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Underpriced Default Spread Exacerbates Market Crashes

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Abstract

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Keywords

real estate bubble, lender optimism, disaster myopia, Asian financial crisis

Disciplines

Business | Real Estate

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Underpriced Default Spread Exacerbates Market Crashes

In this paper, we develop a specific observable symptom of a banking system that underprices the default spread in non-recourse asset-backed lending. Using three different data sets for 18 countries and property types, we find that, following a negative demand shock, the "underpricing" economies experience far deeper asset market crashes than economies in which the put option is correctly priced. Furthermore, only one of the countries in our sample continues to exhibit the underpricing symptom following a market crash. This indicates that market crashes have a cleansing effect and eliminate underpricing at least for a period of time. This makes investing in such markets safer following a negative demand shock.

Keywords: real estate bubble, lender optimism, disaster myopia, Asian financial crisis

1. **Introduction**

All non-recourse asset-backed mortgage loans contain a put option that allows the borrower, through default, to "sell" the asset to the lender for the outstanding mortgage balance. The default spread compensates the lender for this put option. If correctly priced, the imbedded put option has no impact on asset markets. If, however, the put is underpriced, efficient asset markets incorporate this mistake into the transaction price of the asset. This leads to inflated asset prices above their fundamental level.[1]

Our contribution is twofold. First, utilizing the theory of Pavlov and Wachter (2002, 2005), we develop a specific and observable symptom of underpricing in the economy (discussed in Section 2). Second, using data from 18 countries and property types, we empirically find that, following a negative demand shock, markets which exhibit the symptom of underpricing tend to experience far deeper market crashes than markets that do not exhibit the symptom.

Following a negative demand shock, the asset prices in an economy which experiences underpricing have to fall far enough not only to reflect the new supply and demand conditions but also to eliminate the prior price inflation.[2] Therefore, economies that experience underpricing, while not necessarily subject to a higher risk of market crashes, are subject to deeper crashes when they occur.

Furthermore, only one of the countries in our sample continues to exhibit the underpricing symptom after its respective market crash. This suggests that underpricing is

[1] See Allen and Gale (1998 and 1999) and Pavlov and Wachter (2002, 2005) for models that show how underpricing of the put option leads to inflated asset prices.
[2] See Pavlov and Wachter (2002, 2005) for models that show how underpricing of the put option can exacerbate asset market crashes.

typically eliminated following a negative demand shock. Therefore, investing is safer following large negative demand shocks as the risk of inflated asset prices is greatly reduced. Of course, given enough time and absent institutional changes, some of these economies may switch back to underpricing. This, in turn, would exacerbate any subsequent market crashes.

Our study is distinct from the literature which estimates the fundamental price of an asset directly and detects asset price inflation by comparing the estimated to the observed price.[3] While this approach is very intuitive, it ultimately suffers from an inability to distinguish between asset price bubbles and inappropriate models of the fundamental price. Other studies have focused selectively on macroeconomic ratios such as income to mortgage payment or income to price ratios.[4] Yet another branch of this literature investigates local demand and supply conditions and potential for further development and metropolitan area limitations. Such models are always vulnerable to the criticism that they are lacking fundamental features of the market that are efficiently contributing to price rises.

In addition to finding support for our theory, our findings give policy makers and market participants a measurable symptom of underpricing. If such underpricing is suspected, policy makers and regulators can take steps to eliminate it or at least contain its market-wide impact. More importantly, both lenders and market participants can take measures to prepare for or hedge the expected increased magnitude of any future price

[3] See for instance Smith, Smith, and Thompson (2005) for a direct estimation of real estate values in Los Angeles. Other studies of the fundamental real estate values include Case and Shiller (2003), Krainer and Wei (2004), Krugman (2005), Leamer (2002), McCarthy and Peach (2004), and Shiller (2005), among others.
[4] Examples include Edelstein (2005) and Edelstein, Dokko, Lacayo, and Lee (1999).

declines should a negative demand shock occur. Indeed while underpriced lending may not initiate unsustainable "asset bubbles" thereby causing market crashes, the underpricing of risk makes these crashes worse. Moreover, Herring and Wachter (1999) demonstrate that price rises, even if efficient, may set off underpricing episodes. Moreover, inefficient over pricing of assets is unlikely to be sustainable without supportive lending policies.

We proceed as follows. Section 2 develops the symptom of underpricing and formulates the testable empirical implication discussed above. Section 3 describes the data, presents our main results, and provides robustness analysis utilizing various controls and econometric tests. Section 4 examines in detail some of the markets we include in our empirical tests and provides an in-depth review of the economic conditions in each market that led to its respective asset price increase and crash. Section 5 concludes with policy implications and direction for future research.

2. The Symptom of Underpricing

There are two reasons for the lending spread, i.e. the value of the imbedded put option, to fall. First, the default spread can narrow because the asset price volatility falls, which, in turn, reduces the value of the put option. This is a rational reason to reduce the lending spread and has no impact on asset prices. Note that a change in the volatility of the asset has little or no impact on the asset price because investors are diversified.

The second reason lending spreads narrow is that lenders underprice the default risk. This increases the asset prices because rational investors take advantage of the underpriced non-recourse lending even if they are fully diversified.

The transaction price of an asset financed through a non-recourse loan is the composite of the fundamental value of the asset, V, the value of the mortgage loan, M, and the face value of the adjustable-rate mortgage loan:

$$P = V(\sigma) - M(\sigma, s(\sigma)) + B\,, \tag{1}$$

where σ denotes the expected future volatility of the asset and s denotes the spread of lending over deposit rates. This spread compensates the lender for the put option imbedded in the non-recourse mortgage. If the mortgage is priced correctly, its market value equals its face value, and the transaction price equals the fundamental value of the asset. If the lending spread, s, changes in response to σ,

$$\begin{aligned} &\frac{\partial s}{\partial \sigma} > 0 \\ &\frac{\partial P}{\partial \sigma} = \frac{\partial V}{\partial \sigma} - \frac{\partial M}{\partial \sigma} - \frac{\partial M}{\partial s}\frac{\partial s}{\partial \sigma} = \frac{\partial V}{\partial \sigma} \approx 0 \end{aligned} \tag{2}$$

Since the spread adjusts to compensate the lender for the changes in the value of the put option imbedded in the mortgage loan, $\frac{\partial M}{\partial \sigma} + \frac{\partial M}{\partial s}\frac{\partial s}{\partial \sigma} = 0$. If the change in volatility of the asset is fully diversifiable, then $\frac{\partial V}{\partial \sigma} = 0$. If the increase in volatility affects the covariance of the asset return with the market, then $\frac{\partial V}{\partial \sigma} < 0$**,** but still relatively small.

The response of the asset price to the spread is:

$$\frac{\partial P}{\partial s} = \frac{\partial P}{\partial \sigma} \Big/ \frac{\partial s}{\partial \sigma} = \frac{\partial V}{\partial \sigma} \Big/ \frac{\partial s}{\partial \sigma} \approx 0 \qquad (3)$$

Therefore, the correlation between transaction prices and lending spread is zero if the increase in asset volatility is fully diversifiable, and close to zero if it affects the covariance between the asset and the overall market.

If, on the other hand, the spread changes because of underpricing, not in response to changes in expected future asset volatility, the response of the price to the spread is very different:

$$\frac{\partial s}{\partial \sigma} = 0, \frac{\partial V}{\partial s} = 0, \frac{\partial M}{\partial s} > 0, \qquad (4)$$

therefore,

$$\frac{\partial P}{\partial s} = \frac{\partial V}{\partial s} - \frac{\partial M}{\partial s} = -\frac{\partial M}{\partial s} < 0. \qquad (5)$$

Thus, the correlation between asset prices and lending spread is negative and driven by the sensitivity of the value of the mortgage to the lending spread, which is substantial.

The above differential impact of default spread on asset prices produces the following symptom of underpricing:

Underpricing of the default risk in non-recourse lending produces a negative correlation between asset returns and changes in the default spread. Correctly

pricing the default risk in non-recourse lending produces no correlation between asset returns and changes in the default spread.

Following an asset market negative demand shock, "underpricing" economies experience deeper market crashes because the new asset price not only reflects the new supply and demand conditions, but also eliminates the price inflation due to underpricing. This leads to the following empirical implication:

Countries that experience underpricing (i.e., have a negative correlation between asset returns and changes in the default spread), experience larger market crashes following negative demand shocks.

Therefore, narrowing of the lending spread is not sufficient evidence of underpricing or asset price inflation. Instead, we need to observe a negative correlation between the landing spread and asset prices to suspect underpricing. Moreover to determine whether the phenomenon of underpricing is contributing to higher asset prices we need to observe a positive relationship, all else equal, between the correlation and asset price rises. While theoretically appealing, this approach does limit the practical applicability of our symptom as a tool to detect and combat underpricing. Estimating the correlation requires a number of observations and introduces a substantial time lag between the start of underpricing and its detection. Nonetheless, a measurable symptom is useful for countries and markets that track and report lending activity and asset prices in a timely fashion. Absent the symptom we propose here, even these markets may not be able to detect underpricing before a market crash occurs. Thus we develop and implement a test for whether underpricing contributes to asset price inflation based on the statistically

significant joint presence of price rises and a negative correlation of the narrowing of the lending spread with asset price rises across countries, using an international database of property returns. Furthermore, we test the sequential presence of negative correlation and large price declines following a negative demand shock. Finally, we test the absence of negative correlation in all markets following a negative demand shock.

3. **Empirical Support**

To test the above theoretical predictions we need, at the minimum, property return data and the spread of lending over deposit rates for a number of countries and property types. Lending and deposit rates are readily available from the World Bank. Reliable property data with deep history is rare, however. In this paper we use four distinct real estate property data sets, three international and one from a particular U.S. market. While each of the data sets has its own advantages and shortfalls, taken together our empirical findings paint a picture which is strongly consistent the theoretical predictions above.

3.1 **Global Property Research Indices**

The largest of our three data sets is the Global Property Research Indices (GPR) compiled by Eichholtz, et. al. (1998) and refined and extended by Dr. Christopher Shun, Menang Corporation, Malaysia. This data includes property indices for 25 countries over 20 and 12 years for developed and emerging countries, respectively. The GPR 250 Global Property Stocks index only includes property companies with a minimum of USD $50mn of freely available market value and high liquidity in terms of average last-year stock trading volume. As of December 2002, the securities included in the GPR 250 index had a combined available market value of USD$194 bn.

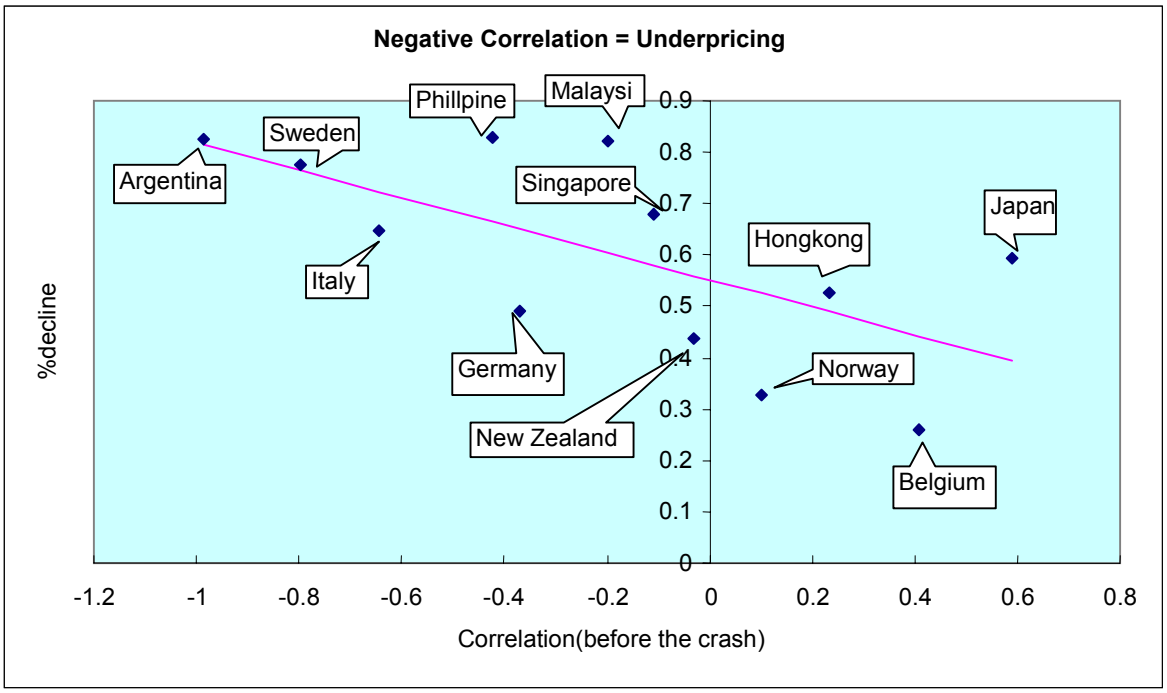
This data set has a number of advantages. In particular, it has the deepest history and the largest cross-sectional span across the globe of any real estate property database. Since the returns are based on publicly traded and liquid securities, the data quality is high, available at a monthly frequency, and is consistent through time. The only drawback of this data is that it provides the returns of publicly traded securities rather then the actual returns to direct real estate investment. As noted by Eichholtz, et. al. (1998) and by Shun (2005), the real estate investment trust returns used to construct the GPR indices are subject to stock market flow of funds effects and do not always follow the returns to direct real estate investment. Nonetheless, our theoretical model is valid for both public and private real estate investments, and the use of REIT return data provides for a legitimate test of the theoretical predictions.

The most direct test of the theoretical model described above is a negative relationship between the correlation of the change in lending spread and asset returns before the crash and the total price decline during the crash for each market. Figure 1 depicts a scatter plot of all observations with enough history to compute the correlation before the respective market crash. The horizontal axis depicts the correlation between asset returns, including dividends, and the change in lending over deposit rate spread before the respective market crash. Since market crashes occurred during different periods in each country, this correlation is computed over different time intervals. We use data going as far back in time as possible up to the peak of the respective real estate market. The vertical axis contains the percent decline, from top to bottom, during the most recent market crash for each country. In some cases this decline spanned only a few months, while for others it

took a year or two. Therefore, the vertical axis depicts the total decline, not annualized or adjusted in any way for the time frame it took for prices to adjust.

Our theory predicts that a large negative correlation between asset returns and changes in lending spreads is a symptom of underpricing. Countries that experience underpricing before their negative demand shock tend to experience far greater price declines during their market crash. Consistent with this, Argentina, Sweden, Italy, Phillipines, Germany, and Malaysia displayed a large negative correlation between asset returns and changes in the lending spread before their respective crashes. These same countries experienced very large price declines following their negative demand shocks, of 50 to 85%. Economies like Singapore, New Zealand, Norway, Hong Kong, Belgium, and Japan exhibited no or positive correlation between asset returns and lending spreads. These countries, therefore, did not exhibit the symptom of underpricing developed in Section 2. While they also experienced negative demand shocks, their price declines were relatively more modest, between 25 and 68%. A single variable regression using these observations has an R^2 of 42% and a slope coefficient p-value of .0217. These findings are consistent with the theory that a negative correlation between asset returns and changes in lending spreads is a symptom of underpricing, and that underpricing exacerbates market downturns.

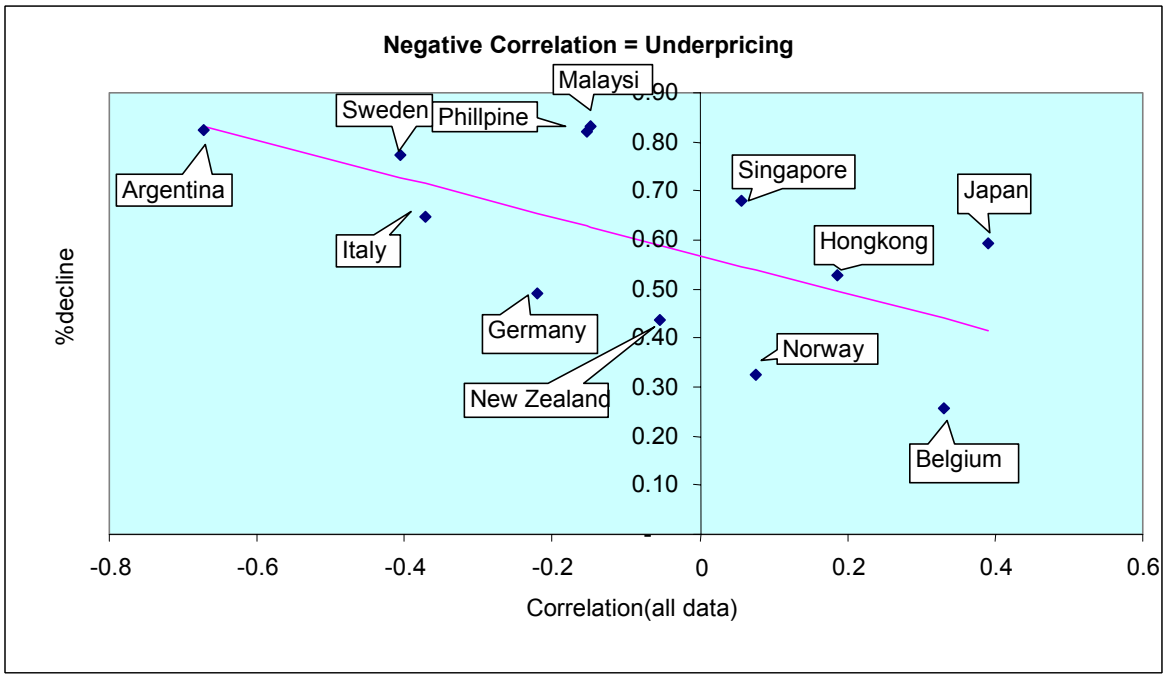
Figure 1: Symptom of Underpricing Vs. Total Market Crash Decline



R^2 of the regression line is 42% and the regression coefficient has p-value 0.0217. The correlation is computed between the total index return, including dividends, and the change in the spread of lending over deposit rates. In this figure, we compute the correlation using data before the crash, i.e., from the beginning of our data set to the peak of the property market. The vertical axis depicts the total percent decline in the property market, from top to bottom. This is over one or more years and is specific for each country. According to our theory, negative correlation is a symptom of underpricing, and is associated with larger losses during a market downturn. Countries that do not exhibit the symptom of underpricing have zero or positive correlation, and their respective property market declines are relatively modest.

As a robustness check, we repeat the above analysis except using all available data, before, during, and after the crash, for each country, to compute the correlation between asset returns and changes in the lending spread. This approach allows us to include more observations in the analysis, but has the major drawback that lending spreads may have increased in response to the market crash. Following a negative demand shock, the perceived or actual risk of the asset markets typically increases. Thus, the lending spread increases, rationally or not, following a negative demand shock irrespective of the underpricing behavior of lenders before the crash. However, since low asset prices (following the crash) are associated with high lending spreads (following the crash), the correlation between asset returns and changes in the lending spreads may appear negative even in the absence of underpricing. In other words, our theoretical implication will hold even in the absence of underpricing and using all data is not a direct test of our hypothesis. Nonetheless, we include it in Figure 2 as a form of robustness check.

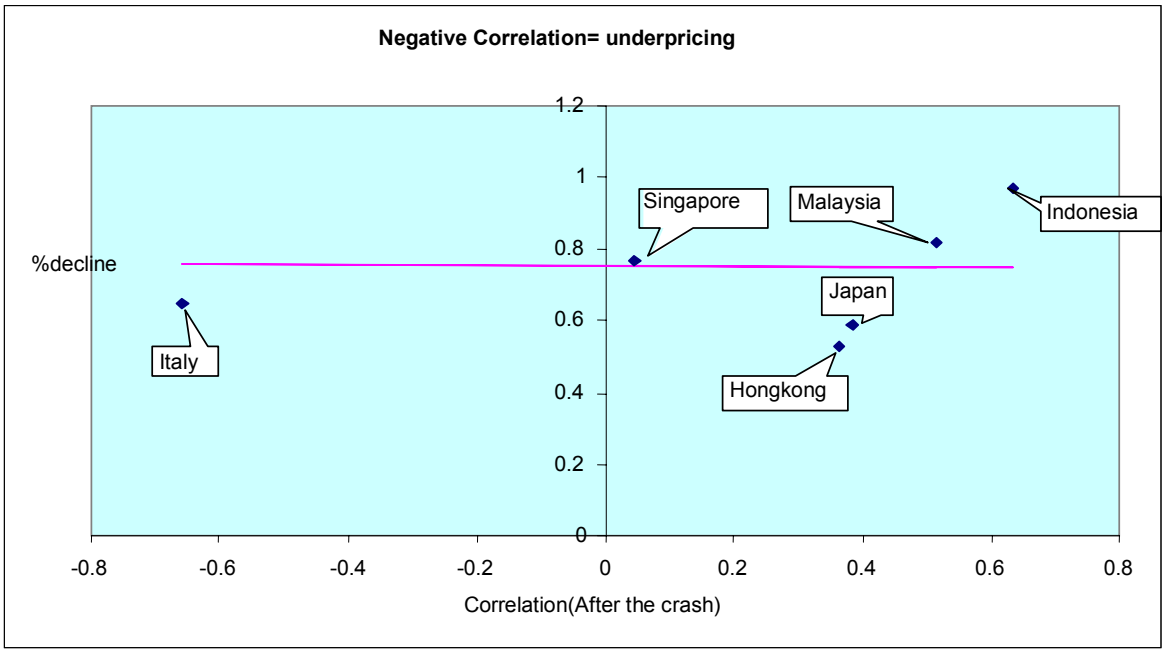
Figure 2: Symptom of Underpricing Vs. Total Market Crash Decline (Using All Available Data)



The R^2 of the depicted regression is 38% and the p-value of the regression coefficient is .03. The correlation is computed between the total index return, including dividends, and the change in the spread of lending over deposit rates. In this figure, we compute the correlation using all available data before, during, and after the crash. The vertical axis depicts the total percent decline in the property market, from top to bottom. This is over one or more years and is specific for each country. According to our theory, negative correlation is a symptom of underpricing, and is associated with larger losses during a market downturn. Countries that do not exhibit the symptom of underpricing have zero or positive correlation, and their respective property market declines are relatively modest.

Pavlov and Wachter (2002, 2005) suggest that underpricing is eliminated, at least for a period of time, following a negative demand shock. Our data presents an opportunity to test this prediction as well. In particular, we compute our symptom of underpricing, i.e., the correlation between asset returns and changes in the lending spread, following the negative demand shock in each country. While we only have six observations with enough data to compute a meaningful correlation, our finding is consistent with the Pavlov-Wachter prediction. Following the negative demand shock, there is no relationship between the correlation of asset returns and changes in the lending spread and the magnitude of the previous crash. Furthermore, only one country, Italy, continues to exhibit a negative correlation between asset returns and changes in the lending spread. This suggests that in most cases negative demand shocks have a cleansing effect and eliminate underpricing in the economy, at least for a period of time.

Figure 3: Symptom of Underpricing Vs. Total Market Crash Decline (Using Data After the Crash)



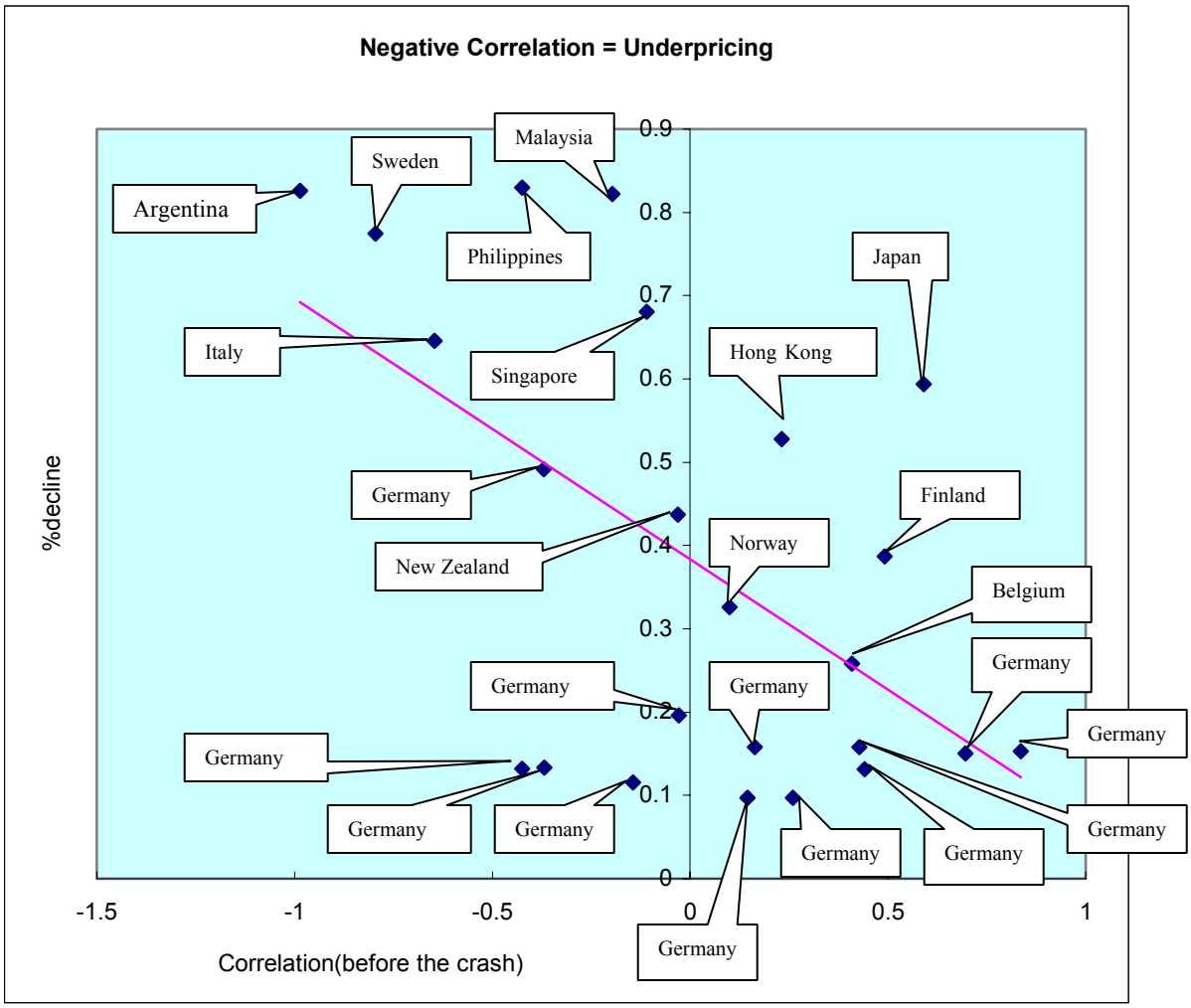
The R^2 of this regression is nearly zero and the slope coefficient is not significant. The correlation is computed between the total index return, including dividends, and the change in the spread of lending over deposit rates. In this figure, we compute the correlation using data after the crash. The vertical axis depicts the total percent decline in the property market, from top to bottom. This is over one or more years and is specific for each country. According to our theory, negative correlation is a symptom of underpricing, and is associated with larger losses during a market downturn. Countries that do not exhibit the symptom of underpricing have zero or positive correlation. Only one country, Italy, continues to exhibit the symptom of underpricing following its market crash. Furthermore, we find no relationship between the correlation between asset returns and changes in lending spreads and the size of the decline.

3.2 **Bank of International Settlements Indices**

To supplement the above data, we include the Bank of International Settlements (BIS) real estate price indices. Figure 4 includes this data in combination with the GPR indices described above. The BIS data has only two property markets that exhibit negative correlation between the change in default spread and the asset return, which prevents us from analyzing it on its own. Nonetheless, when combined with the BIS data described above, it proves to be very useful in verifying our hypothesis. In particular, the regression of percent decline (top to bottom) on the correlation between spread changes and asset returns (computed before the crash) has an R^2 of 31% and the slope coefficient is strongly significant at 99.5%.

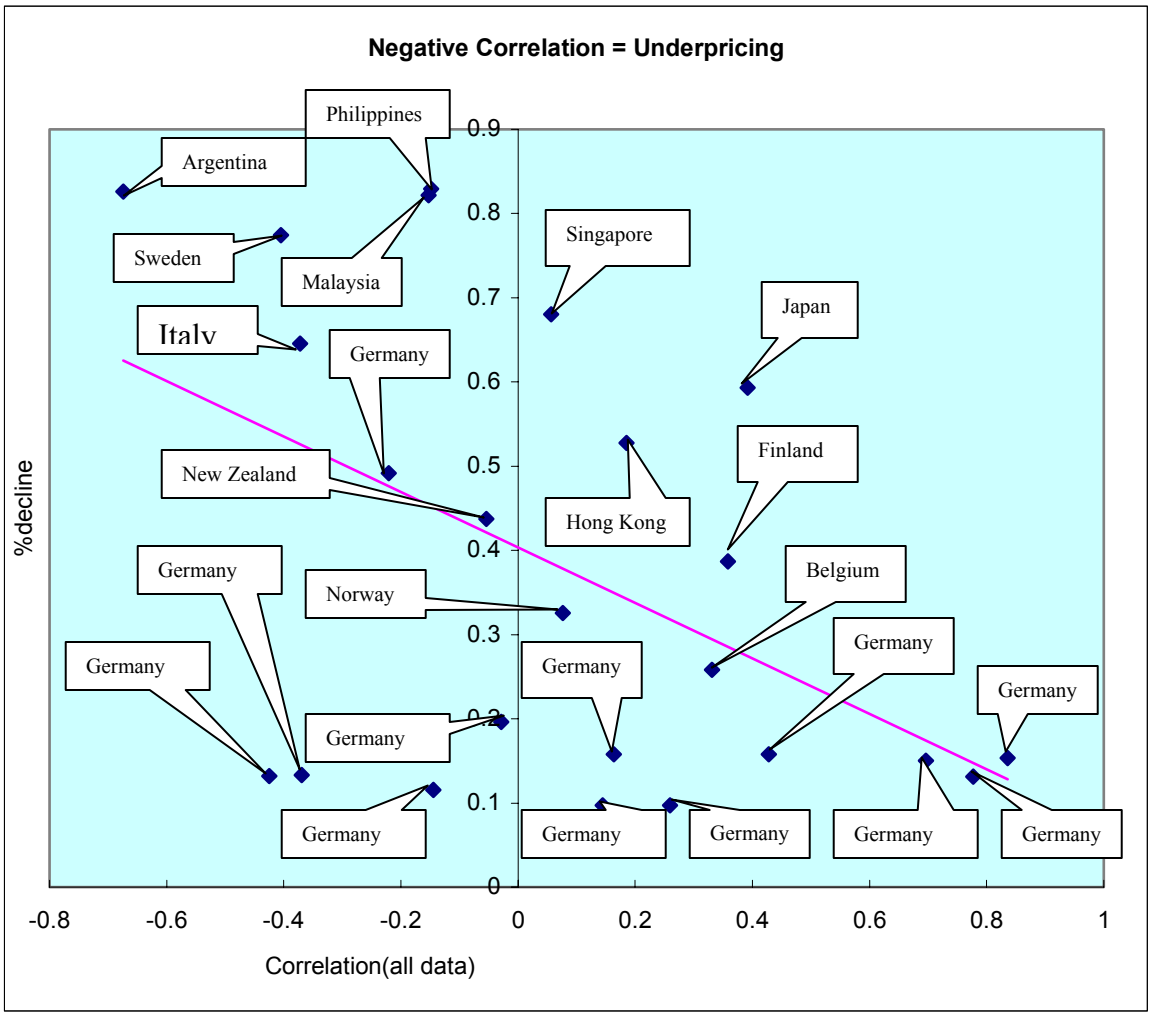
As a robustness check, Figure 5 reports the same relation as Figure 4, except we use all available data to compute the correlation between asset returns and changes in the yield spread. As discussed above, this approach has the problem that the spread may have widened in response to the crash, but it has the benefit of longer time series of returns for computing the correlation. The R^2 of this regression is 23% and the slope coefficient is still strongly significant at a 98% level.

Figure 4: Symptom of Underpricing Vs. Total Market Crash Decline, GPR and BIS data combined



The R^2 of the depicted regression is 31% and the p-value of the regression coefficient is .005. The correlation is computed between the percent decline (top to bottom) and the correlation between spread changes and asset returns (computed before the crash). In this figure, we compute the correlation using data before the crash. The vertical axis depicts the total percent decline in the property market, from top to bottom. This is over one or more years and is specific for each country. According to our theory, negative correlation is a symptom of underpricing, and is associated with larger losses during a market downturn. Countries that do not exhibit the symptom of underpricing have zero or positive correlation, and their respective property market declines are relatively modest.

Figure 5: Symptom of Underpricing Vs. Total Market Crash Decline, GPR and BIS data combined (using all available data



The R^2 of the depicted regression is 23% and the p-value of the regression coefficient is .02. The correlation is computed between the percent decline (top to bottom) and the correlation between spread changes and asset returns. In this figure, we compute the correlation using all available data. The vertical axis depicts the total percent decline in the property market, from top to bottom. This is over one or more years and is specific for each country. According to our theory, negative correlation is a symptom of underpricing, and is associated with larger losses during a market downturn. Countries that do not exhibit the symptom of underpricing have zero or positive correlation, and their respective property market declines are relatively modest.

3.3 **Appraisal-based indices**

The above analysis is based entirely on publicly traded Real Estate Investment Trusts (REITs) to construct the property price indices across countries. While this approach has the advantages of timely, accurate, high-frequency, and market-based data, it is vulnerable to any deviations of publicly traded REIT returns from the returns to direct real estate investment. To mitigate this potential deficiency, we repeat the above analysis using the Investment Property Databank (IPD).[5] This data uses annually appraised values for various types of commercial real estate to construct country and property type indices.

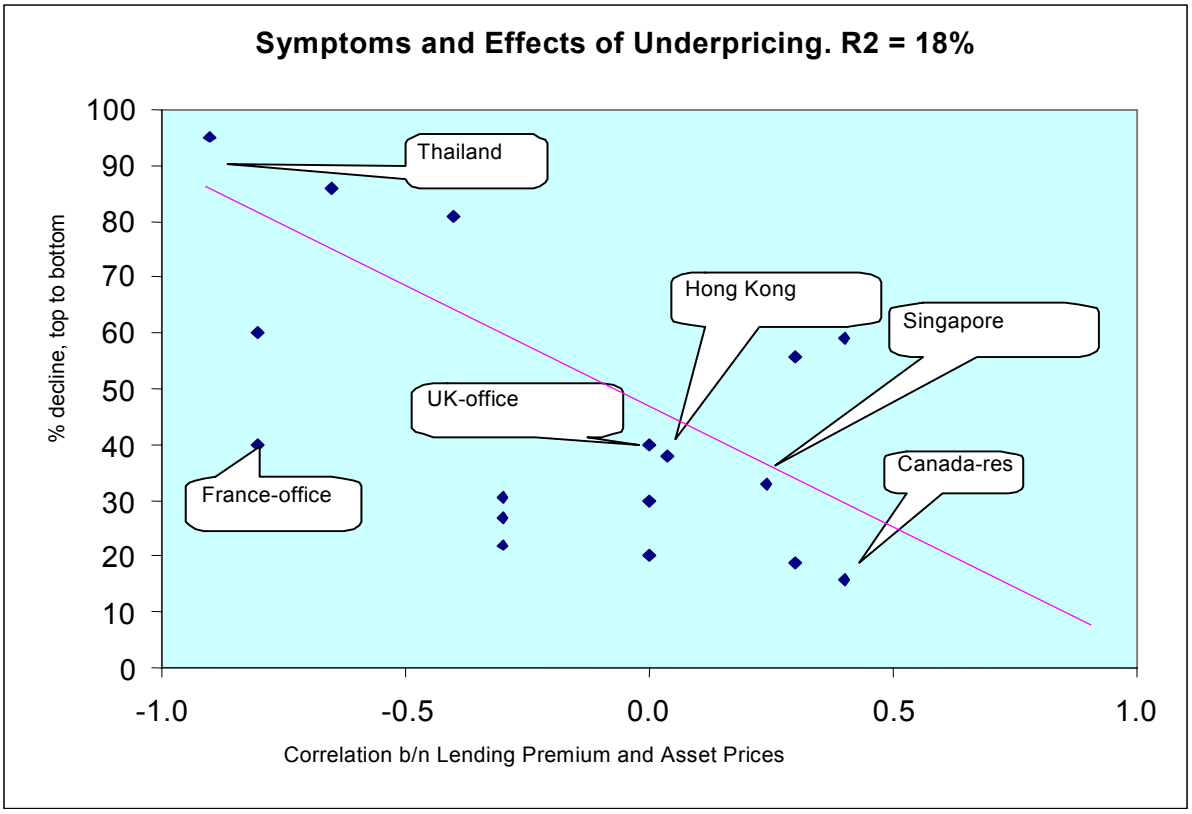
Since this data contains only enough history to compute the correlation between asset returns and changes in the lending spread for only three countries, we use all available data, before, during, and after the crash to compute these correlations. As noted above, this analysis suffers from the caveat that lending spreads may have increased in response to the market crash and independent of our theory. Nonetheless, the similarity between figures 1 and 2 above suggests that high negative correlation, even if computed over the entire sample period, is consistent with underpricing.

Figure 6 depicts the correlation between asset returns and changes in lending over deposit rate spreads versus the percent decline, top to bottom, during the respective market crash for each country. The correlation is computed using all available data. Consistent with our analysis above using publicly traded REIT returns, countries and markets, such as Thailand, exhibit the symptom of underpricing and also experienced very severe price declines. On the other hand, countries and markets like Hong Kong, Singapore, and

[5] 7 Greenland Place, London, NW1 0AP, United Kingdom.

Canada – residential, did not exhibit the symptom of underpricing and experienced more modest price declines during their respective negative demand shocks.

Figure 6: Symptom of Underpricing Vs. Total Market Crash Decline (Using Appraisal-based data)



The R^2 of this regression is 18% and the slope coefficient is strongly significant. The correlation is computed between the total property return, including dividends, and the change in the spread of lending over deposit rates. In this figure, we compute the correlation using all available data. The vertical axis depicts the total percent decline in the property market, from top to bottom. This is over one or more years and is specific for each country. According to our theory, negative correlation is a symptom of underpricing, and is associated with larger losses during a market downturn. Countries that do not exhibit the symptom of underpricing have zero or positive correlation.

3.4 **Transaction-based indices**

The most appropriate data for verification of our hypothesis is real estate price indices based on transaction data. Unfortunately, the availability of such data across countries is extremely limited. Therefore, in what follows, we focus on one particular market for which we have rare and very high quality transaction data. In particular, we use transaction data for apartment buildings in the Los Angeles Metropolitan Area from CoStar COMPS. The firm produces high quality transactions data for a wide range of income producing properties. The firm has provided data for all transactions in Los Angeles County apartment buildings that occurred between January 1989 and July 2001 for a total of 18,168 observations.[6] Table 1 provides summary statistics describing the transactions that occurred during the period. The mean and median per unit price during this period were a little more than $50,000 per unit. As can be seen from the table the typical LA County apartment complex is relatively small and the distribution of complex size is positively skewed, with a median of 10 and a mean of 17 units.

[6] The transaction data were screened for outliers and influential observations.

Table 1: Descriptive statistics for transactions 1/1988-9/2000.

	Price per unit	Cap Rate	Age	Parking Spaces	Number of Units
Mean	$56,896	.09	29	21	17
Median	$52,500	.09	32	12	10
Standard Deviation	$28,076	.03	20	31	20

To calculate the value of an apartment building we estimate the time series of rates of appreciation of the per unit price of LA County apartments. We use the following semi-log hedonic value model to estimate this series:

$$\ln(Value_{it}) = Constant + \sum_{t=2}^{T} \beta_t S_t + \alpha' C_i + \epsilon \qquad (6)$$

where $Value_{it}$ is the price paid for property i sold at time t, C_i is a vector of physical characteristics that describe the building, S_t is a matrix of indicator variables for the time of sale, and β_t is the marginal time effect (i.e., monthly). T is the total number of months in the sample and ϵ is an error term with zero expectation.[7] Thus β_t is an estimate of the rate of appreciation for time period t. The mean of the vector β provides an estimate of the expected monthly rate of apartment appreciation.

Tables 2 and 3 report the parameter estimates and implied appreciation rates obtained by estimating Equation (6). The parameter estimates presented in Table 2 have

[7] The β_t are estimated as follows. If a transaction occurred during January 1989 (i.e., t=1), all time indicator variables are assigned a value of zero. If a transaction occurred during the second month, the first time indicator variable is assigned a value of one and all other time indicator variables are set to zero. If a transaction occurred during the third month, the first two indicators are set to one and all others are set to zero.

the expected signs and are consistent with those obtained from previous research. From Table 3 we can see that our model estimated an average monthly appreciation rate of nearly zero with a standard deviation of more than six percent.

Table 2: Parameter Estimates

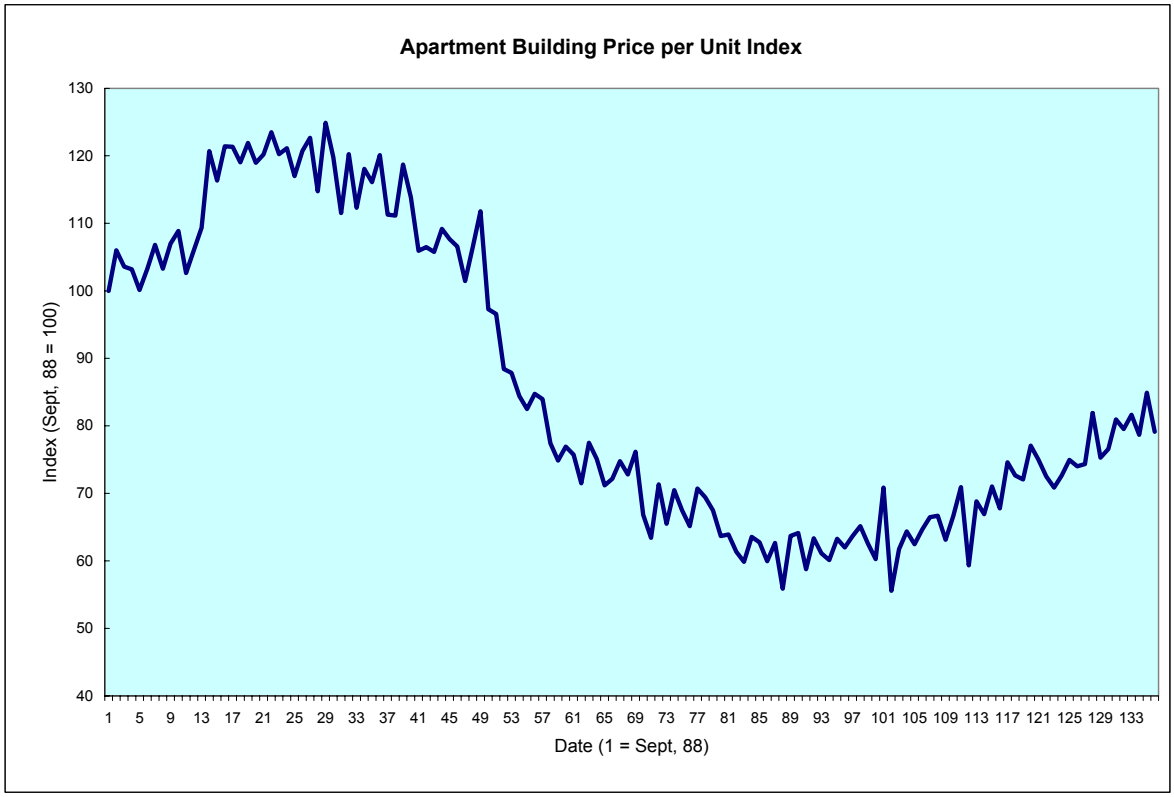
N=18830 R^2 = .44	Age	Age Squared	# of parking spots per unit	# of parking spots per unit squared	# of units	# of units squared
Estimate	-.006	4x10E-5	.22	-.005	-.011	6x10E-4
St. Error	.0004	6x10E-6	.006	.0003	.0003	1x10E-6

Table 3: Implied monthly rates of price appreciation

Average Appreciation Rate	Standard Deviation of the Appreciation Rate	Median Appreciation Rate	Skewness of the Appreciation Rate
≈ 0	.0616	-.001	-.06

Figure 5 depicts the time series of estimates of the value (September, 1988=100) of a typical apartment building implied by the parameter estimates of Equation (6). As can be seen from this figure, the late 1980s and 1990s were a boom/bust period for Southern California property values. Between 1988 and the end of 1989 the per unit price of Los Angeles County apartment building increased by approximately 16 percent. Between the 1989 peak and November 1995 trough per unit prices fell by more than 48 percent. By the beginning of 2000 per unit prices are more than 40 percent above their low.

Figure 5: Apartment Building Price per Unit Index



We use the above time series for the value of the asset to test the empirical implications of out model described in Section 2. The Federal Reserve Bank of St. Louis provides U.S. interest rate data. The first prediction of our theory is that the spread between lending and borrowing rates is negatively correlated with asset prices. We compute the spread as the difference between prime lending rates and 1-month certificate of deposit rates. The correlation between this spread and the asset price described above is – 67%. This high negative correlation provides very strong support for the hypothesis that underpricing was prevalent in Los Angeles during the run-up of property prices.

While this is only a single observation and does not provide a test of whether underpricing magnifies asset price declines during potential market crashes, it allows us to

expand the model by including additional explanatory variables. In particular, we include macroeconomic variables that have the potential to impact real estate values, such as labor force growth, unemployment rate, personal income, and mortgage rates. Table 5 reports the results of these regressions.

Table 5: Asset Prices and Interest Rates (II)

Dep. Var. is percent change in asset price	Spread of lending over deposit rates	Labor Force	Unempl.	Personal income	Mortgage rates
Base Case		.38 (.65)	-.14 (-1.9)	.30 (1.55)	-.09 (-.49)
Spread 1	-.12 (-1.82)	.26 (.44)	-.06 (-.75)	.28 (1.49)	-.02 (-.09)
Spread 2	-.12 (-1.87)	.30 (.50)	-.07 (-.75)	.03 (.21)	
Spread 3	-.12 (1.87)	.31 (.54)	-.07 (-.89)		
Spread 4	-.15 (-2.58)				

Notes to Table 5: All variables, dependent and independent, are in one month percent change form. t-statistic is in prentices. The adjusted R^2 of all regressions varies between 2 and 7%.

The one common feature of all models is that the spread of lending over deposit rates remains negatively correlated with asset returns, even in the presence of various controls. This is consistent with our hypothesis that asset prices in Los Angeles were driven by underpricing of the default put options imbedded in non-recourse lending in addition to all other macroeconomic factors affecting real estate markets.

4. Detailed Analysis of Some of the Markets

In what follows, we provide an in-depth analysis of most of the markets included in our empirical tests above. In particular, we provide the specific market and institutional events and characteristics that contributed to the correctly priced or underpriced lending. While this does not offer a rigorous test of our theory, it does provide some robustness checks to supplement the statistical analysis. More importantly, it summarizes the institutional and market circumstances that have contributed in the past to possible underpricing.

In the case of Singapore, tight control was exercised by the government over land sales and such sales were accelerated in the 1990s to dampen the property market as real estate prices rose. Hence, property prices were not allowed to spiral out of control. Moreover, real estate loans were tightened in 1996 to curb speculation in property. Among the measures introduced was to treat capital gains of real estate transactions as taxable income if the sale of the property took place within three years of purchase. The maximum loan quantum was also fixed at 80% of the appraised real estate value. All these measures combined to reduce the degree of underpricing in the Singapore property market. Our finding that Singapore did not exhibit the symptom of underpricing and that its total market decline following the Asian financial crisis was relatively less severe is not surprising.

In the case of Hong Kong, the currency was pegged to the U.S. dollar at HK$7.8 to one U.S. dollar. As a result, Hong Kong interest rates moved in line with the U.S. interest rates. This in turn acted as a mechanism to prevent Hong-Kong-based banks from underpricing in the property market. Not surprisingly, then, the Hong Kong lending market

did not exhibit the symptom of underpricing (as indicated in Figure 1), and also experienced a relatively modest price decline during the Asian crisis.

Indonesia, on the other hand, enjoyed very strong inflows of foreign capital in the early 1990s up to the eve of the Asian Financial Crisis in 1997, and domestic deposit rates fell in the wake of the inflow. As foreign capital surged into Indonesia, speculation in the real estate market, driven by cheap financing, was rampant. Loan quantum and credit facilities of up to 90% of the collateral value were common for investments in real estate properties (Mera and Renaud, 2000). This flood of liquidity led to a sharp price appreciation in the asset markets, inflated collateral value and prompted further credit expansion as asset prices climbed. Indonesia experienced the symptom of underpricing (Indonesia is part of Figure 4), and a subsequent price decline of 80% or more.

In Thailand, foreign inflows similarly fuelled the rise in the property market, and underpricing was rampant as banks competed by increasing loan amounts, reducing interest rates for certain customers, and even extending renovation loans. With a pegged exchange rate (up to 1 July 1997), it was attractive to borrow in offshore market and then invest in real estate projects. By 1996, the loan exposure of the real estate sector in Thailand was estimated at 30-40% of total loans with a value of US$160 billion. Consistent with our findings (Figure 4), Thailand experienced a very sever case of underpricing and the largest price decline in our dataset.

Malaysia also saw a significant buildup in the exposure to the property market. From 1992-96 more than 70% of bank lending in Malaysia was channeled into real estate and stock-market investments. Barth et al. (1998) estimate that expansion in bank credit to

the private sector, relative to GDP growth during the 1990–1996 period was 40% in Malaysia, 62% in Indonesia, 115% in the Philippines, and 70% in Thailand. By comparison, the growth was 19% in Germany, 3% in Japan, 16% in the United Kingdom, and 21.5% in the United States. Again, consistent with our empirical analysis (Figure 1 and 4), Malaysia exhibited the symptom of underpricing, although to a lesser extent than Thailand and Indonesia, and also experienced a severe price decline during the Asian financial crisis.

At a first glance Japan appears to be an outlier in our analysis. There is no evidence of underpricing as the correlation between asset returns and changes in lending spreads is positive. Japan's steep price decline is, therefore, inconsistent with our theory. The reality is that the explanation for Japan's real estate bubble and subsequent decline lies elsewhere. Monetary and exchange rate policies in the 1980s resulted in excessive money supply and extremely low interest rates. The land boom began in the mid 1980s after the 1985 Plaza Accord amongst the finance ministers and chairmen of central banks from the G5 countries agreed to push down the value of the dollar and strengthen the yen. The yen dramatically appreciated from 244 yen/dollar in September 1985 to 152 in August 1986 (Saito, 2003). The dramatic appreciation over a short period resulted in fears of a recession driven by loss of competitiveness of Japanese exports. This led the Bank of Japan to slash its discount rates from 5 to 2.5 percent over 15 months, and to keep the money supply abundant. Banks, insurance companies and non-banks also invested heavily in real estate. The bubble ended when tight monetary policies, credit controls on bank lending to real estate, and a new real estate tax on land were introduced by Japan's finance ministry between 1988 and 1992. Thus, even though Japan experienced a substantial price decline, this decline was

likely caused by other macroeconomic factors not by underpricing the default spread of mortgage loans.

5. Summary and Policy Conclusions

By any measure, real-estate markets in many countries around the globe, including in the US and Canada, prices are at, or above, their historic highs. Such an environment naturally fuels fears that we are in a midst of a real-estate price bubble that will inevitably burst. Even the strongest proponents of the bubble theories, however, will admit that it is nearly impossible to accurately detect a real-estate bubble. At this stage, we still cannot tell whether there is a bubble or if our economic fundamentals will prove strong enough to support the new higher prices.

While we offer no remedy to this predicament, there are historical precedents around the globe that do provide some insights for the future of the real estate markets around the world. If there is one thing that the most severe real-estate bubbles have had in common, it is easy access to low-cost credit. When this happens, real-estate investors and homeowners take advantage of it and bid up land prices above their fundamental levels. While this may or may not start a market price bubble, it can certainly make it worse. Easy access to low-cost financing stimulates demand and drives up prices. If the lending standards in this type of environment are lax, or weakened further, in order to increase profits for lenders, the risk of a bubble is heightened. The bubble then bursts when market prices exceed the fundamental values of the underlying properties by so much that even virtually costless financing cannot generate more demand.

We all know what follows. The more reckless the lending industry is, the longer the bubble can survive, and the harder it bursts. For instance, we found in this paper that the lending sector was a major contributor to the real-estate price bubble in the mid-1990s in countries such as Thailand, Malaysia, and Indonesia. Conversely, Singapore and Hong Kong maintained far more restrictive lending practices, and the lending sector did not contribute to the price inflation there.

While all of the countries in our study experienced deep price declines during their respective crisis, these declines were two to three times more severe in the countries where access to funds for real-estate development or ownership was unrestricted and very cheap. Empirical evidence from earlier real-estate market bubbles across the globe also seems to strongly support this idea.

In a more recent case, John Laker, Chairman of the Australian Prudential Regulatory Authority, suggested that lax lending standards in Australia are potentially contributing to Australia's real-estate boom where home prices have increased much more dramatically than in North America. In response, the Regulatory Authority has taken steps to strengthen bank lending standards to prevent further price inflation due to excessive availability of funds.

Similarly, there is real concern, recently expressed by former Chairman of the US Fed, Alan Greenspan, that price rises in the US are being artificially fuelled by new and exotic mortgage instruments that embody overly liberal lending standards. While we cannot say to what degree these instruments are contributing to asset price inflation, we do know the direction of their impact. We also know that in the aftermath of a negative

demand shock, prices will fall both to adjust to new supply and demand fundamentals and to compensate for past lending mistakes.

The bottom line is that we are still unable to detect market bubbles before they burst, but at least we can estimate their severity by examining the impact of lending practices prevalent in the market. Furthermore, the model shows the extent to which lending-industry regulators can mitigate the economic impact of a potential bubble by enforcing prudent lending standards.

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