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A Look Back at the 2008 Financial Crisis: The Disconnect between Credit and Market Risks*

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Abstract
This study examines the impact of credit and market risks in the wake of the 2008 financial crisis. In the seven-year period before the collapse of the housing market in 2007, credit risk premiums rose steadily in an apparent reflection of the mounting household debt. However, the equity market failed to take into account the rising default risk that should have served as a signal of the impending disaster. As a result, home prices and stock market values continued to increase and attain record levels. This bullish market behavior was largely driven by low levels of market risk, as evidenced by unusually low levels of implied volatility. To investigate this anomaly, a decomposition of the forecast error variance of stock market returns was performed over an extended period. Two outcomes of the empirical analysis are of note. The first is that prior to the crisis, the equity market showed minimal response to innovations in the credit market. However, in the longer term, the yield on short-term U.S. government obligations had a pronounced effect. The second is that in the period since the crisis began, the credit risk indicator has become particularly preeminent, suggesting a more risk-averse equity market.

1. Background

This study examines the dynamic linkages between the credit and equity markets in the period surrounding the 2008 global financial crisis. Although evidence exists of a long-run relationship between these markets (for example, Melvin and Taylor, 2009; Elkhodiry, 2007; Kassimatis and Spyrou, 2001), the immediate period before the crisis witnessed prolonged anomalous behavior in the two markets. The crisis itself was preceded by an extraordinary run-up in the prices of homes in the United States. Federal Reserve data show that in the 10-year period ending in 2006, the median home price in the U.S. doubled to a record $263,000. As *Figure 1* shows, home prices witnessed dramatic growth in particular between 1990 and 2007. They rose by 9 percent from 1990 to 1995, 17 percent from 1995 to 2000, and by a record 60 percent between 2000 and the first quarter of 2007.

The rapid rise in home prices was in part fueled by very low mortgage interest rates and liberal credit terms. Creative loan terms included little or no upfront equity, subprime mortgage origination, loans with negative amortization, and very low cost

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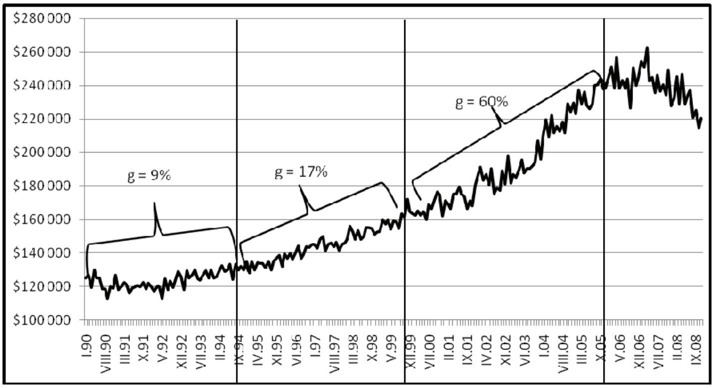
Figure 1 Median U.S. Home Price: 1990–2008



Source: Federal Reserve System

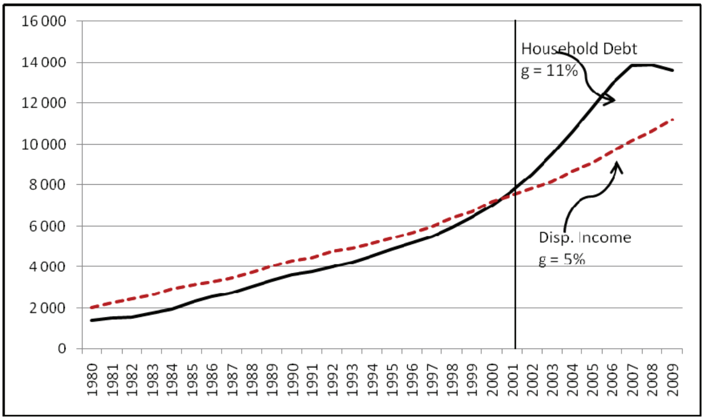
variable-rate loans. The consensus view, as documented in part by Bernanke (2008) and Cihak (2009), is that the problems with subprime mortgages were masked by the rapid pace of home price appreciation, especially between 2000 and 2007. The widely-held notion that home prices would always rise dampened fears of the eventual delinquencies that would soon occur in the housing market. Many of the delinquencies in 2007 and 2008 were due to subprime mortgage loans. Most of these mortgages were financed with adjustable rate mortgages, which enticed many borrowers with initially very low interest rates on high loan-to-value ratios.

Excessive household debt also played a key role in the crisis. According to the Federal Reserve Flow of Funds, home mortgage loans grew by more than $1 trillion between 1990 and 2007, with outstanding mortgage debt approaching $14 trillion. The symbolism of this amount is that it almost equaled the gross domestic product of the United States in 2008.

Two unusual market events occurred between 2000 and 2007, when home prices reached record highs. The first was that household debt grew twice as fast as personal disposable income. This evidence is summarized in *Figure 2*. The second was a remarkable rise in stock market values even as the credit risk premium continued to rise. Because these trends are an anomaly – since debt is serviced from income flows and equity values are discounted by investment risk – the 60 percent home price appreciation during this period was soon to become a bubble.

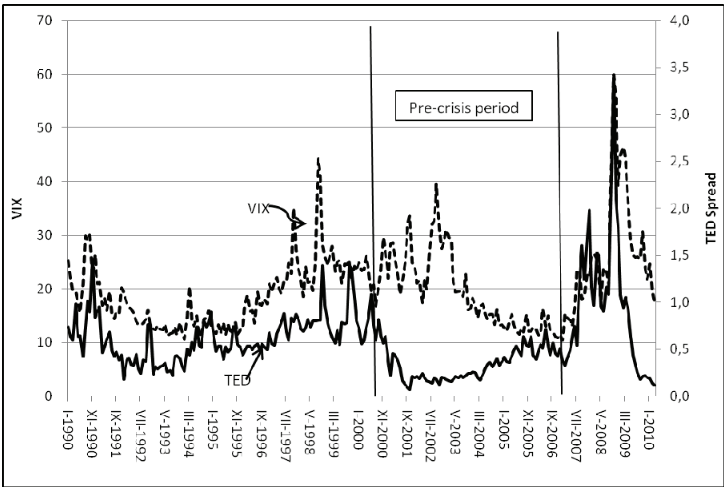
In the financial markets, equity market volatility and credit risk offer a means to gauge investor sentiment. An important measure of expected market risk is the Chicago Board Options Exchange implied volatility index, VIX. This index reflects market uncertainty based on the price of options written on the broad-based S&P 500 index. Because options are bets on future stock price movements, implied volatility serves as a barometer of near-term shock, rising as uncertainty grows and falling as the market stabilizes. The Treasury-Eurodollar (Ted) spread is employed as a credit risk parameter. The Ted spread captures the credit risk premium priced into interbank short-term loans on Eurodollars. A rising spread implies growing risk aversion, as investors require higher premiums on the three-month Libor over three-month U.S. Treasury bills. *Figure 3* shows the remarkable manner by which these two risk in-

Figure 2 Total Household Debt Outstanding versus Disposable Income (billions $)



Sources: Bureau of Economic Analysis (income); Federal Reserve Flow of Funds (household debt)

Figure 3 Options Volatility versus Ted Spread, 2008[a]



Note: [a] VIX is a measure of market risk calculated by the Chicago Board Options Exchange (CBOE) as the *implied options volatility* on the S&P 500 index. Ted is the *Treasury-Eurodollar* spread, which captures the credit risk associated with short-term borrowing.

dicators moved almost in tandem until late 2000, when they moved apart. This period of anomaly ended when the financial crisis began in 2007, which was also when the housing market collapsed.

Because implied volatility and the Ted spread are risk indicators, they are naturally negatively correlated with the equity market, but positively correlated with each other. The Ted spread is typically inversely correlated with the equity market as a reflection of rising credit risk. The following data results generated over the observation period of this study summarize the correlations between the risk and market variables:

	X1X2	X1X3	X2X3
Pre-crisis: Jan 2000–Oct 2007	-0.33	-0.65	0.76
Crisis: Nov 2007–Aug 2010	0.51	-0.77	0.07
Pre-event sample: Jan 1980–Dec 1999	0.89	-0.89	-0.73

X1: CBOE implied options volatility index, VIX
X2: Ted spread
X3: S&P 500 total return

Pursuant to these observed anomalies, this study examines the dynamic relationships between the U.S. equity market and the interest rate variables that define credit risk. The investigation is conducted in a vector autoregressive framework in which we analyze the forecast error variance decomposition of equity market returns. Additionally, a reformulation of the regulatory capital requirement for lending institutions is offered as an improvement over recent financial reforms in the United States. The study continues with a review of some of the literature addressing the financial crisis, followed by a presentation of Johansen's (1991) cointegration model, against which background the dynamic relationships are explored. The final sections contain the empirical results and conclusions.

2. Literature

Virtually all the studies and commentaries on the financial crisis deal primarily with factors believed to have encouraged excessive household debt. In some cases, the arguments are quite declarative. For example, Taylor (2008) blames the abundance of credit as the chief cause of the crisis. He finds that the Federal Reserve's unusually low interest rate policy in the late 1990s and 2000s was responsible for accelerating the housing boom and ultimately the collapse that followed. According to Pattanaik (2009) and Posner (2008), the movement to deregulate the financial services industry went too far by exaggerating the resilience of the free market economic model.

Dell'Aricia et al. (2008a) also blame the credit boom for the sharp increase in delinquency rates. They present evidence which shows that most major banking crises occurred in periods of extremely easy credit. At such times, loan delinquency rates tend to rise with the volume of loan origination. They therefore conclude that economic booms associated with fast rising real estate prices were more likely to end up in a financial crisis. This view was also expressed on March 7, 2001 by former Federal Reserve Chairman, Alan Greenspan, who, in a speech to the Independent Community Bankers of America, pointed to "an unfortunate tendency among bankers to lend aggressively at the peak of a cycle", which is when most bad loans were made.

Barajas et al. (2007) discuss the effects of monetary excesses but find that while most major banking crises in the U.S. occurred in periods of credit boom, not all credit booms are followed by banking crises. They show that only about 20 percent of boom periods ended in a crisis. On the flip side, as much as half of the banking crises they studied were preceded by lending booms. Moreover, Dell'Aricia et al. (2008b) find that larger and longer-lasting booms, as well as those coinciding with higher inflation and lower growth, were more likely to result in a crisis.

The findings in Dell'Aricia et al. (2008b) and also Demyanyk and Van Hemert (2008) present evidence that the growth in mortgage securitization may have affected lender behavior by showing that lending standards fell in regions with higher rates of mortgage securitization. In particular, Demyanyk and Van Hemert show that the rise and fall of the subprime mortgage market is consistent with a classic lending boom--bust scenario in which unsustainable growth in credit expansion leads to the collapse of the financial markets. Similar findings were made by Enoch and Ötker-Robe (2009) in an examination of the effects of credit growth in Europe over the same period.

In an empirical examination of factors contributing to the rise in mortgage defaults, Mayer et al. (2009) find that declines in home prices and poor underwriting standards were preeminent. Poor standards include increases in loan-to-value ratios and the share of mortgages with little or no documentation of income. Ho and Cross (2007) find that although no less than 23 states had enacted anti-predatory lending laws by 2004, these laws proved ineffectual because they were not strictly enforced. However, Bernanke (2008) finds that tying the incomes of subprime mortgage originators to loan volume rather than the quality of the underlying loans encouraged predatory and high-risk lending. He also identifies the loosening of credit standards and poor risk management by banks as additional factors that contributed to the financial turmoil.

Rogers (2008) takes a more macroeconomic view and blames the rapid development of free market globalization for the eventual economic recession that followed the financial crisis. He argues that globalization produced two conflicting results. The first, a benefit, is a boost in economic growth. The second, a detriment, is a deepening wealth-poverty gap. To combat the latter, the U.S. government encouraged subprime credit, which, although it was well intentioned, resulted in the transnational banking and economic crisis that followed.

In this study, we identify the debt overhang created by excessive borrowing and the disconnect between income and household leverage as a key factor that led to the collapse of the housing market and the crisis that followed. Using a business cycle model, Occhino and Pescatori (2010) show how debt overhang exacerbates credit risk, which, if ignored, eventually leads to a financial crisis. They show in particular that as credit spreads widen, as was the case between 2000 and 2007, default rates increase; eventually, the economy collapses. In support, Campbell (2010) finds that in a climate of excessive debt, every 10 percent increase in leverage decreases the amount that firms invest in projects by up to 20 percent. Unfortunately, as Campbell shows, such decreases in investments further raise the probability of default owing to slow or no growth, and this creates a vicious cycle in which the initial effects of rising credit risk are amplified. These findings provide the motivation for this study, which finds that during the pre-crisis period, the equity market failed to take into account the rising default risk that should have served as a signal of impending disaster.

3. Modeling the Long- and Short-Run Dynamics

The variables employed in this analysis are the monthly values of the S&P 500 total returns index, the three-month Libor, the three-month yield on U.S. Treasury bills, and the yield on 10-year U.S. Treasury bonds. The overall working sample is from January 1980 to August 2010. The pre-crisis observation time that coincides with the observed market anomalies is from January 2000 to October 2007. The crisis event time is the period from November 2007 to August 2010. Except for the equity market data, obtained from the Chicago Board Options Exchange, the three interest rate variables were obtained from the U.S. Federal Reserve. All data are expressed in their natural logarithm. Of note is that in lieu of the Ted spread, the direct rates for the Libor and T-bills were employed in the analysis. This is because the Ted spread, which may be viewed as a linear combination of the two interest rate variables, is typically stationary at level and is therefore not suitable for investigating long-run dynamics.

In order to examine whether there is an equilibrium relationship between equity market returns and the interest rate variables, one needs to determine whether common stochastic trends are present in the variables under investigation. First, Engle and Granger (1987) explain that if variables are individually I(1), in that their level series contain a stochastic trend but are stationary after their first differences, then a linear combination of the series may be stationary. To explore this behavior, Johansen (1991) suggests tests for determining the number of cointegrating vectors among a set of I(1) time series variables. Consider the following *p*-variable vector autoregressive (VAR) model:

$$y_t = \alpha + \sum_{i=1}^{p} \beta_i y_{t-i} + \varepsilon_t \tag{1}$$

where α is a constant term, y_t is a $(px1)$ vector of the variables examined, and ε_t is the disturbance term of dimension $(px1)$ and is iid. Assuming the series are cointegrated, equation (1) may be rearranged to give the following error correction representation (Johansen and Juselius, 1990):

$$\Delta y_t = \alpha + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \boldsymbol{\Pi} y_{t-1} + \varepsilon_t \tag{2}$$

where

$$\boldsymbol{\Pi} = \sum_{i=1}^{p} A_i - I \, , \; \Gamma_i = -\sum_{j=i+1}^{p} A_j \tag{3}$$

The long-run relationship is determined by the rank of $\boldsymbol{\Pi}$. If the time series are nonstationary and cointegrated, then $\boldsymbol{\Pi}$ is not of full rank, in which case $r < p$. If $r = p$ (i.e., $\boldsymbol{\Pi}$ has full rank), then all the elements in y_t are stationary I(0). In the specification, r is the number of cointegrating relations. Johansen (1988, 1991) proposes two likelihood testing procedures in order to estimate the rank of $\boldsymbol{\Pi}$. The first, the *trace statistic*, is a joint test where the null is that the number of cointegrating vectors is less than or equal to r against the alternate that the number of cointegrating vectors is greater than r. The second, the *maximum eigenvalue* test statistic, tests the null hypothesis that the number of cointegrating vectors is r against the alternate hypothesis that there are $r + 1$ cointegrating vectors. When the series are cointegrated, Johansen further demonstrates that $\boldsymbol{\Pi}$ could be factored as

$$\boldsymbol{\Pi} = \alpha\beta'$$

where β is the matrix of r cointegrating vectors and α is the matrix of weights attached to each cointegrating vector. Both α and β are pxr matrices. The number of lags used in the VAR is based on the evidence provided by a criterion such as the Akaike Information Criterion (AIC).

If the risk and market variables behave in the expected manner, a cointegrating relationship should exist. Based on the *Granger representation theorem*, if variables are cointegrated, their relationship can be expressed as an error correction mechanism. A vector error correction (VEC) is a restrictive VAR designed for use with nonstationary time series that are verified to be cointegrated. The VEC has cointegrating relations built into the specification so that it restricts the long-run behavior of the endogenous time series to converge to their cointegrating relationships while allowing for short-run adjustment dynamics. The cointegration term is the error correction term (ect) since the deviation from long-run equilibrium is corrected through a series of partial short-run adjustments. The non-structural VEC model may be expressed as

$$\Delta y_t = \alpha_0 + \alpha_1(y_{t-1} - \delta x_{t-1}) + \sum_{i=1}^{p} c_i \Delta y_{t-i} + \sum_{j=1}^{q} d_i \Delta x_{t-j} + \varepsilon_t \tag{4}$$

where y represents each of the endogenous variables being modeled, and x represents each of the others when one is being modeled. The coefficient α_1 is the error correction term which captures the speed of adjustment.

4. Results of the Empirical Analysis

Table 1 presents the descriptive statistics for the time series. The results show that except for Treasury bond yields, the variables are negatively skewed. This means that the left tail of the density is particularly extreme. The two variables that define the Ted spread, the Libor, and the Treasury bill yield show evidence of fat tails, since their kurtosis values exceed 3, the value for a normal variable. The Jarque-Bera statistics reject normality at the 0.05 level for all four variables. These characteristics are similar to existing evidence shown in Engle (2001).

Unit root test results are presented in *Table 2*. This test covers the entire sample period (January 1980–August 2010). The results show that all four series are nonstationary in levels but are stationary in their first differences. Thus, the series are individually I(1). This finding enables investigation of the long-run relationship among these variables. Pursuant to this, cointegration tests are carried out on the overall sample. The results are summarized in *Table 3*.

Both the trace test and the maximum eigenvalue test indicate two cointegrating equations at the 0.05 level. The finding that the variables are cointegrated means that the short-run dynamics of their relationship may be specified as a vector error correction (VEC). The VEC results (not presented) help to explain how much of the short-run disequilibrium is corrected each period, based on the error correction term.

The main intent of this analysis, however, is to examine how much explanatory power the interest rate variables have on the performance of the equity market. This line of inquiry is guided by the dissonance observed before the financial crisis between the Ted spread, the credit risk indicator, and the broad-based equity market index. One way to evaluate this impact is through the forecast error variance decompositions (VDC) of each time series. The decompositions show the proportion of fore-

Table 1 Descriptive Statistics

	L	T	B	S
Mean	1.5822	1.3405	1.8857	6.2420
Std. Dev.	0.7831	1.0763	0.4058	0.8320
Skewness	-1.0592	-2.0418	0.0968	-0.3597
Kurtosis	4.1796	7.6148	2.2415	1.7624
Jarque-Bera	90.1496	582.2549	9.3972	31.4192
Probability	0.0000	0.0000	0.0091	0.0000

Notes: Series: L = ln(Libor), T = ln(T-bill), B = ln(T-bond), S = ln(SP 500)
Sample period: January 1980–August 2010

Table 2 Unit Root Test Results

	Level Series							
	L		T		B		S	
Method	Statistic	Prob.*	Statistic	Prob.*	Statistic	Prob.*	Statistic	Prob.*
PP – Fisher Chi-square	0.27	0.8758	0.20	0.9026	0.25	0.8820	1.66	0.4353
PP – Choi Z-stat	1.15	0.8758	1.30	0.9026	1.18	0.8820	-0.16	0.4353
	1st Differences							
	L		**T**		**B**		**S**	
Method	Statistic	Prob.**	Statistic	Prob.**	Statistic	Prob.**	Statistic	Prob.**
PP – Fisher Chi-square	99.01	0.0000	125.15	0.0000	126.09	0.0000	146.78	0.0000
PP – Choi Z-stat	-9.62	0.0000	-10.89	0.0000	-10.93	0.0000	-11.83	0.0000

Notes: * Unit root exists in both level series (nonstationary series).
** Series stationary after 1st differencing. All series I(1).

Series: L = ln(Libor), T = ln(T-bill), B = ln(T-bond), S = ln(SP 500)
Sample period: January 1980–August 2010

Table 3 Cointegration Test Results

Series: L T B S			
Unrestricted Cointegration Rank Test (Trace):			
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**Prob.****
None *	0.0798	71.4885	0.0007
At most 1 *	0.0604	41.1255	0.0102
At most 2	0.0423	18.4028	0.0883
At most 3	0.0071	2.6140	0.6550
Unrestricted Cointegration Rank Test (Maximum Eigenvalue):			
Hypothesized No. of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**Prob.****
None *	0.0798	30.3629	0.0293
At most 1 *	0.0604	22.7227	0.0436
At most 2	0.0423	15.7888	0.0519
At most 3	0.0071	2.6140	0.6550

Notes: Trace test indicates 2 cointegrating eqn(s) at the 0.05 level.
Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level.

* Denotes rejection of the hypothesis at the 0.05 level.
**MacKinnon-Haug-Michelis (1999) *p*-values.

Series: L = ln(Libor), T = ln(T-bill), B = ln(T-bond), S = ln(SP 500)
Sample period: January 1980–August 2010

Table 4 Variance Decomposition of S&P 500

Period	S.E.	L	T	B	S
Panel A Overall working sample: Jan 1980–Aug 2010					
1	0.0444	1.5193	0.9016	0.2055	97.3736
2	0.0653	3.1023	0.7702	0.4617	95.6659
3	0.0806	3.7267	2.2285	0.7451	93.2997
4	0.0936	3.4117	3.2407	1.3026	92.0449
5	0.1051	3.3553	3.3780	1.6712	91.5955
6	0.1152	3.5144	3.2880	1.8526	91.3450
7	0.1242	3.6018	3.2128	2.0257	91.1597
8	0.1323	3.5834	3.1454	2.2418	91.0293
9	0.1399	3.5271	3.0614	2.4727	90.9387
10	0.1470	3.4642	2.9697	2.6956	90.8705
11	0.1538	3.3959	2.8815	2.9106	90.8120
12	0.1601	3.3223	2.7986	3.1211	90.7580
Panel B Pre-Crisis Phase: Jan 2000–Oct 2007					
Period	**S.E.**	**L**	**T**	**B**	**S**
1	0.0391	0.0089	1.4265	5.7119	92.8527
2	0.0534	0.4832	5.6316	3.8878	89.9974
3	0.0641	1.4979	10.3557	2.7121	85.4344
4	0.0732	2.9257	14.2598	2.2092	80.6053
5	0.0816	4.5511	17.1768	2.1882	76.0839
6	0.0895	6.1723	19.3453	2.4709	72.0114
7	0.0972	7.6575	21.0172	2.9367	68.3886
8	0.1046	8.9460	22.3690	3.5078	65.1772
9	0.1120	10.0253	23.5108	4.1325	62.3313
10	0.1192	10.9086	24.5085	4.7758	59.8070
11	0.1263	11.6192	25.4016	5.4139	57.5654
12	0.1333	12.1825	26.2139	6.0314	55.5723
Panel C Crisis Period: Nov 2007–Aug 2010					
Period	**S.E.**	**L**	**T**	**B**	**S**
1	0.0553	12.7535	15.5312	0.9735	70.7419
2	0.0850	28.4602	13.3715	1.8838	56.2845
3	0.1108	34.4903	18.1197	1.8657	45.5244
4	0.1332	35.3482	22.7564	1.4330	40.4624
5	0.1514	36.7518	23.2277	2.7075	37.3130
6	0.1653	39.5640	21.7278	4.5528	34.1553
7	0.1754	42.3968	20.3241	5.8230	31.4562
8	0.1817	44.3623	19.5173	6.3672	29.7532
9	0.1852	45.5316	19.1246	6.4427	28.9012
10	0.1869	46.2062	18.9158	6.3551	28.5230
11	0.1877	46.5642	18.7851	6.3132	28.3374
12	0.1882	46.7188	18.6957	6.3645	28.2210

Notes: Series: L = ln(Libor), T = ln(T-bill), B = ln(T-bond), S = ln(SP 500)
Cholesky Ordering: L T B S

cast error variance for each variable that is attributable to its own innovation and to innovation in the other endogenous variables. As is often the case, own shocks constitute the predominant source of variation in each time series.

Since the focus of this inquiry is on the stock market variable, variance decomposition results are provided only for it. The results are presented in three panels in *Table 4*. Panel A gives the results for the entire observation period: January 1980 to August 2010. Panel B gives the results for the defined pre-crisis period: January 2000 to October 2007. Panel C contains the results for the period from when the crisis began until the most recent month in the sample. Expressed in this manner, the VDC results may be used to show the relative importance of each of the interest rate variables in explaining the intertemporal variation of the equity market. Kupcheck and Monadjemi (2000) use a similar multi-period model to demonstrate the relative impact of real interest rates among large and small economies. Following the empirical process in Monadjemi and Loadewijks (2003) as well as Kupcheck and Monadjemi (2000), separate cointegration tests were conducted for the two subperiods described in Panels B and C. These secondary cointegration test results, which are not presented (but are available upon request), show that at the 0.05 level, the hypothesis of two cointegrating vectors for both subperiods cannot be rejected.

It is expected that while the importance of the Libor in the pre-crisis period may have been muted, its current impact on the equity market should be much greater due to lessons learned since the crisis began. The three-month Libor is pivotal in this assessment since its incremental return above the yield on the three-month T-bill captures the credit risk premium on dollar-denominated loans in the international money market. In a period of generally low interest rates, a rising Libor signifies the increased risk premium that borrowers must pay as economic uncertainty grows. If the equity market operates efficiently, the impact of such phenomena should be reflected in its performance. While it is sometimes the case that VDC results are sensitive to the ordering of variables, the pattern of the results achieved in this study remains consistent even after the series have been re-ordered.

In *Table 4*, we find that as far as the forecast error variance of the equity index is concerned, over the 12-month period examined for the overall sample (Panel A), the variation attributed to own shocks ranged from 91 percent in the most distant period to 97 percent after the first month. The range is about 56 to 93 percent in the pre--crisis period (Panel B), and only 28 to 71 percent in the most recent period (Panel C). Of particular interest is the relative influence that the short-term interest rate variables have on the equity market before and during the financial crisis. In the precrisis period of January 2000 to October 2007 (Panel B), innovations attributed to the Libor ranged from 0 to 12 percent, while for the Treasury bill the range is 1.4 to 26 percent. Put together, the persistence of shocks from these two credit risk variables, after 12 months of shocks, explains only about 38 percent of the variance of the equity index.

In the period since the crisis began (Panel C), the joint contribution of innovations attributed to the Libor and the T-bill rose markedly to over 65 percent of the variance of the equity market variable after 12 months of shocks. More specifically, as far as the forecast error variance of the equity index is concerned, the joint contribution of the Libor and the T-bill in this latter period is many times the size before the crisis (Panel B). For example, the contribution of the Libor in the first month of the pre-crisis period (Panel B) is virtually nonexistent. For this same month during the crisis period (Panel C), the persistence of shocks due to the Libor rose to almost 13 percent. The longest time period examined is the twelfth month, in which the contributions by the Libor are 12 percent before the crisis and 47 percent during the crisis.

It is noteworthy that the contribution to the forecast error variance of the equity market from shocks to the Libor was half the size of shocks attributed to the Treasury bill before the crisis. As the crisis unraveled, the contribution from the Libor grew to more than twice the size of shocks attributed to the T-bill by the twelfth month. Also of note is that in the latter lags of the crisis period, shocks attributed to the Libor had a greater impact on the equity market's forecast error variance than any of the other variables, including the equity market index itself. In both the pre-crisis and crisis periods, shocks attributed to long-term interest rates hardly exceeded 6 percent of the forecast error variance of the equity market. Therefore, the equity market in these instances appears to have been driven more by changes in short-term interest rates.

Taken together, these results show that in this most recent period, the variables that define short-term credit risk were more important in explaining variations of the equity market than either innovations in the equity market or long-term interest rates. In contrast, shocks to the credit risk variables were diminutive prior to the crisis as far as impact on the equity market was concerned. These latter findings reinforce the view that before the crisis began, the equity market was slow to recognize the rising credit risk as depicted by the uptrend in the Ted spread. This muted relationship between these variables prior to the crisis also confirms the evidence in Occhino and Pescatori (2010) as to how credit spreads, if ignored, ultimately lead to economic collapse.

5. Recent Policy Issues

On July 21, 2010, the United States President, Barack Obama, signed into law the *Dodd-Frank Wall Street Reform and Consumer Protection Act* (formal name: Restoring American Financial Stability Act of 2010). As the name suggests, this legislation focuses on the welfare of consumers as well as investors. It also emphasizes transparency and accountability on the part of lenders, and institutes tougher capital and leverage requirements for internationally active financial institutions, informally branded as too-big-to-fail.

The new legislation, while helpful in various ways, fails to address the demand side of credit, the very reason for the widespread delinquencies that led to the mortgage crisis. Even with greater transparency and supervision, excessive debt is what generates extreme uncertainty and systemic risk. One way to address this systemic flaw is to make bank regulatory capital sufficiently risk sensitive. Regulatory capital is the minimum amount of stockholder equity (or *tier one* capital) that banks must maintain in order to fully absorb bad loans. Risk-based regulatory capital reduces the incidence of insolvency. It also compels lenders to reduce their predatory behavior, which often entices unsuspecting borrowers to overextend themselves.

Due to their unique risk characteristic and the huge distress they brought upon the financial system during the crisis, real estate loans merit being placed in a different tranche from other bank assets. In this regard, the Basel Committee on Banking Supervision (Basel II) has established a risk-based capital requirement designed to ensure that a financial institution holds capital appropriate to the risk to which it is exposed by its lending and investment practices. In the current model, residential mortgages are placed in a homogenous risk class which does not recognize the differing credit risks of borrowers. To fill this gap, these loans are better placed in different tranches, each tranche reflecting specific credit risk. Pursuant to this, a re-formulation of the risk-weighted regulatory capital is expressed in the following respect:

$$\text{Credit risk capital} \geq \lambda \left(\sum_{i=1}^{M} w_i R_i + \sum_{j=1}^{N} h_j L_j + \sum_{k=1}^{P} x_k C_k \right)$$

where

λ = regulatory minimum capital ratio (currently 8 percent under Basel II),
$w_i R_i$ = risk-weighted total of all loans within the real estate loan portfolio,
$h_j L_j$ = risk-weighted total of all other on-balance sheet assets,
$x_k C_k$ = risk-weighted total of off-balance items.

The benefit of this model is that it compels lenders to become more prudent in the measure of risk they take. Accordingly, high-risk loans such as those described as subprime and interest-only would belong in tranches that require greater capital provision.

6. Conclusions

This study began with a review of some of the factors that contributed to the global financial crisis which started in 2007 with the collapse of the U.S. housing market. In addition to factors such as predatory lending, poor risk management, and a high incidence of subprime loans, this study cites excessive debt by homeowners as a key contributor to the crisis. Before the crisis erupted, there was a confluence of abnormal economic events between 2000 and 2007. During this period, when home prices grew at a staggering rate, personal debt grew twice as fast as disposable income. Also, there was a surprisingly inverse correlation between credit and market risks. Stock market values rose almost steadily throughout the period even as credit risk premiums suggested an increased likelihood of borrower default. In effect, the equity market appeared oblivious to the rising credit risk that signaled the impending crisis.

The absence of a connection between market and credit risks during the pre-crisis period, and their relationships with the equity market, prompted us to examine their long-run dynamics. In a variance decomposition of the forecast error variance of equity market returns, it was found that before the crisis, the stock market showed a muted response to innovations in the credit markets. Although credit risk was heavily ignored prior to the crisis, its contribution to the forecast error variance of the equity market has become dominant since the crisis broke. This latter outcome may suggest that investors are increasingly rational in factoring credit risk into the valuation of financial assets.

Recent regulatory reforms in the United States target consumer protection and specify additional capital requirements for depository institutions. However, in order to better manage the excessive credit risk in the home loan market, this study offers a targeted risk-based capital adequacy model. Rather than mandate a broad increase in regulatory capital, this reformulation of *Basel II* assigns varying risk weights to home loan tranches, where each tranche is constructed to reflect the credit risk of the underlying borrower.

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