



## **MARKET MELTDOWN AND THE PROPAGATION MECHANISM OF CONTAGION**

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### **Abstract**

World economy came on a tailspin because of market meltdown and the propagation of contagion triggered by recession, starting mostly from the US economy. This work highlights the grim developments in the financial sectors and the real sectors world-wide, and then an attempt is made to highlight the propagation mechanism of infective contagion. Theoretical structures of such interconnected are showcased through various analytical vehicles. The indices of sensitivities and dispersions are measured in mathematical terms, and in that sense a new analytical framework is presented. However, empirical evaluations of the propagation mechanism remain unfinished because of the dearth of data

Keywords: Market Meltdown, Contagion, Subprime Loans, Troubled Asset Relief Program (TARP), Securitization

JEL Classification: G1, G2

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### **1. Introduction**

From 2007 until the present time, the economy of the United States (US) and almost every other economy of the globe have been suffering a humongous recession approaching the neighborhood of the Great Depression of 20th century. The magnitudes and proportions of downward spirals overwhelmed the entire world. It has been recognized that the American sub-prime loans and reckless disregard for sanity and discipline in lending and liquidity management have bought the world on its knees. The question, of course, has to go beyond the root cause of recession world-wide. It has been the severe contagion of this young century spreading all over and everywhere, and everyone recognizes that. We must attempt to seek answer to the question as to how this US contagion got propagated globally. In Section 2, this paper presents the statistical measures of what happened, who got infected, and how the market meltdown affected individuals, institutions, governments, regulatory bodies, and so on. Then in

Section 3, how markets across nations are integrated (or segmented) is examined. In this context, the existing literature is revived. Then exposition is given on the interconnectedness of national economies, which and attempts to show how the market meltdown made the financial pandemic propagated on the global scale. In Section 4, highlights the difficulty of not giving the test results of our paradigm because of the paucity of data that are needed to verify and conclude the theoretical structure on the sensitivities of dispersions of the contagion.

## **2. Market Meltdown and the US Economy**

Market meltdown has been the buzz word in the world of finance. Crisis has gripped the globe. Financial architecture has collapsed everywhere. Stock markets have plunged, and Dow Jones Industrial Average had come down to its 1997 level. Many banks and major financial institutions have disappeared, and asset values of people have declined beyond belief. The worldwide scramble to appropriate wealth through “financial manipulation” has been the driving force behind this crisis. It is the source of economic turmoil and social devastation. Totally deregulated financial environment characterized by extensive speculative trade has indeed wrought havoc to the framework of financial stability on a global scale. In the wake of the 1987 stock market meltdown, the US Treasury was admonished by Wall Street not to meddle in financial markets. Free of government encroachment, the New York and Chicago exchanges were invited to establish their own regulatory procedures. Financial deregulation in the US has created an environment of unbounded greed and deception out of which came the major tsunami *via* subprime mortgage loan. The subprime loans are the genesis of the current crisis.

Subprime loans to mortgage holders on real estates have put the world economy on a tailspin. Stock markets across the nations have taken nose dives. The questions must then be: what are subprime loans and how have these loans wrought havoc around the world? Let us answer these questions to start off with the issue of financial chaos, or as often noted in the financial press, as crisis, and its spillover effects in the international markets. Prime refers to prime rate at which banks lend money to their most preferred corporate customers, and it is the lowest rate of interest in the credit market. Other borrowers can borrow at prime **plus alpha** where *alpha* is any value above zero. Obviously then subprime loan is a loan with interest cost below prime rate. Although it is not necessarily below prime rate, it has been given the appearance of cheap cost of loans, and made the unworthy home buyers attracted to such seemingly low cost credit. Such loans were extended to home-buyers who even had significantly below average creditworthiness mostly under adjustable mortgage rates. When the adjustment started becoming effective, mortgagees began serially delinquent. The loans became non-performing, and banks started foreclosing on the homes with lien on the properties, and the credit market dried up. It is not the end of the saga; the spillover effects have become global in the era of globalization.

The subprime mortgage problem has been in sharp rise through home foreclosures which started in the US in late 2006 and became what has been often referred to as a global financial crisis during 2007 and 2008. The crisis began with the bursting of the housing bubble in the US and high default rates on subprime and other adjustable rate mortgages (ARM) made to higher-risk borrowers with lower income or lesser credit history than "prime" borrowers. Loan incentives and a long-term trend of rising housing prices encouraged borrowers to assume mortgages, believing they would be able to refinance at more favorable terms later. However, once housing prices started to drop moderately in 2006-2007 in many parts of the US, refinancing became more difficult. Defaults and foreclosure activity increased dramatically as ARM interest rates reset higher. During 2007, nearly 1.3 million US housing properties were subject to foreclosure activity, up 79% versus 2006. Estimate were floating that sub-prime defaults would reach amounts somewhere between US \$200-\$300 billion.

The mortgage lenders that retained credit risk (the risk of payment default) were the first to be affected, as borrowers became unable or unwilling to make payments. Major banks and other financial institutions around the world have reported losses of approximately US \$170 billion as of February 2008, as cited below. Due to a form of financial engineering, called securitization, many mortgage lenders had passed the rights to the mortgage payments and related credit/default risk to third-party investors *via* mortgage-backed securities (MBS) and collateralized debt obligations (CDO). Corporate, individual and institutional investors holding MBS or CDO faced significant losses, as the value of the underlying mortgage assets declined. Stock markets in many countries declined significantly. This paper now delineates the evolving situations, mostly in the US economy, and as they are reflected in the stock markets in the US.

### **2.1 Subprime Loans**

The widespread dispersion of credit risk and the unclear impact on financial institutions have caused lenders to reduce lending activity or to make loans at higher interest rates. Similarly, the ability of corporations to obtain funds through the issuance of commercial paper was impacted. This aspect of the crisis is consistent with a credit crunch. The liquidity concerns drove central banks around the world to take action to provide funds to member banks to encourage the lending of funds to worthy borrowers and to re-invigorate the commercial paper markets.

The subprime crisis also places downward pressure on economic growth, because fewer or more expensive loans decrease investment by businesses and consumer spending, which drive the economy. A separate but related dynamic is the downturn in the housing market, where a surplus inventory of homes has resulted in a significant decline in new home construction and housing prices in many areas. This also places downward pressure on growth. With interest rates on a large number of subprime and other Adjustable Rate Mortgages (ARM) due

to adjust upward during the 2008 period, US Legislators and the US Treasury Department have been taking action. A systematic program to limit or defer interest rate adjustments was implemented to reduce the impact. In addition, lenders and borrowers facing defaults had been encouraged to cooperate to enable borrowers to stay in their homes. The risks to the broader economy created by the financial market crisis and housing market downturn were primary factors in the January 22, 2008 decision by the US Federal reserve to cut interest rates and the economic stimulus package signed by President Bush on February 13, 2008. Both actions were designed to stimulate economic growth and inspire confidence in the financial markets.

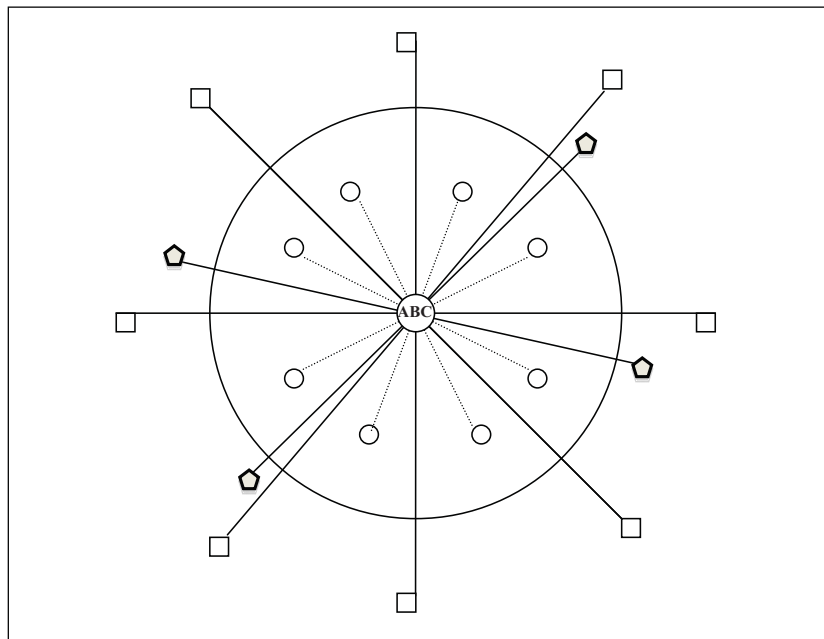
The value of US sub-prime mortgages was estimated at \$1.3 trillion as of March 2007, with over 7.5 million first-lien sub-prime mortgages outstanding. Approximately 16% of subprime loans with ARM were 90 days delinquent or in foreclosure proceedings as of October 2007, roughly triple the rate of 2005. By January of 2008, the delinquency rate had risen to 21%. Subprime ARMs only represented 6.8% of the loans outstanding in the US, yet they represent 43.0% of the foreclosures started during the third quarter of 2007. A total of nearly 446,726 US household properties were subject to some sort of foreclosure action from July to September 2007, including those with prime, alt-A, and subprime loans. This was 2-fold of the 223,000 properties in the year earlier, and 34% higher than the 333,627 in the prior quarter. This increased to 527,740 during the fourth quarter of 2007, an 18% increase *versus* the prior quarter. For all of 2007, nearly 1.3 million properties were subject to foreclosure filings, up 79% *versus* 2006.

## **2.2 Risks of the Subprime Loans**

As a result extensive subprime loans, a few types of risk – credit risk, liquidity risk, asset valuation risk, and risk on relying on financial institutions – came into being, and this 4-tuple risk shook the entire edifice of the financial world. Traditionally credit risk was assumed by the banks giving mortgage loans, but in recent years, owing to innovations in securitization, credit risk was being shared more broadly with investors, because the rights to these mortgage payments had been repackaged into a variety of complex investment vehicles, generally categorized as mortgage-backed securities (MBS) or collateralized debt obligations (CDO). The following diagram (Figure 1) depicts what transpired because of the securitization structure of borrowing, lending and investing.

The small spikes within the circle represent the borrowers (home mortgage holders) from the banks, represented in the cluster (in the center of the circle) that created and sold mortgage-backed securities (MBS), and collateralized debt obligations (CDO). The spikes going beyond the circle represent the investors in the MBS and CDO, longer ones are the international investors and shorter ones are domestic investors. Originally, the home mortgagees with subprime loans were paying mortgages, but when the reset started, they could not pay their dues, and this reality came into being when the income inflows did not

get to the foreign and domestic investors. All spikes became insolvent and got crushed in the windmill of dire financial distress. To manage their risk, mortgage originators (banks or mortgage lenders) created separate legal entities, called special-purpose entities (SPE), to both assume the risk of default and issue the MBS. The banks effectively sold all the mortgage assets (that is, banking account receivables, which were the rights to receive the mortgage payments) to these SPE. In turn, the SPE then sold the MBS to the investors. The mortgage assets in the SPE became the collateral. Another variant of SPE – known as Structured Investment Vehicles (SIV) – and other corporations soon realized the devastation in the markets on commercial papers, causing illiquidity an unmanageable situation. The amount of commercial paper issued as of October 18, 2007 dropped by 25%, to \$888 billion, from the August 8 level. Along with or because of liquidity risk and credit risk, asset market prices fell sharply, and threw the financial markets into chaos and disarray, where the domino effect was observed.



**Figure 1:** Securitization Structure of Borrowing, Lending and Investing

Subprime borrowing was a major contributor to an increase in home ownership rates and the demand for housing. The overall US homeownership rate increased from 64% in 1994 (about where it was since 1980) to a peak in 2004, with an all time high of 69.2%. This demand helped fuel housing price increases and consumer spending. Between 1997 and 2006, American home prices increased by 124%. Some homeowners used the increased property value

experienced in the housing bubble to refinance their homes with lower interest rates and take out second mortgages against the added value to use the funds for consumer spending. US household debt as a percentage of income rose to 130% during 2007, versus 100% earlier in the decade.

Misrepresentation of loan application data is another contributing factor. Like predatory lending, predatory borrowing became unmanageably significant. It had been estimated that almost three-fourth of the delinquency had fraudulent misrepresentations on their original loan applications. Mortgage fraud increased by 1411% between 1997 and 2005, according to the US Treasury Department report. Many analysts have claimed that government policy actually encouraged the development of the subprime debacle through legislation like *the Community Reinvestment Act*, which they say forces banks to lend to otherwise uncreditworthy consumers. Any sane and far-sighted person can criticize the repeal of *Glass-Steagall Act* as contributing to the subprime meltdown. A taxpayer-funded government bailout related to mortgages during the Savings and Loan crisis in late 1989 may have created a moral hazard and acted as encouragement to lenders to make similar higher risk loans. Some have argued that, despite attempts by various US states to prevent the growth of a secondary market in repackaged predatory loans, the Treasury Department's Office of the Comptroller of the Currency, at the insistence of national banks, struck down such attempts as violations of Federal banking laws. In response to a concern that lending was not properly regulated, the House and Senate are both considering bills to regulate lending practices. Some industry officials said that Federal Reserve Bank of New York involvement in the rescue of Long-Term Capital Management in 1998 would encourage large financial institutions to assume more risk, in the belief that the Federal Reserve would intervene on their behalf.

Here is a brief view of the write-down on the value of loans, MBS, CDO and bankruptcies that were already witnessed. Table 1 exhibits the data.

**Table 1:** Write-downs on the value of loans, MBS and CDOs

| <i>Company</i>   | <i>Business Type</i> | <i>Loss (Billion \$)</i> |
|------------------|----------------------|--------------------------|
| Citigroup        | investment bank      | \$24.1 bln               |
| Merrill Lynch    | investment bank      | \$22.5 bln               |
| UBS AG           | investment bank      | \$18.7 bln               |
| Morgan Stanley   | investment bank      | \$10.3 bln               |
| Crédit Agricole  | bank                 | \$4.8 bln                |
| HSBC             | bank                 | \$17.2 bln               |
| Bank of America  | bank                 | \$5.28 bln               |
| <u>CIBC</u>      | bank                 | \$3.2 bln                |
| Deutsche Bank    | investment bank      | \$3.1 bln                |
| Barclays Capital | investment bank      | \$3.1 bln                |

(continued)

**Table 1:** Write-downs on the value of loans, MBS and CDOs

| <i>Company</i>                          | <i>Business Type</i> | <i>Loss (Billion \$)</i> |
|---|----------------------|--------------------------|
| Bear Stearns                            | investment bank      | \$2.6 bln                |
| RBS                                     | bank                 | \$3.5 bln                |
| Washington Mutual                       | savings and loan     | \$2.4 bln                |
| Swiss Re                                | re-insurance         | \$1.07 bln               |
| Lehman Brothers                         | investment bank      | \$2.1 bln                |
| LBBW                                    | bank                 | \$1.1 bln                |
| JP Morgan Chase                         | investment bank      | \$2.9 bln                |
| Goldman Sachs                           | investment bank      | \$1.5 bln                |
| Freddie Mac                             | mortgage GSE         | \$3.6 bln                |
| Credit Suisse                           | bank                 | \$3.7 bln                |
| Wells Fargo                             | bank                 | \$1.4 bln                |
| Wachovia                                | bank                 | \$3.0 bln                |
| RBC                                     | bank                 | \$0.360 bln              |
| Fannie Mae                              | mortgage GSE         | \$0.896 bln              |
| MBIA                                    | bond insurance       | \$3.3 bln                |
| Hypo Real Estate                        | bank                 | \$0.580 bln              |
| Ambac Financial Group                   | bond insurance       | \$3.5 bln                |
| Commerzbank                             | bank                 | \$1.1 bln                |
| Société Générale                        | investment bank      | \$3.0 bln                |
| BNP Paribas                             | bank                 | \$0.870 bln              |
| WestLB                                  | bank                 | \$1.37 bln               |
| American International Group            | insurance            | \$11.1 bln               |
| BayernLB                                | bank                 | \$2.8 bln                |
| Natixis                                 | bank                 | \$1.75 bln               |
| Countrywide                             | mortgage bank        | \$1.0 bln                |
| DZ Bank                                 | bank                 | \$2.1 bln                |
| <i>Businesses filing for bankruptcy</i> |                      |                          |
| <i>Business</i>                         | <i>Type</i>          | <i>Date</i>              |
| New Century Financial                   | subprime lender      | April 2, 2007            |
| American Home Mortgage                  | mortgage lender      | August 6, 2007           |
| Sentinel Management Group               | investment fund      | August 17, 2007          |
| Ameriquest                              | subprime lender      | August 31, 2007          |
| NetBank                                 | on-line bank         | September 30, 2007       |
| Terra Securities                        | securities           | November 28, 2007        |
| American Freedom Mortgage, Inc.         | subprime lender      | January 30, 2007         |

### 2.3 US Government and Central Bank

In the wake of the almost free-falling economies all around the world in general, and the economy of the US in particular, President George W. Bush

signed into law on February 13, 2008 an economic stimulus package of \$168 billion, mainly in the form of income tax rebates, to help stimulate economic growth. The **Troubled Asset Relief Program (TARP)** which was a program of the US government to purchase assets and equity from financial institutions to strengthen its financial sector was created. It was the largest component of the government's measures in 2008 to address the subprime mortgage crisis. TARP allowed the US Treasury Department to purchase or insure up to \$700 billion of "troubled" assets. "Troubled assets" were defined as "(A) residential or commercial mortgages and any securities, obligations, or other instruments that are based on or related to such mortgages, that in each case was originated or issued on or before March 14, 2008, the purchase of which the Secretary determines promotes financial market stability; and (B) any other financial instrument that the Secretary, after consultation with the Chairman of the Board of Governors of the Federal Reserve System, determines the purchase of which is necessary to promote financial market stability." Next, under the new Presidency of Barack Obama, the **American Recovery and Reinvestment Act of 2009 (ARRA)** (Pub.L. 111-5) - an economic stimulus package enacted by the 111th United States Congress in February 2009 appeared to calm and soothe financial nerve centers and had indeed controlled the turbulence. The Act followed other economic recovery legislation passed in the final year of the Bush presidency including the Economic Stimulus Act of 2008 and the Emergency Economic Stabilization Act of 2008 which created the Troubled Assets Relief Program (TARP). These measures are nominally worth \$787 billion. The Act includes federal tax cuts, expansion of unemployment benefits and other social welfare provisions, and domestic spending in education, health care, and infrastructure, including the energy sector. The Act also included numerous non-economic recovery-related items that were either part of longer-term plans. The stock markets all around the world have rebounded with still bumps here and there. European governments and central banks have followed the US lead in the containing contagion. Japan has been on board.

The Fed and other central banks have conducted open market operations to ensure member banks have access to liquidity. These are effectively short-term loans to member banks collateralized by government securities. Central banks have also lowered the interest rates charged to member banks (called the discount rate in the US) for short-term loans. Both measures effectively lubricate the financial system, in two key ways. First, they help provide access to funds for those entities with illiquid mortgage-backed assets. This helps lenders, SPE, and SIV avoid selling mortgage-backed assets at a steep loss. Secondly, the available funds stimulate the commercial paper market and general economic activity. Specific responses by central banks are included in the subprime crisis impact timeline. The Fed has been utilizing the Term Auction Facility (TAF) to provide short-term loans (liquidity) to banks. The Fed has increased the monthly amount of these auctions to \$100 billion during March 2008, up from \$60 billion in prior months. In addition, term repurchase agreements expected to cumulate to \$100 billion were announced, which enhanced the ability of financial institutions to



sell mortgage-backed and other debt. The Fed indicated that both the TAF and repurchase agreement amounts would continue and be increased as necessary. It appears that these measures have created a slow but steady rebound.

### 3. Are International Markets Integrated?

#### 3.1 Conventional Approach

In this section how much the spill-over effect is evaluated. How did sub-prime loans spread the virus across nations? Numerous studies and serious research have shown different conclusions and this paper is more in disagreement on the question as to whether international markets are integrated or segmented. Black (1974), Stulz (1981a, 1981b), Eun and Janakiraman (1986), Hietala (1989) have viewed that international capital markets are segmented, and Adler (1974), Adler and Dumas (1983), and Stapleton and Subramanyam (1977), ignoring exchange risk, examined the implication of market segmentation. French, Schwert, and Stambaugh (1987) have presented evidence that there is a positive correlation between the conditional expected excess return on the market portfolio and the conditional variance of its return, using generalized autoregressive conditional heteroscedasticity representation, as expounded by Bollerslev (1986) and Engle (1982) for the excess return on the market with the Standard and Poor's 500 index (S&P 500) for the market portfolio. In their sample, it appeared that foreign capital markets are significantly segmented from the US capital markets. The studies of Cho, Eun and Senbet (1986), Wheatley (1988), Korajczyk and Viallet (1990), and Harvey (1991) have provided evidence of integration by employing different asset pricing models and using monthly data. By making use of the arbitrage pricing theory (APT), Gultekin, Gultekin and Penati (1989) have established that for fifteen years the US and the Japanese markets had been more and more integrated. Chan, Karolyi, and Stulz (1991) have attempted to reexamine and generalize the work of French, Schwert, and Stambaugh (1987) by assuming that (i) markets are internationally integrated, (ii) investors are optimizers in the mean-variance framework in a common numeraire currency such as the US dollar, and (iii) the aggregate relative risk aversion,  $Z = \sum_{i=1}^n Z_{it} / \sum_{i=1}^n W_{it}$ , is constant, where  $Z_{it}$  is the i-th individual's risk aversion, and  $W_{it}$  is the wealth at time t.

Under these assumptions, they have begun with the following equations:

$$E_t(R_{mt} - R_{ft}) = Z^{-1} \text{var}_t(R_{mt} - R_{ft}) \quad (1)$$

$$E_t(r_{dt}) = Z^{-1} \text{cov}(r_{dt} - m_{mt}) \quad (2)$$

where  $E_t$  is the expectation operator,  $R_{mt}$  the return on market portfolio,  $R_{ft}$  the risk-free rate, and  $\text{var}_t(R_{mt} - R_{ft})$  the variance of the excess return on the market portfolio,  $r_{dt}$  and  $m_{mt}$  the excess return on the US domestic market portfolio and that of the world market portfolio, while  $\text{cov}$  stands for the covariance. Since the return on the world market portfolio can be expressed as:

$$m_{mt} = w_{dt}r_{dt} + (1 - w_{dt})r_{nt} \quad (3)$$

where  $w_{dt}$  is the weight on the excess return on the domestic market portfolio and is  $r_{nt}$  the excess return on the non-domestic (foreign) market portfolio, one can rewrite (2) by plugging (3) into it as follows:

$$E_t(r_{dt}) = Z^{-1}[w_{dt} \text{var}(r_{dt}) + (1 - w_{dt}) \text{cov}_t(r_{dt}, r_{nt})] \quad (4)$$

It is obvious now that if  $r_{dt}$  equation (4) is reduced to French et al. relation. However, if the covariance term is zero in (4), it is not the same case that French, Schwert, and Stambaugh (1989) had examined. Chan, Karolyi, and Stulz (1991) parameterize equation (4) as follows:

$$r_{dt} = \alpha_d + \beta_{dv}w_{dv}h_{dv} + \beta_{dc}(1 - w_{dv})h_{ct} + \theta_{d1}\varepsilon_{dt-1} + \theta_{d2}\varepsilon_{dt-2} + \varepsilon_{dt} \quad (5)$$

$$r_{nt} = \alpha_n + \beta_{nv}w_{nv}h_{nv} + \beta_{nc}(1 - w_{nv})h_{ct} + \theta_{n1}\varepsilon_{nt-1} + \theta_{n2}\varepsilon_{nt-2} + \phi_n\varepsilon_{dt-1} + \varepsilon_{nt} \quad (6)$$

where  $h_{dv}$  and  $h_{nv}$  are the variances and  $h_{ct}$  is the covariance, which depends upon past returns, lag structure of stochastic terms were introduced through  $\varepsilon$ , and  $\phi$  captured the effects of infrequent trading and non-synchronous trading hours. Making use of the general process, modeled after Baba, Engle, Kraft, and Kroner (1989), Chan et al. reported that their “tests are ... supportive of the hypothesis that markets are internationally integrated over sample period”they consider.”

Blenman (1991), in an interesting theoretical model, consisting of two countries in which one country’s market is perfectly competitive for everyone, including domestic and foreign investors, but the other country’s market is barrier-free for its domestic investors, but quite partitioned for foreign investors, derives a number of useful result in a unified exchange rate regime. It was shown that all investors’ risky assets hold a common factor share, appropriately weighted by their tastes. When they face further restrictions, their asset demands are modified to reflect those restrictions unless the variance-covariance matrix is block diagonal, and/or the restrictions mutually cancel each other, and/or the total risk tolerance factors are all zero.

Along these traditional routes some more works are noteworthy. Stulz (1995) discussed globalization of capital market and the cost of capital, which under a different fold extend the issue of international connectivity of markets. Portes, and Rey (1999) examined the determinants of cross-border equity, and Pagano, Roell, and Zechner (2001) looked at the geography of equity listing and

asked the question: Why do companies list abroad? In his Presidential Address to *American Finance Association*, published in *The Journal of Finance* (2005), Stulz re-examined the limits of financial globalization, and threw the issue of market integration or segmentation into further focus.

### 3.2 Investment Flow Matrix Approach

Following Leontief's celebrated structure, Ghosh and Khaksari (187) taken us to a new line of analytical framework of flow structure. Bringing that flow structure alive, one can examine the investment flows of investors of different countries into different capital markets existing across several nations under the assumption that individual investors are rational and they face no political risks with their investment funds. Let  $a_j$  be the amount of the investment funds in market  $i$  needed to buy one unit investment in market  $j$ ,  $X_j$  be the total investment units in market  $j$ , and  $Y_i$  be the amount of funds in market  $i$  kept exogenously for other purposes. Then the available funds balance can be stated as follows:

$$X_i = \sum_{j=1}^n a_j X_j + Y_i \tag{7}$$

To put (7) in matrix notation, we have

$$(I - A).X = Y \tag{7'}$$

where  $I$  is an  $n \times n$  identity matrix,  $A \equiv [a_j]_{n \times n}$  matrix,  $X$  and  $Y$  are  $n$ -element column vectors. The solution of (7') is given by:

$$X = (I - A)^{-1}.Y \tag{8}$$

or

$$X_i = \sum_{j=1}^n \omega_{ij}..Y_j \tag{8.1}$$

Here  $\omega_j$  is the  $ij$ -th element of the  $(I-A)$  inverse matrix.

Consider now that  $A$  matrix assumes one of the following forms:

$$A_1 \equiv \begin{bmatrix} a_{11} & 0 & 0 & \dots\dots & 0 \\ a_{21} & a_{22} & \dots\dots & 0 \\ \cdot & \cdot & & \cdot & 0 \\ \cdot & \cdot & & & 0 \\ a_{n1} & a_{n2} & \dots\dots & a_{nn} \end{bmatrix}, \quad A_2 \equiv \begin{bmatrix} a_{11} & a_{12} & \dots\dots & a_{1n} \\ 0 & a_{22} & \dots\dots & a_{2n} \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ 0 & 0 & \dots\dots & \vdots & a_{nn} \end{bmatrix},$$

$$A_1 \equiv \begin{bmatrix} a_{11} & a_{12} & 0 & \dots & 0 & 0 \\ a_{21} & a_{22} & 0 & \dots & 0 & 0 \\ 0 & 0 & a_{33} & a_{34} & 0 & 0 \\ 0 & 0 & a_{43} & a_{44} & \dots & 0 & 0 \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & \dots & \dots & a_{n-1,n-1} & a_{n-1,n} \\ 0 & 0 & \dots & \dots & a_{n,n-1} & a_{nn} \end{bmatrix}$$

If  $A \equiv A_1$ ,  $X_1$  is independent of other markets, but  $X_2$  depends on  $X_1$ , and  $X_3$  depends on  $X_1$ , and  $X_2$ , and so on. This sort decomposability of investment flow structure defines the first market as the “key” market that drives the rest of the world market. Mortgage meltdown in the US with its tentacles on other mortgage-backed securities appeared to have driven world markets down. If, on the other hand,  $A \equiv A_2$  then  $n$ -th market is obviously the key generator of the global market movements. If  $A$  assumes the form of  $A_3$ , we then have a number of subsets of the global markets, each subset being independent of the others. Here we find that (1, 2), (3,4), …, (n-1, n) markets are intra-subset integrated, and inter-subset segmented. However, if the flow matrix is not triangular (upper or lower), the key market can still be captured through the following indices of power of dispersion and sensitivity of dispersion, originally noted by Rasmussen (1956):

$$d_j = \frac{\left\{ (1/n) \sum_{i=1}^n \omega_{ij} \right\}}{\left\{ (1/n^2) \sum_{j=1}^n \sum_{i=1}^n \omega_{ij} \right\}} \quad \text{for } 1 \leq j \leq n \quad (9.1)$$

$$d_i = \frac{\left\{ (1/n) \sum_{j=1}^n \omega_{ij} \right\}}{\left\{ (1/n^2) \sum_{i=1}^n \sum_{j=1}^n \omega_{ij} \right\}} \quad \text{for } 1 \leq i \leq n \quad (9.2)$$

The index  $d_j$  defines the extent to which an increase in investment flow in market  $j$  is dispersed throughout the global economy. If  $d_j > 1$ , it signifies

that market  $j$  draws heavily on the system of markets (and conversely, if  $d_j < 1$ ). The index  $d_i$ , on the other hand, measures the extent to which the system of markets draws upon market  $i$ . If  $d_i > 1$ , it means that the  $i$ -th market is required to accommodate more investment funds than other markets corresponding to an exogenous increase in investment. These two indices serve well, but they are not without some weaknesses as they are un-weighted. To correct this deficiency, one can modify, for instance, the sensitivity of dispersion as follows:

$$d_i^w = \frac{\left\{ (1/n) \sum_{j=1}^n \omega_{ij} Y_j / \sum_{j=1}^n Y_j \right\}}{\left\{ (1/n^2) \sum_{i=1}^n \sum_{j=1}^n \omega_{ij} Y_j / \sum_{j=1}^n Y_j \right\}} \quad \text{for } 1 \leq j \leq n \quad (10)$$

### 3.3 Global and National Markets: The Relationship

Assume that markets are indexed  $h$  and  $i$  (where  $h = 1, 2, \dots, m$ ;  $i = 1, 2, \dots, n$ ) such that  $\{h\} \subset \{i\}$ , the balance holds for a nation, and for markets  $i$  balance holds for the world as a whole. That is,

$$(I - A).X = Y \quad (11)$$

For the world as a whole, and

$$\left[ (I^{NN} - A^{NN}) - A^{NW} \right] \begin{bmatrix} X^{N(d)} \\ X^{W(d)} \end{bmatrix} = YN(d) \quad (12)$$

for a nation,  $d$  ( $1 \leq d \leq n$ ), where

$$I^{NN} \equiv [\delta_{hk}]_{m \times m} \quad \delta_{hk} \text{ is the Kronecker delta that is,}$$

$$\delta_{hk} = 1 \quad \forall h = k; \delta_{hk} = 0 \quad \forall h \neq k$$

$$A^{NN} \equiv [a_{hk}]_{m \times m} \quad \text{for } h, k = 1, 2, \dots, m$$

$$A^{NW} \equiv [a_{hs}]_{m \times (n-m)} \quad X^{W(d)} \equiv \{X_h^{(d)}\}, X^{N(d)} \equiv \{X_s^{(d)}\},$$

$$Y^{N(d)} \equiv \{Y_h^{(d)}\} \quad \text{for } d (1 \leq d \leq n) : \text{national markets.}$$

From (11) one can get the following:

$$X^{N(d)} = (I^{NN} - A^{NN})^{-1} (Y^{N(d)} + A^{NW} X^{N(d)}) \quad (13)$$

Since  $(n - m)$  equations in (11) yield  $X^N = V^N Y$ , where

$X^N \equiv \{X_s\}$ ,  $[V^N V^W] \equiv (I - A)^{-1}$ ,  $m + 1 \leq s \leq n$ , equation (13) can be re-expressed as follows:

$$X^{N(d)} = (I^{NN} - A^{NN})^{-1} (Y^{N(d)} + A^{NW} (\beta_r^{(d)} \delta_{rs}) \cdot V^W Y) \quad (14)$$

provided the following proportionality holds:

$$X^{N(d)} = (\beta_r^{(d)} \delta_{rs}) X^N, r, s = m + 1, \dots, n, \text{ and } X^N \equiv \{X_s\}, m + 1 \leq s \leq n.$$

Following the procedure outlined earlier, one can compute the indices of power and sensitivity of dispersions of investment flows within this structure of global market network, and determine if markets are integrated or segmented. To support the above theoretical segments with the applications that are undertaken by other researchers, some parallel information may be given. For example, a variant of the above is empirically applied by Parhizgari (2002). Using equity data on the stock exchanges of seven regions and 18 countries for January 1982–October 2002, Parhizgari (2002) shows that substantial degrees of convergence have been achieved across the global stock markets over the noted period.

#### 4. Concluding Remarks

As noted in the introduction, empirical data are scarce and scant. This section needs to be written. This study was not capable of computing the indices that were presented in Section 3. It appears from the little we know that markets are substantially integrated with openness in trade transactions and more so by the portfolio investment. The countries seriously affected by the contagion are apparently created by the US and the countries with stock exchanges projecting the powers of securities trade world-wide.

The extensive securitization (or the creation of these asset-backed bonds) has eliminated the incentive for the originator of the loan to be credit sensitive. Thus, the loss experienced on these loans after securitization became no longer comparable to that experienced prior to securitization (called a “moral” hazard). Several trillion dollars investment in asset-backed bonds outstanding in the US was not all from the US investors alone, - a big chunk from the overseas institutions and individuals. Insurance companies, money managers and banks –

in the main – all reached for yields, given the excellent ratings for these bonds. What happens if air pocket is hit?

The legacy of Alan Greenspan has been cast into doubt with Senator Chris Dodd claiming he created the “perfect storm”, a professor at New York University and head of Roubini Global Economics, has said that if the economy slips into recession “then you have a systemic banking crisis like we haven’t had since the 1930s”. On September 7, 2007, the *Wall Street Journal* reported that Alan Greenspan has said that the current turmoil in the financial markets is in many ways “identical” to the problems in 1987 and 1998.

The Associated Press described the current climate of the market on August 13, 2007, as one where investors were waiting for “the next shoe to drop” as problems from “an overheated housing market and an overextended consumer” are “just beginning to emerge.” MarketWatch has cited several economic analysts with Stifel Nicolaus claiming that the problem mortgages are not limited to the subprime niche saying “the rapidly increasing scope and depth of the problems in the mortgage market suggest that the entire sector has plunged into a downward spiral similar to the subprime woes whereby each negative development feeds further deterioration”, calling it a “vicious cycle” and adding that they “continue to believe conditions will get worse”.

As of November 22, 2007, analysts at a leading investment bank estimated losses on subprime CDO would be approximately US\$148 billion. As of December 22, 2007, a leading business periodical estimated subprime defaults between US\$200-300 billion. As of March 1, 2008 analysts from three large financial institutions estimated the impact would be between US\$350-600 billion. Alan Greenspan, the former Chairman of the Federal Reserve, stated: “The current credit crisis will come to an end when the overhang of inventories of newly built homes is largely liquidated, and home price deflation comes to an end. That will stabilize the now-uncertain value of the home equity that acts as a buffer for all home mortgages, but most importantly for those held as collateral for residential mortgage-backed securities. Very large losses will, no doubt, be taken as a consequence of the crisis. But after a period of protracted adjustment, the U.S. economy, and the world economy more generally, will be able to get back to business.”

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