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Banking System, Real Estate Markets, and Nonperforming Loans

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This paper examines the link between nonperforming loans, real estate prices, and the banking system. We found that the level of nonperforming loans affects bank profitability as well as the price performance of real estate markets. We also analyzed the factors that cause the ratio of nonperforming loans to total loans to fluctuate. We observed that a higher ratio of corporate loans to individual loans results in a lower percentage of nonperforming loans. In contrast, a lower real estate lending rate relative to the primary lending rate leads to a higher percentage of nonperforming loans. These results suggest that the percentage of nonperforming loans can be partially governed by the lending practices of banks.

Keywords
Nonperforming Loans, Real Estate, Banking System

Introduction

Since the Asian Financial Crisis of 1997, the subject of nonperforming loans has been revisited heavily by academics and practitioners alike (Kwack,

2000, Quigley, 2001, Collyns, and Senhadji, 2002). Nonperforming loans (NPL) have been labeled one of the likely suspects of the financial markets' collapse in Asia. Their effects on the financial and real estate markets and the factors that cause them are of interest to researchers.

Kwack's (2000) data set of Asian economies between the years 1994 and 1997 shows that the percentage of nonperforming loans increased steadily in some countries such as Taiwan, and dramatically in other countries such as Korea and Thailand.[1] The Goldman Sachs study of Asian bank portfolios conducted in September 1998 reported even higher estimates of NPL percentages between 1997 and 1999: 11% for Singapore, 15% for Hong Kong, 20% for Malaysia, 29% for the Philippines, 34% for Korea, and 50% for Thailand. The NPL ratio in Taiwan was reported as high as 9% at the beginning of 2002.[2]

Table 1 Real Estate Sector and National Economy

Country	Real Estate Loans as a Percent of Total Bank Loans	Average Exposure to Real Estate as Percent of GNP
Hong Kong	40-50	76
Taiwan	35-45	58
Malaysia	30-40	58
Thailand	30-40	44
Singapore	30-40	30
Korea	15-25	17
Philippines	15-25	17
China	35-40	9
Indonesia	25-30	7

Table 1 represents statistics of Asian economies' dependence on real estate markets. The source is Quigley (2001).

What causes the percentage of nonperforming loans to rise in some of the emerging Asian economies? Although the results up to now have been rather indirect, the lending practices of banks are viewed as likely candidates. Reynolds, Ratanakomut, and Gander (2000) suggested that the banks' aggressive lending policies, coupled with weak profitability, led to the financial crisis. Kwack (2000) found that a high corporate leverage ratio

[1] The percentage of nonperforming loans in 1994 for Taiwan, Korea, and Thailand was 1.85%, 7.80%, and 7.50%, respectively. By 1997, these percentages had increased to 3.82%, 17.00%, and 18.00% for the same countries.
[2] Taiwan Financial Statistical Abstract

affects the level of nonperforming loans. A troubled real estate sector could be another contributing force to a rising nonperforming loan ratio. The potential exposure of the national economy to the real estate sector in these economies is relatively large. Table 1 has statistics on the average exposure to real estate as a percentage of GNP, and the real estate loans as a percentage of total bank loans (Quigley, 2001). The ratio of real estate debt to GNP was more than half in Taiwan and Malaysia, and more than three quarters in Hong Kong in 1996. Furthermore, the percentage of real estate loans is around 40% to 55% in Hong Kong, followed closely by Taiwan at 35% to 45%. Based on the same Goldman Sachs study, Quigley also reported real estate loans as a percentage of the total nonperforming loans portfolio for Hong Kong. This figure was expected to be as high as 60% in 1997, 52% in 1998, and 50% for 1999.

The rise in nonperforming loan ratios has serious consequences for the economy. Bernstein (1996) developed a model in which he showed that the level of nonperforming loans is a significant determinant of the level of bank costs, as well as the estimates of scale economies in banking. Kwack (2000) is one of the numerous authors who suggested nonperforming loans as a cause of the Asian Financial Crisis.

Several authors have also linked real estate markets with financial markets. Allen, Madura, and Wiant (1995) and He, Myer, and Webb (1996) have found that bank stocks are very sensitive to changes in real estate market returns. King (2001) claimed that the Asian Financial Crisis was triggered by Japanese commercial banks that were considerably weakened by the collapse of real estate markets. Quigley (2001) suggested that the activities in the real estate market contributed to the severity of the crisis. Lu and So (2003) found that Asian banks were significantly exposed to real estate risk in the post-crisis era.

The lending policy of banks is also affected by nonperforming loan ratios. Banks will adjust their loan preference ratios and the weight of risky loans in order to avoid a crisis. This will lead to a more conservative real estate lending policy, as suggested by Shen and Chang (2002). However, the more restrictive lending policy may lead to a poor performance in the real estate sector, thereby exacerbating a possible crisis.

In summary, real estate markets, nonperforming loans and the banking system are all closely related. Most past studies have concentrated on two out of these three factors at a time, but far less has been documented on the interaction of these three variables. We attempted to analyze the determinants and consequences of nonperforming loans by focusing on their ability to link real estate markets and the banking system. We also added

two new explanatory variables that have not received a lot of attention before. The real estate lending rate relative to the primary lending rate is the first variable. We would expect this variable to shift the percentage of real estate loans, as well as change the characteristics of the pool of borrowers. We also controlled for the amount of corporate real estate loans with respect to the amount of individual real estate loans. Since corporate loans, on average, are viewed as being less risky than individual loans, this would have a direct impact on the percentage of nonperforming loans.

Taiwan experienced a rise in nonperforming loans prior to the crisis. Furthermore, the Taiwanese economy has had a relatively high exposure to real estate both in terms of GNP and total bank loans. This makes Taiwan an ideal candidate for analyzing the issues mentioned above. Using the Granger causality test (1996), we modeled the causal relationships between the performance of the real estate market (as proxied by the housing prices), nonperforming loans, and returns to the banking sector. We confirmed that the percentage of nonperforming loans Granger-caused the profitability of the banking sector. We then used simultaneous equations to estimate the determinants of nonperforming loans and to analyze their impact on the real estate markets and the banking system. We found that lower real estate lending rates relative to primary lending rates cause nonperforming loans to rise. In contrast, a higher ratio of corporate real estate loans to individual real estate loans leads to lower levels of nonperforming loans. Finally, we observed that the nonperforming loan ratio has negative and significant effects on both real estate markets and the banking system.

The remainder of this paper is organized as follows: Section 2 builds the hypothesis and discusses existing literature. Section 3 introduces the data and sample statistics. Section 4 introduces the econometric model and analyzes the empirical results. Section 5 is the conclusion.

Hypothesis Development

Although the topics of real estate, nonperforming loans, and the banking system have always been of interest to researchers, the related literature on these topics experienced a surge during and after the Asian Financial Crisis.

One of the earlier studies done on the topic of the banking and real estate sectors is by Mei and Saunders (1995). They developed an asset pricing framework in which they looked at the interaction of ex-ante risk premiums on both bank stock returns and real estate returns for the period 1970 to 1989. They also studied the time-varying component of these premiums with respect to economic and real estate market conditions. They found that the

time variations in bank risk premiums are partially determined by interest rates and the real estate market. They also discovered that the real estate factor was important for banks during the 1980s.

Similarly, Allen, Madura, and Wiats (1995) used a seemingly unrelated regression model to determine whether bank returns are systematically affected by real estate market performance. Their data set spans the years between 1979 and 1992. They were able to document a positive and significant relationship between bank returns and changing real estate values even after accounting for the effects of the financial markets and interest rates. They also observed that bank performance sensitivity to the real estate sector increases over time.

He, Myer, and Webb (1996) used a three-index model to examine the sensitivities of stock returns for different bank groups. They found that bank stocks are quite sensitive to changes in real estate returns. Specifically, they observed that banks with high proportions of real estate loans are most affected by changes in real estate returns.

Mei and Saunders (1997) took a slightly different route and examined bank performance in light of real estate as an investment tool. They found that the strategy of commercial banks and thrifts is to base their decisions on past real estate returns rather than projected ones. The authors labeled this strategy "trend-chasing," and presented their findings as an explanation as to why these real estate investments have performed poorly. Their data set spans 1970 to 1989 for commercial banks, savings and loans, and life insurance companies, and they used monthly REIT returns as their proxy for real estate asset returns. They found that real estate markets excess returns are mean reverting; therefore, buying after positive excess returns and selling after negative excessive returns will produce a money-losing strategy.

The relative risk factor of real estate loans has been studied from an agency cost standpoint as well. Bernanke and Gertler (1995), Mishkin (1996), and Allen and Gale (2000) all discussed the moral hazard and adverse selection issues that are amplified in the real estate market. Due to weaknesses in financial regulations, banks take on excessive levels of risk by lending to risky subjects, such as real estate developers or buyers. In turn, the investors who are the most likely to default tend to apply for these loans, thereby generating a temporary bubble.

There has also been some work done on the effect of nonperforming loans on the banking system. Bernstein (1996) showed that the level of nonperforming loans is a significant determinant of the level of bank costs, as well as of the estimates of scale economies in banking. He found that the

cost curve of banks with high levels of nonperforming loans have the standard U-Shape, with the optimal point residing between five and ten billion dollars. On the other hand, the banks with low levels of nonperforming loans do not exhibit the same characteristics. Their cost curve shows that scale economies increase continuously with bank size.

Reynolds, Ratanakomut, and Gander (2000) also looked at bank size and further examined the bank financial structure in Asia prior to the financial crisis. They regressed financial performance ratios such as loan preference, capital adequacy, liquidity, and profitability on structural variables such as assets and income. They found that during financial liberalization, loan-preference ratios were lower, which they interpreted as increased levels of risk. They also found that for some countries (Indonesia, Korea, and Thailand), the banks showed a stronger lending performance but weaker profitability, which may have led to the financial crisis. They also observed that bank size matters, since profits and loan preferences increase with size, and capital adequacy decreases with size.

The Asian Financial Crisis generated a lot of questions regarding the culprits and the underlying reasons for this phenomenon. Quigley (2001) is one of the many authors who suggested that real estate markets were very significant in explaining the Asian Financial Crisis. His study bears similarities to ours. He pointed out the increasing supply of office space (as proxied by vacancy rates), the high ratio of asset prices to market rents, the high growth rate of bank credit, the high ratio of nonperforming real estate loans, the relative size of the real estate sector, and the relative weight of real estate among nonperforming assets as indicators of an upcoming crisis. Quigley reported the percentage of real estate bank loans in Taiwan to be in the 35 to 45% range with an average Moody's rating of D. He also reported a bank intermediation ratio of 1.46 and the average exposure to real estate as percentage of GNP to be 58%. He likened the price increase in real estate to a Ponzi scheme by stating that when real estate is the only form of collateral, there is a strong incentive for investors to buy into an appreciating market in order to borrow funds to expand.

Collyns and Senhadji (2002) examined the link between lending booms, asset price cycles, and financial crises across the East Asian countries. They found a strong relationship between bank loans and asset price inflation. They stated that the optimistic growth expectations, heavy capital inflows, inadequate corporate governance, and dependence on intermediation by under-regulated banks all led to a rapid credit growth, especially in the real estate market. Like earlier papers regarding agency cost issues, they stated that the real estate market is particularly vulnerable to the formation of price bubbles because information asymmetries are larger, the supply is more rigid,

and the market is therefore more imperfect. They documented the contemporaneous rise of non-performing loans, property exposure, and real estate prices in Korea, Indonesia, Malaysia, the Philippines, Thailand, Hong Kong, and Singapore. Through a VAR analysis, they concluded that property prices are strongly pro-cyclical, and bank loans contributed to the inflation of property prices prior to the crisis period. They also found that the response of property prices to credit is stronger during times of rising prices than the response during times of falling prices. The main policy implications of the paper are to strengthen credit assessment while reducing reliance on collateral, and to reduce the moral hazards in the banking system.

In a related vein, Kallberg, Liu, and Pasquariello (2002) examined the impact of regime shifts on Asian equity and real estate markets between 1992 and 1998. They applied Granger causality and found that equity returns cause real estate returns, but not vice versa. However, they did observe two-way causality for the volatilities of both markets. They also found that a country's exposure to trade and firm leverage are important. They concluded that regime shifts lead to higher relative risk for real estate securities.

Another study that is closely related to ours is that of Kwack (2000), who looked at whether there is a relationship between the Asian Financial Crisis and the weakness of financial institutions, as well as the levels of international interest rates, short-term debt, excessive lending, and current account deficits. The author conducted empirical analyses between 1995 and 1997 in seven Asian countries: Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand. He found that the 3-month LIBOR interest rate, the nonperforming loan rates, and the corporate leverage ratio are very significant in explaining the Asian Financial Crisis. He also modeled the level of nonperforming loans by including corporate leverage, LIBOR, the weight of short-term debt with respect to total debt, the claims of bank deposits of the private sector as a multiple of GDP, the current account balance as a fraction of GDP, the corporate operating margin, and the weight of equity with respect to total assets for banks. With the exception of the corporate leverage ratio, he did not find any significance for any of the variables using OLS.

Our study attempts to link real estate, nonperforming loans, and the banking system. The determinants of nonperforming loans are classified into three categories: macroeconomic financial performance, real estate market performance, and the lending policies of the banking sector. When both the macroeconomy and real estate market perform well, the level of

nonperforming loans should be lower.[3] In contrast, if the banks' loan portfolios bear more risk, nonperforming loans are likely to be higher. Specifically, we suggest using the relative cost of real estate borrowing to general borrowing as a determinant of the level of moral hazard and adverse selection issues that have been discussed by other authors. If the relative cost of real estate borrowing is low, then we would expect more of the riskier candidates to apply for loans. In other words, a higher relative real estate lending rate will result in lower amounts of real estate loans. The credit risk and probability of nonperforming loans would thus be reduced. We also predict the ratio of corporate real estate loans with respect to individual real estate loans to be important in explaining the percentage of nonperforming loans. The diversification principle suggests that corporations are not as risky as individuals due to their size and the quality of their assets. Therefore, if banks decrease the weight of individual real estate loans in their real estate loan portfolios, the level of nonperforming loans should go down.

Another piece of the puzzle is analyzing the determinants of banking return. We proxied the banking return with several variables: banking profitability (BP),[4] the return on assets (ROA),[5] the return on equity (ROE),[6] the stock return to the banking sector, and a composite index of the last three factors mentioned (GBRI).[7] We classified the key determinants as credit risk, macroeconomic performance, interest rates, and size. The nonperforming loan ratio is used to express credit risk. As the credit risk is higher, the banking return is expected to be lower. As with the nonperforming loans, the macroeconomic conditions should have an impact on the banking returns. The net difference between the lending rate and the deposit rate is another important determinant of performance, and should have a positive impact on bank returns. Consistent with previous literature, the size of the loan portfolio is also expected to affect bank returns positively.

Finally, the last piece of the puzzle is the determinants of the real estate market performance, which we propose to proxy by the level of housing prices. We hypothesized that the relevant factors are the nonperforming loan ratio, macroeconomic performance, and the demand for housing. A higher nonperforming loan ratio can indirectly affect the real estate market, since higher nonperforming loan ratios will push banks to be more conservative, thereby causing tighter lending policies and lower housing prices due to

[3] In line with prior studies, we propose using GDP as a proxy for macroeconomic performance and housing price as a proxy for real estate market performance.
[4] BP = Net Benefits/Net Revenues
[5] ROA = Net Benefits/Assets
[6] ROE = Net Benefits/Equity
[7] GBRI = 50% stock return to the banking sector + 25% Return on Assets + 25% Return on Equity.

lower demand. If the financial economy is performing well, then housing prices should also be higher. The demand for housing can be proxied by the rate of change for vacant housing. When the demand for housing is lower, prices will inevitably go down. The three specifications of nonperforming loans, banking returns, and real estate returns help us look at all of the factors at once and close the feedback loop.

Data and Descriptive Statistics

The stock return to the banking sector (SRB), GDP growth rate (GDP), the real estate lending rate (R_r), the primary lending rate (R_l), the deposit interest rate (R_d), the corporate real estate loans (Corp), the individual real estate loans (Ind), the total loans (Loan), and the nonperforming loan ratio (NPL) are all obtained from the Taiwan Financial Statistical Abstracts. The housing price (P) is defined as the hedonic housing price measured by the Taiwan Real Estate Research Center in Taiwanese Dollars/Ping. The number of vacant houses (Vacq) is reported as a descriptive statistic and derived from the data provided by Tai-Power Company.[8]

Due to the availability of monthly nonperforming loan data,[9] the sample period starts in January 1996 and ends in April 2003, which produced 88 observations. The descriptive statistics are available in Table 2. The bank return figures were all less than 1.5 percent, with the lowest indicator being the bank profitability (BP) at 0.009 % and the highest indicator being the return on equity (ROE) – 1.486 %. The ratio of corporate to individual real estate loans was less than ¼ at 0.23. The average GDP growth rate (g) during the sample period was close to 4 percent. The nominal housing price in NT dollars per ping (P) was 176,313, and the real housing price in NT dollars per ping was 169,051. The nonperforming loan ratio (NPL) hovered around 5 percent, which confirms the statistics found in other studies like Quigley's (2001). The difference between the lending rate and the deposit rate averaged around 3 percentage points. The quantity of vacant housing (Vacq) was under 2 million at 1,577,681, and the rate of change (Vac) was less than 1 percent at 0.657 percent. The ratio of the real estate lending rate to the primary lending rate was slightly less than unity at 0.924. The real estate loans comprised more than one third of total loans at approximately 37 percent.

[8] If the electricity use of a house is lower than a lower limit threshold value, the house is defined as vacant.

[9] Before 1996, the nonperforming loan ratio data was only available on a yearly basis.

Table 2 Descriptive Statistics

Variables	Mean	Std Dev
Bank Assets (Nominal Terms) (NT$ million)	11,691,763	2,226,386
Bank Assets (Real Terms) (NT$ million)	11,175,330	1,996,757
Bank Benefits (Nominal Terms) (NT$ million)	11,463	26,221
Bank Benefits (Real Terms) (NT$ million)	11,116	24,945
Bank Equity (Nominal Terms) (NT$ million)	914,864	199,717
Bank Equity (Real Terms) (NT$ million)	874,068	180,998
Bank Profitability (Net Benefits/Net Revenues) (BP) (%)	0.009	0.018
Corporate Real Estate Loans (Nominal Terms) (NT$ million)	644,568	93,996
Corporate Real Estate Loans (Real Terms) (Corp) (NT$ million)	613,756	82,651
Corporate R.E. Loans/Individual R.E. Loans (Corp/Ind)	0.232	0.194
Deposit Rate (R_d) (%)	4.501	1.359
GDP Growth Rate (Nominal Terms) (g) (%)	3.765	3.698
GDP Growth Rate (Real Terms) (%)	3.163	3.306
General Banking Return Index (GBRI) (%)	0.357	5.256
Housing Price (Nominal Terms) (NT$/ping)	176,313	5,790
Housing Price (Real Terms) (P) (NT$/ping)	169,051	9,486
Individual Real Estate Loans (Nominal Terms) (NT$ million)	2,775,733	311,088
Individual Real Estate Loans (Real Terms) (Ind) (NT$ million)	2,643,670	263,872
Nonperforming Loan Ratio (NPL) (%)	5.177	1.382
Primary Lending Rate (R_l) (%)	7.771	0.8683
Primary Lending Rate – Deposit Rate ($R_l - R_d$) (%)	2.913	0.167
Quantity of Vacant Housing (Vacq) (units)	1,577,681	671,335
Rate of Change of Vacq (Vac) (%)	0.657	14.771
Real Estate Lending Rate (R_r) (%)	6.822	1.857
Real Estate Lending Rate/Primary Lending Rate (R_r/R_l)	0.924	0.092
Real Estate Loans (Nominal Terms) (NT$ Million)	3,841,230	381,093
Real Estate Loans (Real Terms) (LoanR) (NT$ Million)	3,659,004	324,565
Real Estate Loans/Total Loans (LoanR/Loan) (%)	37.347	2.066
Return on Bank Assets (ROA) (%)	0.116	0.205
Return on Bank Equity (ROE) (%)	1.486	2.801
Stock Return to the Banking Sector (SRB) (%)	0.120	10.192
Total Loans (Nominal Terms) (NT$ million)	10,365,820	1,521,093
Total Loans (Real Terms) (Loan) (NT$ million)	9,867,669	1,328,217
Sample Size	88	88

Note: This table shows the descriptive statistics for the sample from January 1996 to April 2003. The units and, if applicable, the variable acronyms and whether the variables are shown in real or nominal terms are presented in parentheses. The general banking return index is calculated as follows: GBRI = 25% ROA + 25% ROE + 50% SRB

The Econometric Model and Empirical Analyses

Since all of three main variable groups, namely, real estate valuation, banking profitability, and nonperforming loans, are unit root processes; we applied Granger causality tests (Granger, 1969). We first applied the Johanson (1988) co-integration tests as shown in Table 3. Using the optimal lag length of 12, we found the following: The nonperforming loan ratio (NPL) was co-integrated with the housing price (P), the stock return to the banking sector (SRB), and the general banking return index (GBRI). The housing price (P) was also co-integrated with the stock return to the banking sector (SRB) and the general banking return index (GBRI).

We used vector autoregression models (VAR) for the sets of variables that were not co-integrated. The results reported in Table 4 closely follow our predictions. We observed that the return on assets Granger-causes the nonperforming loan ratio and the housing price at the 5 percent level of significance. In turn, the nonperforming loan ratio Granger-causes both the return on bank assets, as well as the return on bank equity at the 1 percent level of significance. These findings suggest that there is a two-way causal relationship between the nonperforming loan ratio and bank returns measures by the return on assets. Furthermore, there is evidence that bank returns (ROA) also affect housing prices.

For those sets of variables that are co-integrated, we ran the Granger causality tests with the vector error correction model (VEC). The results are presented in Table 5. This analysis confirms that the nonperforming loan ratio Granger-causes the stock returns to the banking sector and the general banking return index at the 1 percent level of significance, and housing prices at the 10 percent level of significance. We found that the housing price Granger-causes the stock returns to the banking sector at the 5 percent level and the general banking return index at the 10 percent level. Furthermore, we observed that the stock return to the banking sector Granger-causes the nonperforming loan percentage and the housing price at the 10 percent level. Both Tables 4 and 5 indicate that the nonperforming loan ratio is a very important determinant of both the banking sector's profitability and the real estate market's performance.

Table 3 Johanson Co-integration Tests

Variables Included	Optimal Lag Length	LR Test Statistics for No Co-integration	Inferred Number of Co-integrating Relationship
NPL and P	12	14.31	1
NPL and SRB	12	24.20	1
NPL and ROA	12	5.11	0
NPL and ROE	12	6.42	0
NPL and GBRI	12	17.17	1
P and SRB	12	14.71	1
P and ROA	12	5.42	0
P and ROE	12	4.22	0
P and GBRI	12	12.91	1

Note: This table shows the results of the Johanson co-integration tests. NPL is the nonperforming loan ratio, P is the housing price in NT$ per ping in real terms, ROA is the return on bank assets, ROE is the return on bank equity, SRB is the stock return to the banking sector, and GBRI is the general banking return index. All series are in real terms with respect to the first quarter of 1996. If the log likelihood ratio is greater than the 5% critical value, the null hypothesis of no co-integration is rejected. The 5% critical value is 12.53 for all tests reported. The inferred number of co-integrating relationship is shown in the last column.

To further our analysis and to perform a robustness check, we developed a set of simultaneous equations stemming from our hypotheses discussed in Section 2. The first specification expresses the relationship between the nonperforming loan ratio (NPL) and its possible determinants:

$$NPL_t = \alpha_0 + \alpha_1 g_{t-1} + \alpha_2 \Delta P_t + \alpha_3 \left(\frac{R_{r,t-1}}{R_{l,t-1}} \right) + \alpha_4 \left(\frac{Corp_{t-1}}{Ind_{t-1}} \right) + \varepsilon_t \qquad (1)$$

where NPL is the nonperforming loan ratio, ΔP is the change in the housing price in nominal terms, R_r is the real estate lending rate, R_l is the is the primary lending rate, Corp is the amount of corporate real estate loans, and Ind is the amount of individual real estate loans. We expected $\alpha_1 < 0$, $\alpha_2 < 0$, $\alpha_3 < 0$, and $\alpha_4 < 0$, according to our hypothesis.

Table 4 Granger Causality Tests of the Interaction of Nonperforming Loans, Banking Sector Profitability, and Real Estate Performance Using Vector Autocorrelation (VAR)

Null Hypothesis	F-Statistic	P-value
ROA does not Granger-cause NPL	1.91**	0.05
NPL does not Granger-cause ROA	3.24***	0.00
ROE does not Granger-cause NPL	1.77	0.08
NPL does not Granger-cause ROE	3.13***	0.00
ROA does not Granger-cause P	2.00**	0.04
P does not Granger-cause ROA	0.88	0.57
ROE does not Granger-cause P	1.53	0.14
P does not Granger-cause ROE	1.08	0.39

Note: This table shows the results of the Granger causality tests. NPL is the nonperforming loan ratio, P is the housing price in NT$ per ping in real terms, ROA is the return on bank assets, and ROE is the return on bank equity. All series are in real terms with respect to the first quarter of 1996. The lag length of 12 quarters is from the co-integration analysis reported in Table 3. The second column of the table shows the F statistics of the null hypothesis that the lag coefficient of the causal variable is equal to zero. The asterisks indicate rejection of the null hypothesis at the 1 percent or better (***) and 5 percent (**) levels of significance.

Table 5 Granger Causality Tests of the Interaction of Nonperforming Loans, Banking Sector Profitability, and Real Estate Valuation Using Vector Error Correction (VEC)

ECM 1	D(NPL) -0.002 (-0.52)	D(P) -0.036 (-2.75)*
ECM 2	D(NPL) -0.002 (-1.86)*	D(SRB) -0.77 (-3.15)***
ECM 3	D(NPL) -0.002 (-0.52)	D(GBRI) -0.036 (-2.75)***
ECM 4	D(P) -0.002 (-1.86)*	D(SRB) -0.224 (-2.47)**
ECM 5	D(P) 0.000 (0.00)	D(GBRI) -0.013 (-2.61)***

Note: This table shows the Granger causality tests using the vector error autocorrelation model (VEC). NPL is the nonperforming loan ratio, P is the housing price in NT$ per ping in real terms, SRB is the stock return to the banking sector, and GBRI is the general banking return index. The first column of the table indicates the five error correction models (ECM), which correspond to the five pairs of variables that are consistent with the co-integration vectors found in Table 3. The dependent variables, which are the first differences (as indicated by the letter "D") of the quantities in parentheses, are shown next to the model number. The numbers below the dependent variables are the coefficients of the error correction terms, which indicate the long-term influence of the causal variable. The numbers in parentheses are the t-

statistics of the coefficients. All series are in real terms with respect to the first quarter of 1996. The lag length of 12 quarters is from the co-integration analysis reported in Table 3. The coefficients for the 12 lagged variables of the dependent variables, as well as those for the causal variables, are not shown in the table. One asterisk indicates a 10 percent level of significance; two asterisks indicate a 5 percent level of significance; and three asterisks indicate a 1 percent level of significance or better.

The second specification arises from the determinants of the bank profitability (BP) and is expressed as follows:

$$BP_t = \beta_0 + \beta_1 NPL_t + \beta_2 g_t + \beta_3 \left(R_{l,t} - R_{d,t}\right) + \beta_4 Loan_t + \mu_t \tag{2}$$

where BP is the bank profitability, NPL is the nonperforming loan ratio, g is the GDP growth rate, R_l is the is the primary lending rate, R_d is the deposit rate, and Loan is the amount of total loans in nominal terms. We expected $\beta_1 < 0$, $\beta_2 > 0$, $\beta_3 > 0$, and $\beta_4 > 0$.

The third specification explains the housing price level in nominal terms:

$$P_t = \gamma_0 + \gamma_1 NPL_t + \gamma_2 g_t + \gamma_3 Vac_t + \xi_t \tag{3}$$

where P is the housing price in nominal terms, NPL is the nonperforming loan ratio, g is the GDP growth rate, and Vac is the rate of change of vacant housing. We predicted $\gamma_1 < 0, \gamma_2 > 0,$ and $\gamma_3 < 0$.

Equation (1) can be incorporated into Equations (2) and (3); therefore, we can rewrite the structural form model as a reduced form model consisting only of the banking profitability and the housing price determinants. This reduced form model is shown as follows:

$$BP_t = A_1 + A_2 g_{t-1} + A_3 g_t + A_4 P_{t-1} + A_5 \left(\frac{R_{r,t-1}}{R_{l,t-1}}\right) + A_6 \left(\frac{Corp_{t-1}}{Ind_{t-1}}\right) + A_7 \left(R_{l,t} - R_{d,t}\right) + A_8 Vac_t + A_9 Loan_t + \lambda_t \tag{4}$$

$$P_t = B_1 + B_2 g_{t-1} + B_3 g_t + B_4 P_{t-1} + B_5 \left(\frac{R_{r,t-1}}{R_{l,t-1}}\right) + B_6 \left(\frac{Corp_{t-1}}{Ind_{t-1}}\right) + B_7 Vac_t + \eta_t \tag{5}$$

where BP is the bank profitability, g is the GDP growth rate, P is the housing price in nominal terms, R_r is the real estate lending rate, R_l is the is the primary lending rate, Corp is the amount of corporate real estate loans, Ind is the amount of individual real estate loans, R_d is the is the deposit rate, and

Vac is the rate of change of vacant housing. We expected the following relationships to hold: $A_2 > 0$, $A_3 > 0$, $A_4 > 0$, $A_5 > 0$, $A_6 > 0$, $A_7 > 0$, $A_8 < 0$, $A_9 > 0$, $B_2 > 0$, $B_3 > 0$, $B_4 > 0$, $B_5 > 0$, $B_6 > 0$, and $B_7 > 0$.

In other words, the banking profitability depends on current and previous GDP growth rates, the housing price, the relative cost of real estate borrowing, the ratio of corporate to individual real estate loans, the spread between the lending rate and the deposit rate, the rate of change in vacant housing, and the total amount of loans. Similarly, the housing price depends on the current and previous GDP growth rates, the previous level of housing price, the relative cost of real estate borrowing, the ratio of corporate to individual real estate loans, and the rate of change in vacant housing.

Table 6 Regression Results - Structural Form

Model	1 (NPL)	2(BP)	3 (P)
Constant	20.251***	0.022	20.140***
	(13.86)	(0.45)	(68.16)
g_{t-1}	-0.122***		
	(-6.28)		
g_t		-0.002	-0.087***
		(-1.36)	(-4.26)
$P_t - P_{t-1}$	0.361		
	(1.03)		
$R_{r,t-1} / R_{l,t-1}$	-13.761***		
	(-16.11)		
$R_{l,t} - R_{d,t}$		0.010	
		(0.42)	
$Corp_{t-1} / Ind_{t-1}$	-1.929**		
	(-2.06)		
$Loan_t$		0.002	
		(1.15)	
NPL_t		-0.011***	-0.391***
		(-2.77)	(-8.88)
Vac_t			-1.743
			(-1.235)
Sample Size	81	81	81
R^2	0.927	0.249	0.540

Note: This table shows the results of Equations (1), (2), and (3), respectively. The first model has the nonperforming loan ratio (NPL) as the dependent variable, the second model has the bank profitability (BP) as the dependent variable, and the third model has the housing price (P) as the dependent variable. All variable definitions remain the same as in Table 2. The figures in parentheses represent the t-values. One asterisk (*) represents significance at the 10 percent level, two asterisks (**) represent significance at the 5 percent level, and three asterisks (***) represent significance at the 1 percent level or better.

In order to avoid the biases caused by institutional changes, we excluded the recent observations. The sampling period thus spans from January 1996 to September 2002, which resulted in 81 observations. Table 6 shows the results of Equations (1), (2), and (3). With the exception of one result, the significant outcomes are consistent with our hypotheses. We found that the ratio of corporate to individual real estate loans is negatively significant at the 5 percent level in determining the nonperforming loan ratio. We observed that the relative cost of real estate borrowing is negatively significant at the 1 percent level in determining the nonperforming loan ratio. We also observed that the GDP growth rate is negatively significant in determining the nonperforming loan ratio.

Table 7 Regression Results - Reduced Form

Model	BP	P
Constant	-0.160	0.670
	(-1.26)	(1.32)
g_{t-1}	-0.004	0.022
	(-1.09)	(0.93)
g_t	0.003	-0.020
	(0.96)	(-0.86)
P_{t-1}	0.004	0.890***
	(0.55)	(22.82)
$R_{r,t-1} / R_{l,t-1}$	0.150***	0.693
	(2.92)	(1.69)
$R_{l,t} - R_{d,t}$	-0.017	
	(-0.88)	
$Corp_{t-1} / Ind_{t-1}$	-0.051	0.652
	(-0.81)	(1.69)
$Loan_t$	0.006**	
	(2.05)	
Vac_t	0.120**	0.090
	(2.07)	(0.19)
Sample Size	81	81
R^2	0.37	0.95

This table shows the results of Equations (4) and (5), respectively. The first model has the bank profitability (BP) as the dependent variable and the second model has the housing price (P) as the dependent variable. All variable definitions remain the same as in Table 2. The figures in parentheses represent the t-values. One asterisk (*) represents significance at the 10 percent level, two asterisks (**) represent significance at the 5 percent level, and three asterisks (***) represent significance at the 1 percent level or better.

The only significance for the banking profitability came from the nonperforming ratio percentage, which has a negative and significant effect at the 1 percent level. The puzzling outcome is the negative and significant relationship between the housing price and GDP growth rate. We predicted the coefficient to be positive, since we would expect the real estate market to perform better when the overall economy is doing well. One possible reason is that Taiwan's housing prices display a certain degree of rigidity while economic growth fluctuates. Therefore, the concurrent changes do not necessarily represent a reaction to the same variables. The nonperforming loan ratio also has a negative and significant (1 percent level) impact on the housing price. The reduced form equations are regressed in Table 7. We observed that the banking profitability is positively affected at the 1 percent level by the relative cost of real estate borrowing, which is consistent with our hypothesis. We also found that the total amount of loans is a positive and significant determinant of bank profitability at the 5 percent level. The rate of change in vacant housing is expected to have a negative impact on profitability, but instead the coefficient is positive and significant at the 5 percent level. Again, this is presumably due to the real estate market behaving fairly rigidly when compared to the banking sector or the general economy. Finally, we observed that the past level of housing prices is a very significant and positive determinant of the current level of housing prices.
The analysis was also conducted with variables in real terms and the results, which were not reported in the tables, are qualitatively similar. Where there is indication of autocorrelation as measured by Durbin-Watson tests, Cochrane-Orcutt generalized differencing procedures were used. The results (not shown) are qualitatively identical.

Conclusions

The risky lending behavior of banks and the recessive real estate sector can cause increasing levels of nonperforming loans. In turn, a high percentage of nonperforming loans can push banks to adopt more restrictive real estate lending policies, causing the real estate market to slump. This paper analyzed the interactions of the nonperforming loan ratio, the returns to the banking sector, and the real estate market. Using Granger causality tests, we found that the nonperforming loan ratio can indeed have an effect on bank profitability. The converse is also true: bank profitability has an impact on the nonperforming loan ratio. We also found that the bank profitability and the housing price have causal relationships. To better analyze the determinants of each of these three factors, we modeled a set of simultaneous equations. We predicted that the nonperforming loan ratio can be explained by the GDP growth rate, the change in housing price, the

relative cost of real estate borrowing, and the ratio of corporate to individual real estate loans. We found that all but the change in housing price are important determinants of the nonperforming loan ratio. We also modeled the banking profitability by including the GDP growth rate, the spread between the lending rate and the deposit rate, the total amount of loans, and the nonperforming loan ratio. The results suggested that the nonperforming loan ratio affects banking profitability negatively, as expected. Furthermore, we predicted the explanatory variables for the housing price. We expected the GDP growth rate, the nonperforming loan ratio, and the rate of change in vacant housing to be important in explaining the housing price. We found that the growth rate was significant, but with the wrong sign, which could be due to the inflexibility of the real estate market in the short run. In contrast, we observed that the nonperforming loan ratio affects the housing price negatively. Finally, we modeled two reduced form equations and found that the relative cost of real estate borrowing and the total amount of loans affect the banking profitability. Another possible result, perhaps due to the inflexibility of the real estate market, is the positive relationship between the rate of change in vacant housing and the banking profitability. We observed that the past level of the housing price is the single most important determinant of the current level of the housing price.

The findings of this study provide policy insights. Reducing the nonperforming loan ratio has a positive influence on both the real estate sector as well as the banking system. Adjusting the real estate lending policies is a possible way of reducing the nonperforming loan ratio. However, banks must perform this adjustment with care. If they make their policies too conservative, real estate lending could drastically contract, exerting a downward pressure in the real estate market.

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