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Mortgage Put Options and Real Estate Markets

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Abstract

In this paper we offer direct evidence that financial intermediation does impact underlying asset markets. We develop a specific observable symptom of a banking system that underprices the put option imbedded in non-recourse asset-backed lending. Using a dataset for 19 countries and over 500 real estate investment trusts, 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.

Keywords

real estate bubble, mortgage lending put options, Asian financial crisis

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Mortgage put options and real estate markets

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Mortgage put options and real estate markets

In this paper we offer direct evidence that financial intermediation does impact underlying asset markets. We develop a specific observable symptom of a banking system that underprices the put option imbedded in non-recourse asset-backed lending. Using a dataset for 19 countries and over 500 real estate investment trusts, 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.

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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]

The subprime mortgage crisis and the recent price boom in the US, now reversed, is the most recent example of a price bubble associated with lax and expanding access to credit. The concern that price rises in the US were artificially fuelled by new and exotic mortgage instruments that embody overly liberal lending standards led to an advisory of caution in the use of these instruments in September, 2006.[2] This paper does not offer a mechanism to measure the extent of a market bubble before they burst, but it does offer a mechanism to examine the impact of lending practices prevalent in the market on their potential severity.

The contribution of this paper is twofold. First, utilizing the theory of Pavlov and Wachter (2004, 2006), we develop a specific and observable symptom of underpricing of non-recourse asset backed lending (discussed in Section 2) . Our symptom distinguishes between rational changes in the lending spread and those associated with the underpricing

[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 "Interagency Guidance on Nontraditional Mortgage Product Risks" (http://www.federalreserve.gov/BoardDocs/SRLetters/2006/SR0615a2.pdf)

of the put option. We show the second is associated with unsustainable price rises and, therefore, deeper crashes.

While the literature has associated underpricing with rising asset prices, in this paper we develop a specific symptom of underpricing in mortgage markets and develop a model to show that this symptom is associated with price rises in efficient equity markets only when there is underpricing of the put option. Our symptom distinguishes between rational changes in the lending spread and those associated with the underpricing of the put option. We show the second is associated with unsustainable price rises and, therefore, deeper crashes.

Second, using data from 19 countries and over 500 individual real estate investment trusts and property companies, we empirically find, as we would expect, 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 credit-induced price rise. Therefore, economies that experience underpricing, while not necessarily subject to a higher risk of market crashes, are subject to deeper crashes, all else equal, when they occur.

This finding is direct evidence that financial intermediation does impact the underlying asset markets if the intermediaries misprice the loans they provide. Intermediaries' misaligned incentives, such as focus on short-term results and market share, government-sponsored deposit insurance and/or bailout tendencies, and/or takeover barriers

make underpriced lending in any sector possible and even likely. This problem is compounded for real estate-backed mortgage lending because of lack of proper pricing data, heterogeneity of the underlying assets, and prolonged price cycles. In this paper we document, both theoretically and empirically, that loan underpricing does impact the underlying markets, even if these markets are efficient.

Furthermore, we find no relationship between our measure of underpricing and the size of the market decline using data after the decline. This suggests that, as expected, our theory only holds before the market crash.

This study develops an economic indicator, or symptom, of loan underpricing. It does not address the issue of why underpricing might occur and how to prevent it. For a detailed discussing of the causes and potential remedies of underpricng please refer to Pavlov and Wachter (2004, 2006) and Herring and Wachter (1999).

This 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] Rather the specific and observable symptom of underpricing that we develop here is likely to be found in an economy in which asset bubbles are being supported by lending behavior. In addition to finding support for the theory, the 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: both lenders and market participants can take measures to prepare for

[3] See for instance Smith, Smith, and Thompson (2005) for a direct estimation of real estate values in Los Angeles. Other studies and popular articles on 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), Edelstein (2005) and Edelstein, Dokko, Lacayo, and Lee (1999), among others.

or hedge the expected increased magnitude of future price 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.

Koh, et. al. (2006) investigate the mortgage lending institutional arrangements across countries to directly assess the likelihood of an economy entering an underpricing equilibrium. Consistent with the results reported here, they find that lending industry institutional mechanisms that are prone to underpricing tend to exacerbate market crashes.

This study provides support for the recent sentiment arguments put forward in Clayton, Ling, and Naranjo (2007). They examine the time-series and cross-sectional variation in MSA-level cap rates by measuring investment sentiment. Such sentiment is a source of market inefficiency and, as demonstrated by Herring and Wachter (1999), 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 the main results, and provides robustness analysis utilizing various controls and econometric tests. Section 4 concludes with policy implications and direction for future research.

2. The Symptom of Underpricing

The spread between duration-matched bank lending and deposit rates for a non-recourse loan is the value of the imbedded put option.[4] There are two reasons for the lending spread to fall. First, the default spread can narrow because the expected future 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 no impact on the asset price if investors are diversified.[5] We address the possibility that investors are not diversified below.

The second reason lending spreads narrow is that lenders underprice the default risk. This increases 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, B:

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

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

[4] The lending spread also covers the bank's operating costs, but these are relatively small and constant throughout the market cycle.

[5] If investors are diversified, only covariance with the overall economy affects the price of the asset. (see for instance Sharpe, 1964). Even if the fortunes of real estate markets have an impact on the overall economy, changes in asset volatility will have a smaller, second-order effect on the asset price when compared to the effect on an underpricied option to default.

its face value, and the transaction price equals the fundamental value of the asset. If the mortgage is mispriced, then the transaction price reflects not only the fundamental value of the asset, but also the mispricing of the mortgage, $B - M(\sigma, s(\sigma))$. If the market value of the mortgage is below the face value of the mortgage, then the transaction price exceeds the fundamental value of the asset because efficient equity markets take advantage of the mispricing and the asset is assumed to be of fixed supply.

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.[6]

The response of the asset price to the spread is:

$$\frac{\partial P}{\partial s} = \frac{\partial P / \partial \sigma}{\partial s / \partial \sigma} = \frac{\partial V / \partial \sigma}{\partial s / \partial \sigma} \approx 0 \tag{3}$$

[6]The price impact of real estate volatility changes through the covariance with the overall market are likely to be far smaller then the impact through changing the value of the option to default.

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:

$$\frac{\partial s}{\partial \sigma} = 0, \frac{\partial V}{\partial s} = 0, \frac{\partial M}{\partial s} > 0, \tag{4}$$

therefore,

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

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 rises due to underpricing. This leads to the following empirical implication:

> *Economies that experience underpricing (i.e., have a negative correlation between asset returns and changes in the default spread), can be expected to experience larger market crashes, all else equal, following negative demand shocks.*

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 lending 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. We also test the absence of negative correlation in all markets following a negative demand shock.

Finally, if investors are not diversified, the changes in expected future asset volatility will impact the asset prices. This, in turn, could produce the negative correlation between asset returns and changes in the lending spread. However, in this case economies that exhibit the negative correlation will not exhibit larger market crashes than economies that do not. If anything, the possibility that the marginal investor in a particular country is not diversified would bias our findings towards zero.

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. Duration-matched lending and deposit rates are available from the World Bank.[7] The theoretical framework above refers to the default spread, which is only one component of the lending spread. Thus, our empirical analysis assumes that the remaining components of the lending spread, such as prepayment options and servicing costs, remain unchanged throughout the business cycle.[8] Furthermore, we need to assume that changes in the lending over deposit spreads in the economy are representative of changes in the real estate mortgage lending rate over the deposit rate spread.[9]

In this paper we utilize is the Global Property Research Indices (GPR) described in Eichholtz (1996). These data include property indices for 25 countries over 20 and 12

[7] World Bank World Economic Indicators CD-ROM.
[8] In fact, virtually all commercial loans contain substantial prepayment penalties, so the option to prepay is not worth very much.
[9] In addition to the deposit rate, one could use measures of the default spread based on the cost of capital for the lender or other risk-free securities, such as Treasuries. In this analysis we use deposit rates primarily because they are measured precisely and available for all countries in our sample.

years for developed and emerging countries, respectively. We utilize the GPR Genral database, which includes 543 international REITs and property companies.

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, and is consistent through time. Table 1 provides a summary statistic of the data, including the number of REITs available in each country.

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. Figures 1 and 2 depict scatter plots of all included observations. The correlation is computed using a 5-year window in Figure 1, and using all available data in Figure 2. The horizontal axis depicts the correlation between asset price changes, excluding dividends, in local currency, and the change in lending over deposit rate spread before the respective market crash. The vertical axis reports 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 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 loan underpricing. Loan underpricing results in asset price inflation. Countries that experience loan underpricing (and asset overpricing) before their negative demand shock tend to experience far greater price declines during

their market crash. Consistent with this, countries such as Singapore, Malaysia, Belgium, and Sweden exhibit 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 The Netherlands, New Zealand, and Switzerland exhibited no or positive correlation between asset returns and lending spreads. These countries, therefore, did not exhibit the symptom of loan underpricing developed in Section 2. While they also experienced negative demand shocks, their price declines were relatively more modest, between 10 and 40%. As a robustness check, we perform this regression by excluding all observations one at a time, and all possible combinations of two observations at a time. The slope coefficient remains significant at the 5% level in all of these regressions. In other words, there is no one observation or a combination of two observations whose removal substantially influences our results. 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.

Pavlov and Wachter (2004, 2006) suggest that after a negative demand shock there should be no relationship between the correlation of asset price changes and deposit spreads on one hand and the size of the market decline, on the other. 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. Figures 3 and 4 display these estimates using 5-year windows and all available data, respectively. 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. As a robustness check,

excluding one or two observations at a time does not generate a statistically significant relationship either.

Finally, we repeat the above analysis at the individual REIT level. Figures 5 and 6 provide scatter plots of the correlation between asset price changes and changes in the default spread versus the size of the market decline. Figure 5 reports the data using 5-year window to compute the correlations, while Figure 6 uses all available data. Both results strongly suggest that funds that seem to be able to take advantage of loan underpricing experience larger price declines following negative demand shocks. While we also report the regression estimates of these results, we note that the observations are not strictly independent, as REITs within a country tend to be highly correlated.

Figures 7 and 8 report the correlation versus the magnitude of price declines using data after the price decline. These two figures are analogous to Figures 3 and 4, except they use REIT-level data. Again, as predicted by the theory, there is no relationship between the correlation and the magnitude of price declines.

4. Summary and Policy Conclusions

In this paper we develop a specific and observable symptom of loan underpricing in the economy. This symptom is based on the relationship between changes in the lending spread and changes in asset prices. If the put option in non-recourse loans is underpriced, then we expect this correlation to be negative, as narrowing spreads are an indicator of underpricing which is taken into account by equity investors.

While this economic indicator of underpricing is unable to detect market bubbles before they burst, it does allow us to examine the impact of lending practices prevalent in

the market on the underlying property markets, especially when those market bubbles burst. We find that countries that experience severe underpricing also experience far deeper market declines, when those declines occur. This is an intuitive finding, as the post-crash asset price needs reflect not only the new, lower, demand fundamentals, but also eliminate the impact loan underpricing had pre-crash.

By any measure, mid-2000's real-estate markets in many countries around the globe appear to have been at, or above, their historic highs; nonetheless it is very difficult to accurately detect a real-estate bubble. While we offer no remedy to this predicament, there are historical precedents around the globe that do provide some insights for evaluating 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 certainly enables the bubble formation and makes it worse. 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.

The more reckless the lending industry is, the longer the bubble can survive, and the harder it bursts. For instance, we find 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, other economies, such as Switzerland and Hong

Kong, maintained far more restrictive lending practices, and, we find that the lending sector did not contribute to the price inflation in these countries. 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 recent case, John Laker, Chairman of the Australian Prudential Regulatory Authority, suggested that lax lending standards in Australia contributed to Australia's real-estate boom. In response, the Regulatory Authority implemented steps to strengthen bank lending standards to prevent further price inflation due to excessive availability of funds. Similarly, as noted above, in response to historic price rises, a similar lending advisory was issued in the US. Both of these were responses to eroding lending standards. To the extent policies are in place and can prevent pro-cyclical easing of lending standards, this source of instability can be avoided. This is difficult, since collateralized lending depends on loan-to-value ratios. As we have shown in this paper, values can be artificially raised due to mortgage loan underpricing. Thus, there is an inherit difficulty in developing and implementing such policies. Nonetheless, it appears from our data, that some countries have been more successful than others in maintaining prudential lending standards.

The bottom line is that we are still unable to detect market bubbles before they burst, but at least we can examine the impact of lending practices prevalent in the market on their potential severity. 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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Table 1: Description of the data by country

Countries	No. of funds	Included in regression: yes/no	Experienced decline: yes/no	Year of decline	Total Decline	decline lasting (in years)
Argentina	1	no*	n/a	2001	-62%	2
Australia	41	yes	yes	2000	-15%	1
Austria	12	no*	n/a	n/a	n/a	n/a
Belgium	13	yes	yes	1997	-67%	4
Canada	43	yes	yes	1998	-32%	1
France	58	yes	yes	2000	-23%	2
Germany	17	yes	yes	1991	-18%	4
Hong Kong	36	yes	yes	1997	-30%	1
Ireland	2	yes	yes	1999	-32%	3
Indonesia	6	yes	yes	1997	-62%	3
Italy	9	yes	yes	1995	-21%	4
Japan	60	yes	yes	1997	-36%	1
United Kingdom	101	yes	yes	1992	-25%	2
Malaysia	16	yes	yes	1997	-69%	1
Mexico	2	no**	n/a	n/a	n/a	n/a
Netherlands	18	yes	yes	1999	-25%	2
Norway	4	yes	yes	1990	-11%	4
New Zealand	11	yes	yes	1997	-25%	4
Portugal	3	no***	n/a	n/a	n/a	n/a
Philippines	3	yes	yes	2000	-19%	1
Spain	7	no***	n/a	n/a	-40%	n/a
Singapore	28	yes	yes	1997	-56%	1
Sweden	30	yes	yes	1995	-58%	1
Switzerland	18	yes	yes	1999	-19%	2
Thailand	4	no***	n/a	n/a	n/a	n/a
Total No. of Funds	**543**					

*due to insufficiency of spread data

**due to unreliability of total return data

***due to insufficiency of total return data

Total Return Data for computing :

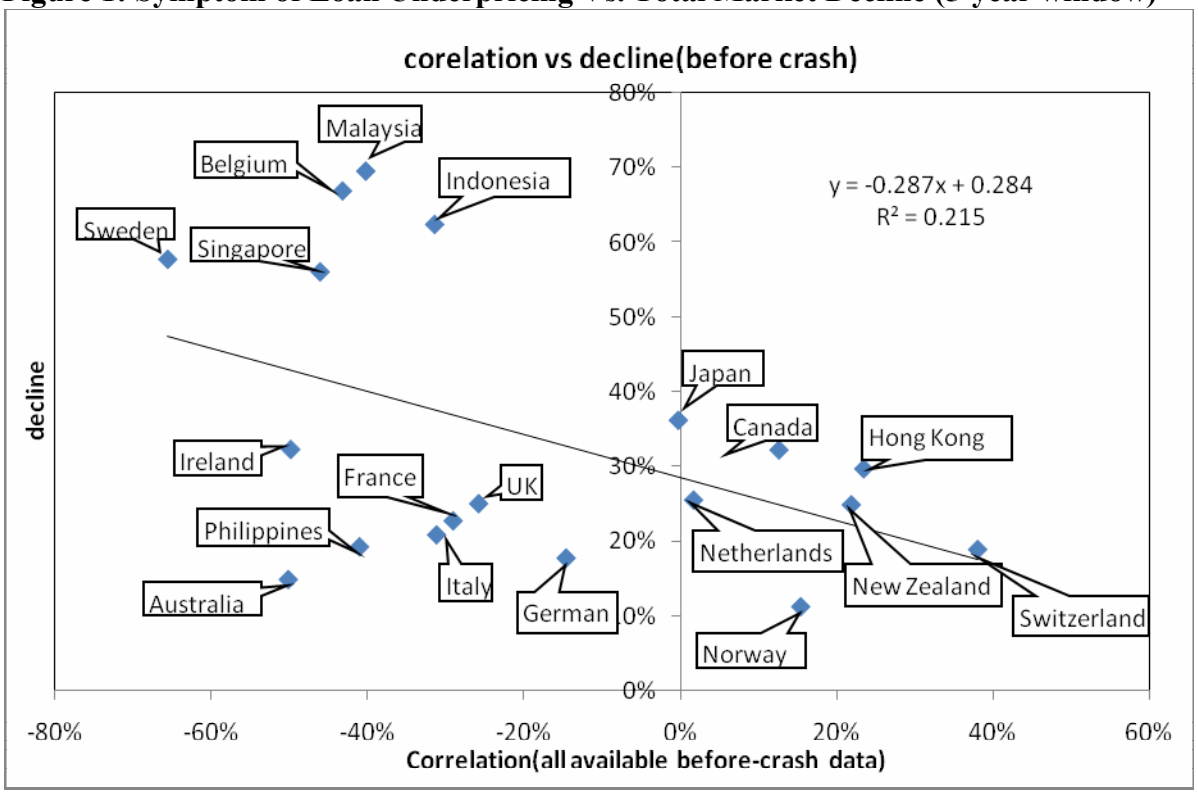
- Data source : GPR General
- 1980 Jan – 1996 Nov

Spread is computed as the difference between lending and deposit rate

- Date source: World Bank CD

Table 1 provides the number of REITs by country and information on the timing of the REIT declines.

Figure 1: Symptom of Loan Underpricing Vs. Total Market Decline (5-year window)

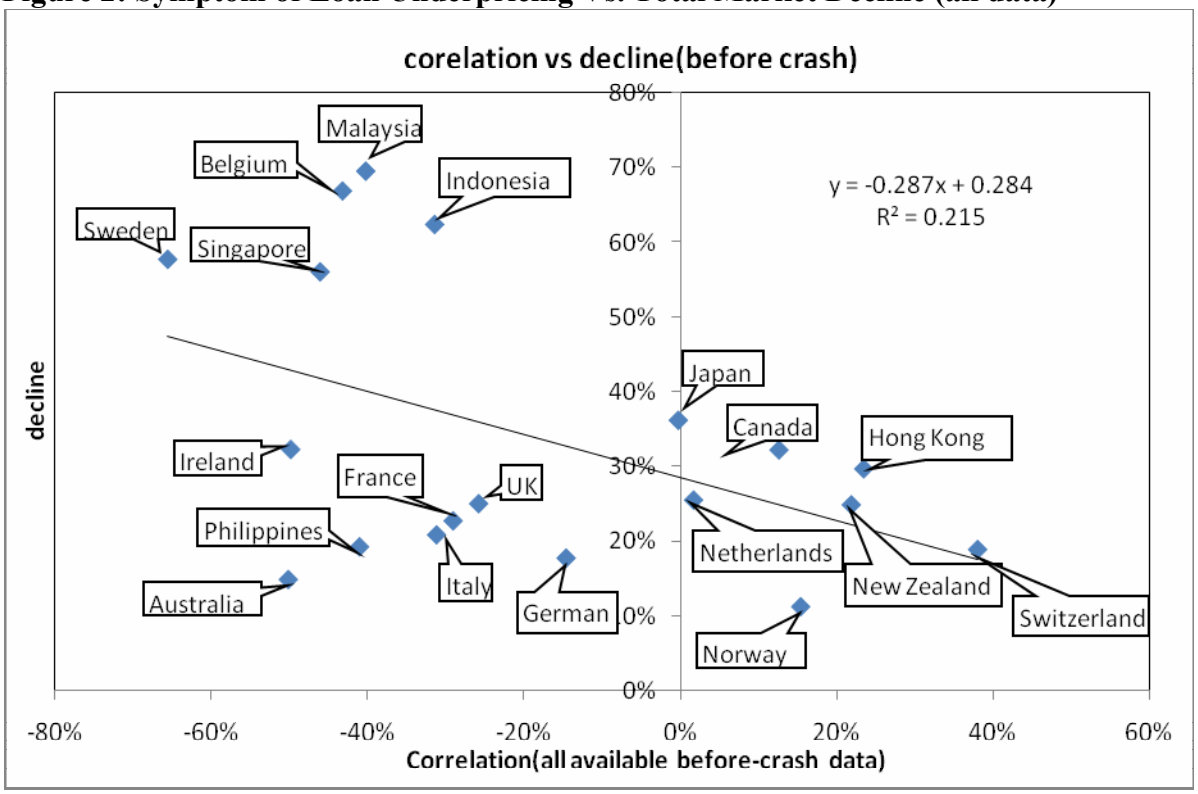


The correlation is computed between the change in index value, excluding dividends, and the change in the spread of lending over deposit rates. In this figure, we compute the correlation using 5-year window before each crash. The vertical axis depicts the total percent decline in the property market, 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 loan underpricing (asset overpricing), and is associated with larger losses during a market downturn. Countries that do not exhibit the symptom of loan underpricing have zero or positive correlation, and their respective property market declines are relatively modest.

The statistics of the regression line are as follows:

	Intercept	Slope	R^2
Estimate	.29	-.25	.41
t-statistic	(8.03)	(-3.48)	

Figure 2: Symptom of Loan Underpricing Vs. Total Market Decline (all data)

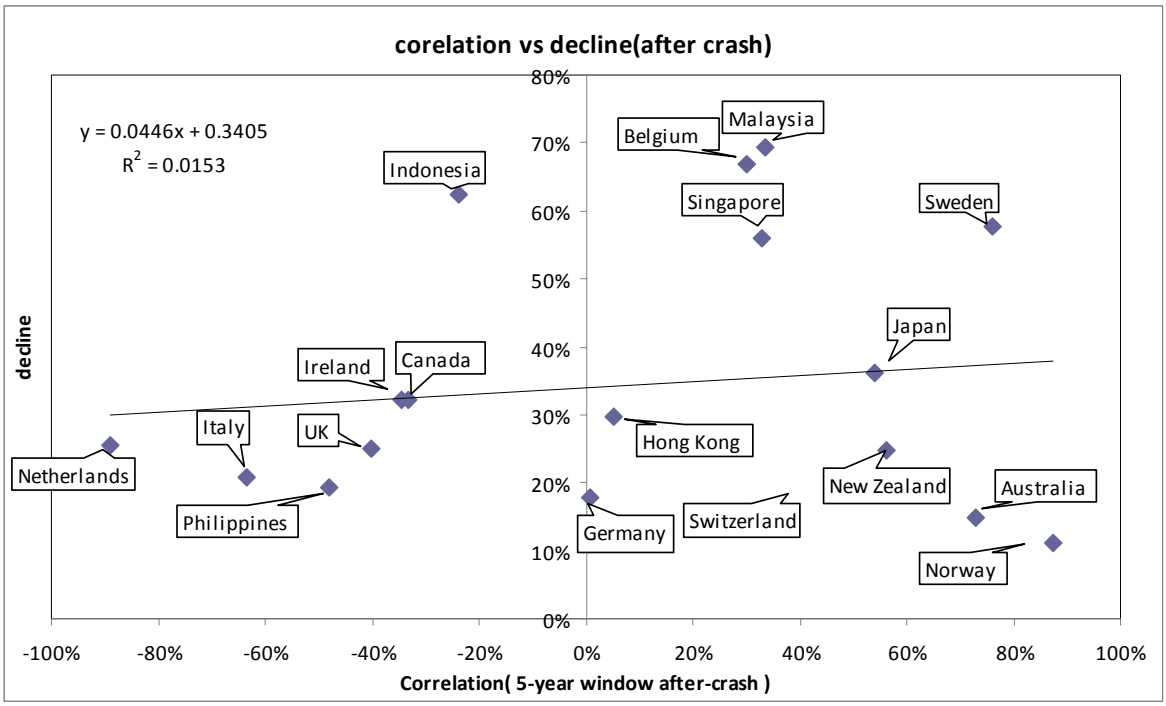


The correlation is computed between the change in index value, excluding dividends, and the change in the spread of lending over deposit rates. In this figure, we compute the correlation using all available data before the crash, i.e., from the beginning of our data set to the peak of the property market. 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 loan underpricing (asset overpricing), and is associated with larger losses during a market downturn. Countries that do not exhibit the symptom of loan underpricing have zero or positive correlation, and their respective property market declines are relatively modest.

The statistics of the regression line are as follows:

	Intercept	Slope	R^2
Estimate	.28	-.29	.21
t-statistic	(6.12)	(-2.16)	

Figure 3: Symptom of Underpricing Vs. Total Market Crash Decline (Using 5-year Window After the Crash)

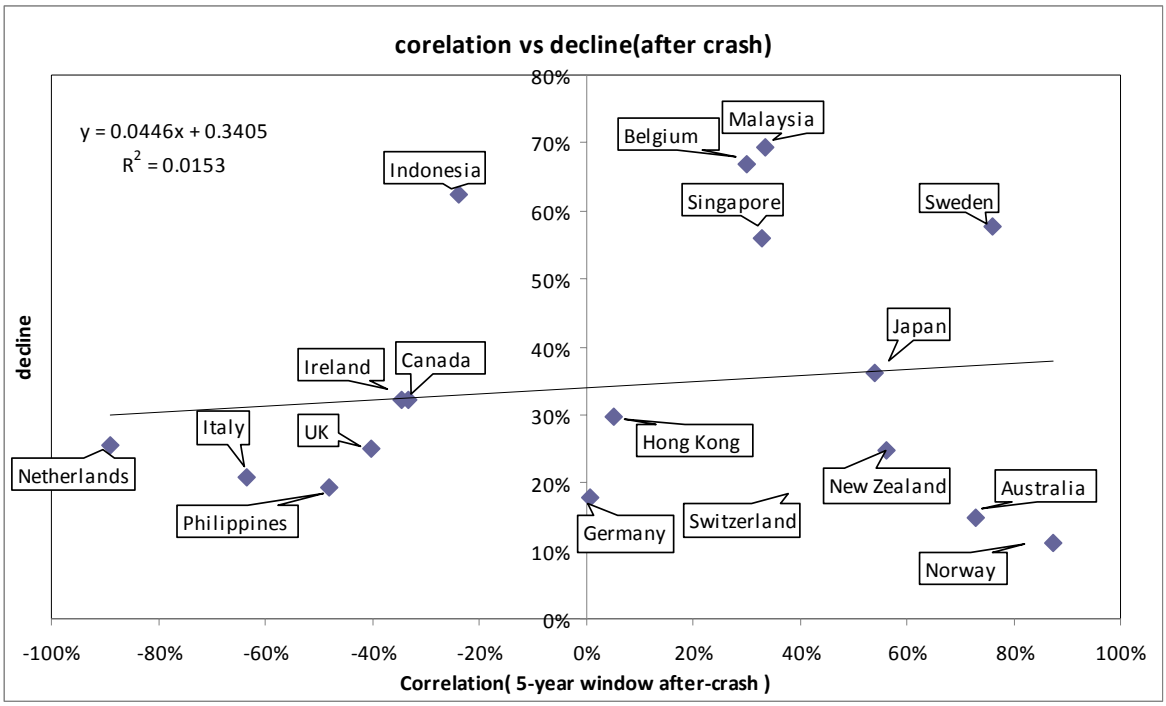


The correlation is computed between change in index value, excluding dividends, and the change in the spread of lending over deposit rates. In this figure, we compute the correlation using 5-year window after the crash. The vertical axis depicts the total percent decline in the country index, from top to bottom. This is over one or more years and is specific for each country. As expected, we find no relationship between the correlation between asset returns and changes in lending spreads and the size of the decline.

The statistics of the regression line are as follows:

	Intercept	Slope	R^2
Estimate	.34	.04	.02
t-statistic	(7.27)	(.49)	

Figure 4: Symptom of Underpricing Vs. Total Market Crash Decline (Using All Data After the Crash)

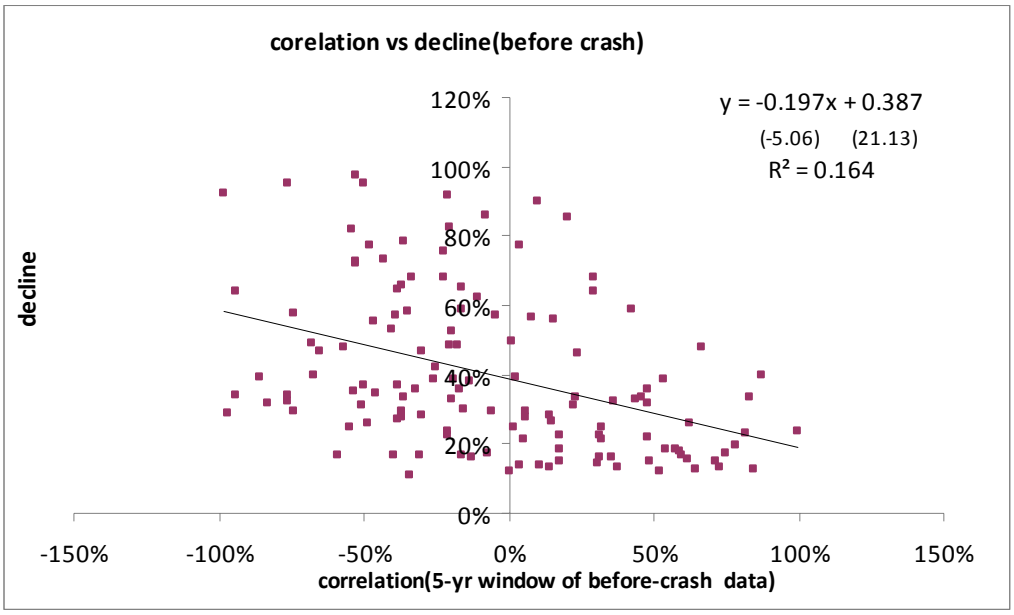


The correlation is computed between change in index value, excluding dividends, and the change in the spread of lending over deposit rates. In this figure, we compute the correlation using all available data after the crash. The vertical axis depicts the total percent decline in the country index, from top to bottom. This is over one or more years and is specific for each country. As expected, we find no relationship between the correlation between asset returns and changes in lending spreads and the size of the decline.

The statistics of the regression line are as follows:

	Intercept	Slope	R^2
Estimate	.34	.07	.03
t-statistic	(7.38)	(.73)	

Figure 5: Symptom of Loan Underpricing Vs. Total Market Decline (REIT-level, 5-year window)

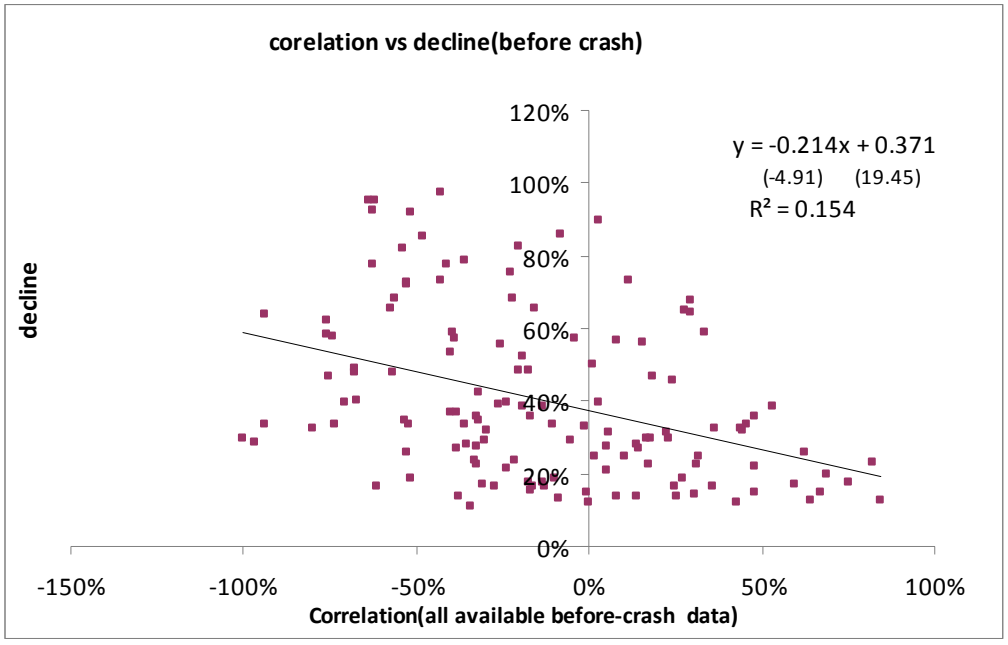


This figure is analogous to Figure 1, except it uses REIT-level data to test our theory. The correlation is computed between the change in REIT share value, excluding dividends, and the change in the spread of lending over deposit rates. In this figure, we compute the correlation using 5-year window before each 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 loan underpricing (asset overpricing), and is associated with larger losses during a market downturn. Countries that do not exhibit the symptom of loan underpricing have zero or positive correlation, and their respective property market declines are relatively modest.

The statistics of the regression line are as follows:

	Intercept	Slope	R^2
Estimate	.39	-.2	.16
t-statistic	(21.13)	(-5.06)	

Figure 6: Symptom of Loan Underpricing Vs. Total Market Decline (all data)

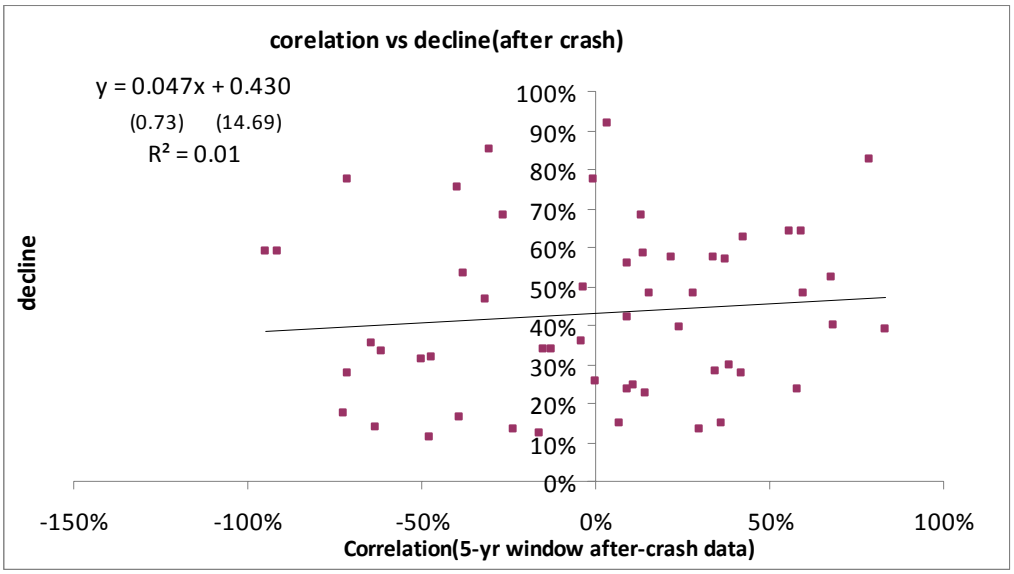


This figure is analogous to Figure 2, except it uses REIT-level data to test our theory. The correlation is computed between the change in REIT share value, excluding dividends, and the change in the spread of lending over deposit rates. In this figure, we compute the correlation using all available data before each 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 loan underpricing (asset overpricing), and is associated with larger losses during a market downturn. Countries that do not exhibit the symptom of loan underpricing have zero or positive correlation, and their respective property market declines are relatively modest.

The statistics of the regression line are as follows:

	Intercept	Slope	R^2
Estimate	.37	-.21	.15
t-statistic	(19.45)	(-4.91)	

Figure 7: Symptom of Underpricing Vs. Total Market Crash Decline (Using 5-year Window After the Crash)

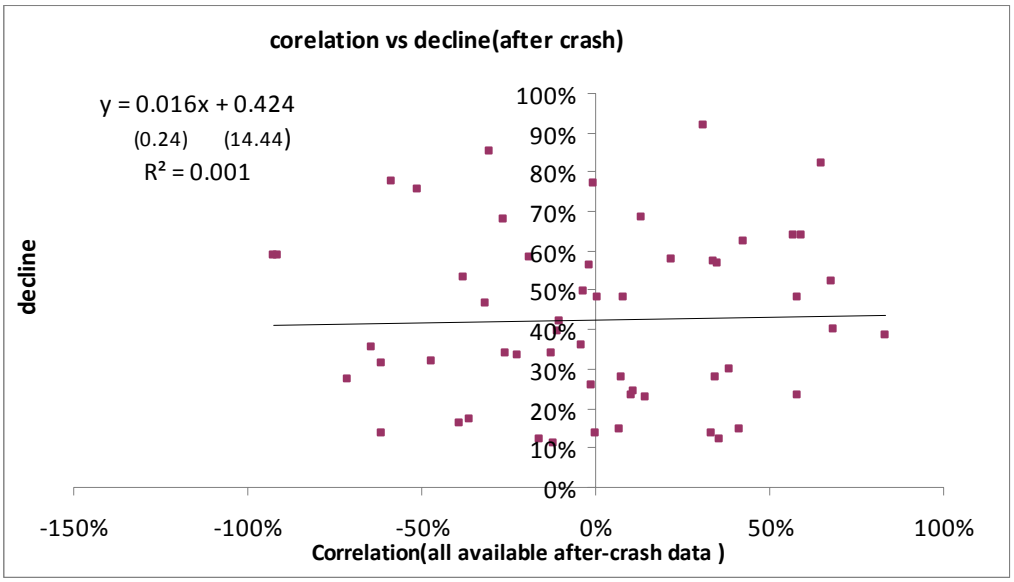


This figure is analogous to Figure 3, except it uses REIT-level data. The correlation is computed between the change in REIT share price, excluding dividends, and the change in the spread of lending over deposit rates. In this figure, we compute the correlation using 5-year window after the crash. The vertical axis depicts the total percent decline in the country index, from top to bottom. This is over one or more years and is specific for each country. As expected, we find no relationship between the correlation between asset returns and changes in lending spreads and the size of the decline.

The statistics of the regression line are as follows:

	Intercept	Slope	R^2
Estimate	.43	.05	.01
t-statistic	(14.69)	(.73)	

Figure 8: Symptom of Underpricing Vs. Total Market Crash Decline (Using All Data After the Crash)



This figure is analogous to Figure 4, except it uses REIT-level data. The correlation is computed between the change in REIT share price, excluding dividends, and the change in the spread of lending over deposit rates. In this figure, we compute the correlation using all available data after the crash. The vertical axis depicts the total percent decline in the country index, from top to bottom. This is over one or more years and is specific for each country. As expected, we find no relationship between the correlation between asset returns and changes in lending spreads and the size of the decline.

The statistics of the regression line are as follows:

	Intercept	Slope	R^2
Estimate	.42	.,02	0
t-statistic	(14.44)	(.24)	