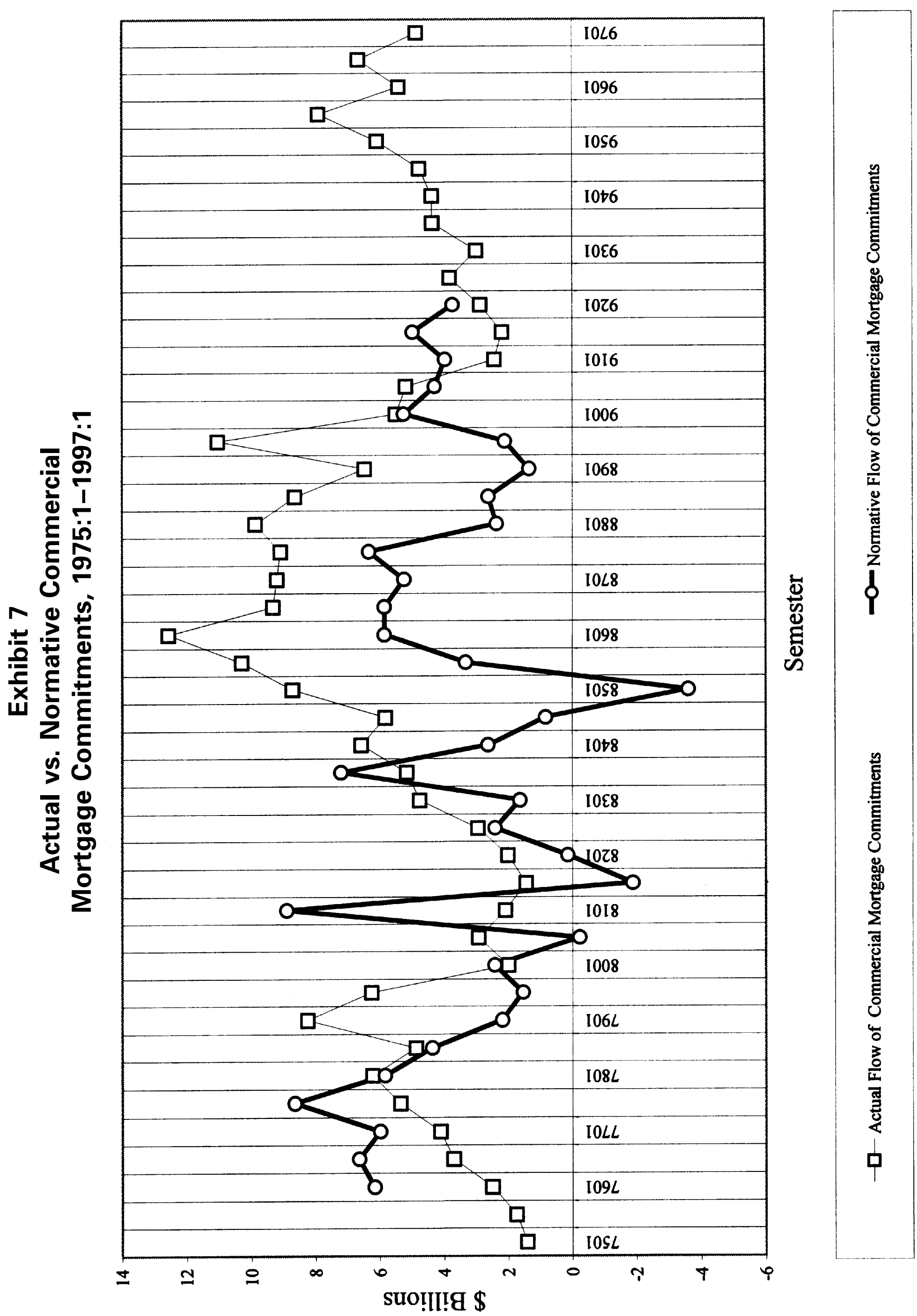


Exhibit 7
Actual vs. Normative Commercial Mortgage Commitments, 1975:1–1997:1
$ Billions
14
12
10
8
6
4
2
0
-2
-4
-6
7501
7601
7701
7801
7901
8001
8101
8201
8301
8401
8501
8601
8701
8801
8901
9001
9101
9201
9301
9401
9501
9601
9701
Semester
Actual Flow of Commercial Mortgage Commitments
Normative Flow of Commercial Mortgage Commitments

based, analyses. As Wolfson (1994) notes, the real estate downturn appears to be the result of incorrect expectations of speculative increases in the price of commercial real estate, which is consistent with the argument that lenders form property return expectations that are extremely high at the peak of the cycle. While regulatory measures contributed to the liberal lending behavior, the lenders' inability to assess the credit supply effect multiplied the consequences.

Conclusion

This article empirically explains the behavior of the commercial mortgage supply cycle. The estimated model examines the effect that the flow of mortgages has on loan delinquencies and the lender's ability to adjust the availability of credit in response to this effect. Particular emphasis is placed to understanding the 1982–1989 liberal lending period that preceded the most recent commercial mortgage crisis.

Several results are worth noting. First, the estimates indicate that changes in loan defaults follow changes in the flow of commercial mortgage credit. In other words, they confirm the presence of a credit supply effect. Second, the hypothesis that lenders behave myopically when making decisions about mortgage supply is not rejected. Although the estimates suggest some form of forward-looking behavior associated with credit spread decisions, they do not support the argument that lenders include forward-looking expectations about loan defaults when designing their lending supply strategy. Third, a simulation of the commercial mortgage supply series provides a normative representation of the lending cycle. The simulation shows that if lenders had properly incorporated loan default expectations into the lending supply decisions the expansion of the cycle during the 1982–1989 period would have been less intense. The simulation shows that correct timing of the lending supply cycle would have been helpful in maintaining a successful lending supply strategy.

These empirical observations are valuable for lenders, CMBS and REIT security investors, developers and regulators. For lenders, the results have important loan underwriting implications. Loan underwriting decisions are usually based on a set of borrower and property characteristics. Given the results of the model, loan underwriters should also consider the effect of the flow of capital on the riskiness of the investments. Holding borrower and property characteristics constant, loan-underwriting standards should get stricter as the supply of financing increases.

The results have portfolio allocation and risk management implications for investors. They may find it in their interest to keep away from risky security investments as the flow of capital increases. As shown during the second half of 1998, investors may find it beneficial to limit the purchase of CMBS, among other securities, if the possibility of capital and space oversupply increases.

The results have important project feasibility implications for developers. They should arguably look at the flow of mortgage supply as a leading indicator of future space supply. Under this view, they should adopt cycle-based, as opposed to trend-based, feasibility approaches that account for the cyclical nature of the credit supply effect.

Finally, for regulators the results have important economic policy implications. As Eppli and Shilling (1995) show, the commercial mortgage crisis in the mid– and late–1980s could be blamed, at least in part, for the slow economic growth of the late 1980s and early 1990s. Hendershott and Kane (1992) illustrate this point by showing that overbuilding transformed approximately $100 billion of productive resources into vacant real estate. They confirm that the value of resources misallocated (as a result of overbuilding) is an economic cost associated with inappropriate lending. Regulators should look at this experience and realize the importance of maintaining standards that control the speed at which capital flows into the real estate market.

In sum, the results show lenders, investors, developers and regulators the credit supply effect inherent to the commercial lending supply cycle. The overall results indicate that making lending, investment, development, or regulatory decisions requires some form of forward-looking expectations about the effect that the flow of commercial mortgages has on future loan defaults, and that failure to do so may translate into significant losses. This requirement has increasing importance as the sources of commercial property financing, including CMBS and REIT, expand.

Endnotes

[1] This view is consistent with more general discussions about the interdependence of the supply and demand functions in the credit markets. Hillier and Ibrahimo (1993) and Stiglitz (1987), for instance, explain this issue and discuss how in certain cases the supply of credit may affect the riskiness of the projects in which borrowers invest.

[2] Important regulatory legislation that affected commercial real estate lending was introduced in the 1980s. A critical piece of legislation was the Garn-St. Germain Depository Institutions Act of 1982, which attempted to strengthen the thrift industry by creating new lending opportunities. However, there was also regulation that affected developers. Hendershott and Kane (1992) show that Federal Tax laws introduced in the 1980s encouraged developers to undertake projects by providing generous depreciation allowances. These two regulatory efforts together created the conditions for the dramatic real estate market crisis of the late 1980s and early 1990s.

[3] The ACLI data include aggregate summary reports for mortgage commitment and loan delinquency activity (the data do not include loan-by-loan information). Note that although most data are available on a quarterly basis, the ACLI delinquency data are semiannual in some periods. As a result, the final data set is semiannual.

[4] It is possible to include S_t in Equation (3) and interpret the credit spread equation as the demand equation. However, using S_t as a measure of demand and supply implies that all loans demanded are actually offered. Specifying a demand equation would require data on the volume of loans requested, which are not available.

[5] The series used as a proxy for mortgage defaults is the ACLI series for delinquent loans including loans in foreclosure for all loans types combined (1-4 family, commercial and farm).

[6] The adjustment for inflation is done with a CPI measure whose base year is 1982–1984.

[7] This specification implies that the dependent variable of the loan default equation, p_{t+n}, coincides with the explanatory variable, ${}_tp^e_{t+n}$, in the mortgage supply equation. If so, the simultaneous equation system should be estimated through an instrumental variable method (an ordinary least squares method would create a bias where some independent variables would be

correlated with the error term). As the SAS Institute's *SAS/ETS User's Guide* (1993) shows, an instrumental variable method such as the two- or three-stage least square methods replace the independent variables in question with predicted values, obtained through a preliminary ''instrumental'' regression. Estimating the empirical equation through an instrumental variable approach implies that the explanatory variable ${}_tp^e_{t+n}$ in the mortgage supply equation is replaced with a prediction of this variable based on all other explanatory variables in the system. As indicated, this estimation approach is consistent with the need to test the lenders' ability to forecast the actual value of p_{t+n}, given all other information in the model.

[8] Martin and Smyth (1991)'s model focuses on the residential market. They use a contemporary, rather than expected, default rate and a measure of inflation costs, rather than the inflation rate. The models in Vandell (1992) and Ambrose, Benjamin and Chinloy (1996) focus on the commercial market.

[9] The first difference equations are estimated with no intercept because the intercept disappears in the transformation of the level variables. See Lardaro (1992) and Maddala (1992).

[10] For a discussion of the three-stage least square see the SAS Institute's *SAS/ETS User's Guide* (1993).

[11] The 1982:2–1989:2 period coincides with the passage of important regulatory legislation that affected the commercial real estate lending process. In 1982:2, the Garn-St. Germain Depository Institutions Act was signed into law (see Graddy, Kyle and Strickland, 1994). Although regulatory measures were introduced as early as 1980 to provide thrifts with new investment powers, the Garn-St. Germain Act served as a final step toward the period that Hendershott and Kane (1992) refer to as ''lending frenzy.'' As Follain, Hendershott and Ling (1992) document, during this period savings and loans significantly increased their commercial mortgage loan (at an annual rate of 30% during the 1982–1984 period and at an annual rate of approximately 10% between 1984 and 1989). In 1989:2, in turn, the Financial Institutions Reform, Recovery and Enforcement Act (FIRREA), was signed into law (see Barth, Pugh and Jahera, 1995). Handorf and Sachlis (1997) refer to FIRREA as the legislation that restricted the lenders' ability to make commercial real estate loans. Similarly, Follain et al., refer to FIRREA as the legislation that ended the lending frenzy in markets such as that for rental housing. As indicated by Fergus and Goodman, Jr. (1994), the passage of FIRREA created the conditions for the beginning of a credit crunch. For additional discussions about the role of the Garn-St. Germain Act, see Lary (1989) and DeGennaro, Lang and Thomson (1993). Similarly, for additional discussions about the role of FIRREA, see Madura and Whyte (1992) and Rosenblum and Clair (1993).

[12] Looking at the value of the RMSE and the *t*-Statistic of the S_t variable simultaneously helps identify equations where the RMSE is low relative to the significance of the S_t variable. Arguably, an equation could have a very low RMSE and yet have a nonsignificant S_t variable, or viceversa. The interest in this analysis is in equations where the fit is good (low RMSE) relative to the significance of the S_t variable (high *t*-Statistics).

[13] Note that models of adverse selection actually imply that the relation between mortgage supply and the interest rate is concave. The concave relation between the lending rate and credit supply is important, for example, in Stiglitz and Weiss (1981). To explore the possibility of a concave interest rate relation, the structural equation model is estimated with an interest rate squared term. However, this term is not significant at any lag. Additionally, note that the relation the credit spread and the 10-year Treasury variable may be particular to the 1982–1989 liberal lending period. To explore this possibility, the model is estimated with an additional interactive term. This term is defined as the product of the 10-year Treasury variable and the multiplicative dummy variable, D_p, The additional interactive term, however, is not significant at any lag.

[14] The coefficient of the ${}_tp^e_{t+n}$ variable, which approximates 1 point, indicates that lenders expected full loss severity. Interestingly, this expectation is more than sufficient relative to

traditional levels of loss severity (as Snyderman (1991, 1994) reports, loss severity has ranged from –7% to 96% in the 1972–1986 period). However, the entire credit spread is not sufficient to cover actual levels of loan delinquency. Even if the expectation seems more than sufficient to cover the losses associated with a 1% loan delinquency, the expectation of the total delinquency rate is not appropriate (see Corcoran and Kau (1994) for a discussion of calculations regarding loss severity and credit spreads).

[15] As noted earlier, the loan default equation for a lag of five years has the best fit relative to the significance of the S_t variable.

[16] Zero or negative lending is assumed to represent points in the normative series with no commitment activity and/or negative mortgage flow.

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