# FINANCIAL CRISIS OF 2007 AND CO-INTEGRATION OF GLOBAL MARKETS

**Ali Ashraf**[1]

Department of Economics and Finance, University of New Orleans
2000 Lakeshore Dr. College of Business Administration, New Orleans, LA 70148
E-mail Address: aashraf@uno.edu
E-mail Address: shuhan.ashraf@uno.edu

## ABSTRACT

Using a daily data set of stock market indexes and foreign exchange rates for twenty countries for a ten year period from July 02, 2001 to January 18, 2011, we analyze whether the global financial crisis of 2007 has any significant impact on the pattern of global market integration. Unit root tests of the stock market and foreign exchange show that these time series variables are, in general, I(1) process in all the three sample periods; a) overall sample, b) pre-crisis sample and c) post-crisis period. Engle and Granger (1987) residual based cointegration test results show that impact of global financial crisis on market integration is heterogeneous in these three sample periods. Out of twenty countries, eight countries (Austria; Canada, Hong Kong, Malaysia, India, Korea, Mexico and Norway) are cointegrated in all three periods while two others (Australia and China) are not cointegrated in any period. Remaining ten countries (Belgium, Brazil, France, Germany, Japan, Netherland, Sweden, Switzerland, Taiwan and United Kingdom) show variations in the cointegrating patterns across the three sample periods. Pedroni (2004) panel co-integration tests and Granger causality analysis exhibit similar patterns of cointegrating relationships.

## 1. INTRODUCTION

Cointegration of global financial markets is a frequently researched phenomenon in finance and economics literature. However, the recent financial crisis of 2007, because of its global nature, cointegration of global market is still an appealing research issue. Existing literature in market contagion and global market cointegration uses commonly used time series techniques; like: Vector Auto Regressive (VAR), Auto-Regressive Conditional Heteroscedacity (ARCH), and Cointegration analysis. However, econometricians [see: Pedroni(2004)] argue the consistency of such time series technique estimates once they are used on relatively shorter time horizon. Shiller and Perron (1985) find that shorter time horizon is the cause of such biases and use of high frequency data does not provide any remedy to such problem. Pedroni (2004) also provides evidence that; under the restrictive time horizon; drawing more cross-sectional information may

[1] Author is a PhD student at Financial Economics Program in University of New Orleans; and expected Job Market candidate in 2012. Author is personally thankful to Dr. Atsuyuki Naka and Dr. M. Kabir Hassan of University of New Orleans, and two anonymous referees of SouthWest Decision Sciences Institute (SWDSI) conference; and Ms. Janet L. Bailey, PhD, Associate Professor of MIS, University of Arkansas at Little Rock for their kind feedback. All remaining errors belong to the author. Comments are appreciated.

provide robust and consistent estimates. In such situation, Perron (2004) argues that a residual-based Panel Cointegration approach will be more appropriate and preferable to Johansen and Jesulius (1988, 1991) structural cointegration approach and Vector Error Correction Model (VECM) approach.

This paper analyzes whether the patterns of global market integration has changed following the financial crisis of 2007 or not. Our data set of consists of twenty countries over the period of July 02, 2001 to January 18, 2011 with 55,020 daily observations. We differ from the extant literature on market cointegration in three different ways.

First, we consider three combinations of the sample period from July 2001 to January 2011; a) before the financial crisis of 2007, b) after the financial crisis and c) the overall period; to enhance a complete understanding of the 2007 financial crisis. Second, we consider a simple model from the perspective of an US investor who chooses investment possibilities across different markets in the absence of any barrier to investment across the borders. Assuming that her domestic market returns i.e. US market returns represent her expected return, she chooses to invest in other market when foreign exchange adjusted return from that market exceeds her expectations. In such a case, we expect the co-integrating equation to capture a linear relationship between US market with foreign exchange and stock market in other countries.

Third, we consider the plausible biases from shorter time series nature of the data. As, post financial crisis data cannot be extended for obvious reason, in line with Pedronni (2004) criticism of time series techniques, we use Panel Cointegration technique that is novel initiative in this literature. To ensure that our Panel Cointegration estimates are consistent and comparable, we use the same technique for all the three periods.

Accordingly, this study may contribute to the extant literature on financial market cointegration in three ways. First, it may provide better understanding of whether and how the nature of global cointegration has fared during and around the financial crisis. Second, as we include exchange rate as a plausible source of transmission channel, it provides additional insight to what role currency exchanges have played in the market integration. Third and most importantly, the use Panel Cointegration technique, that is argued to be more consistent and least bias estimation technique to other time series tools during shorter time horizon data, may provide better empirics to the literature. A brief discussion on the existing literature and methodology follow this introductory section. Section three reports the empiric results and section four summarizes the key findings.

### 1.1 Literature Review

Integration of financial markets is a well-researched issue in finance literature. Many of the previous empirical works apply (Bessler & Yang, 2003; Kim & Rogers, 1995; Neaime, 2002) apply Vector Auto-Regressive (VAR), cointegration, Vector Error Correction Model (VECM), Granger causality, impulse response analysis, GARCH and other time series techniques. While the earlier empirical works focus on Granger-causality tests and VAR, recent studies like; Kim & Rogers (1995) and Neaime (2002) analyze the impact of market integration on security prices.

Bessler and Yang (2003) use a combination of Error Correction Modeling (ECM) and Directed Acyclic Graphs (DAG) to analyze the direction of causality between innovations across stock markets.

Cointegration, as a time series technique, is popularly used in finance literature. Engle and Granger (1987) lay down the theoretical framework and testing procedures of residual based testing procedure for cointegration. Later, Johansen (1988, 1991) presents system approach of cointegration tests. Although extensively used by the researchers, many of the cointegration tests are noted to have "inherently low power" when applied to time series for postwar period. Shiller and Perron (1985), Perron (1989, 1991), Pierse and Snell (1995) observe that low power of these tests is contributed by the relatively smaller span of data rather than its frequency. Pedroni (2004) discusses two possible solution; a) expanding time horizon, b) bringing in additional cross-sectional data of similar relevance rather additional time periods. In cases where time horizon may not be expanded, the latter may be more appropriate. However, number of cross-section increases, systems methods such as Johansen (1988, 1991) procedure may become infeasible and panel methods become more appropriate.

## 2. DATA AND METHODOLOGY

### 2.1 Data

Initially, exchange rate data for 25 countries and Return data for 28 Indexes from Federal Reserve St. Louis database; yahoo-finance and http://www.wessa.net/finmardata.wasp respectively. After matching the sample periods for each time series, a common sample period of Feb 07, 2001 to April 15, 2011 with number of daily observation for each panel is selected. Our final sample includes a total of 20 countries; a) 14 OECD member countries (Australia, Belgium, Canada, United Kingdom, France, Germany, Japan, Mexico, Netherland, Norway, South Korea, Sweden, Switzerland, and United States of America) and b) 06 Non-OECD economies (Brazil, China, Hong Kong, India, Malaysia and Taiwan). All the foreign exchange rates are based on indirect quote convention.

### 2.2 Long Run integration between US stock index and other markets

We rely on the theory of cointegration discussed in Engle and Granger (1987) that requires variables to be integrated at orders one. We use the augmented Dickey–Fuller (ADF) test to analyze whether the time series data of our sample are I(1) or not. The ADF test examines the null hypothesis that a time series $y_t$ is I(1) against the alternative that it is I(0), given the assumption that the data is ARMA process. The ADF test is based on estimating the test regression:

$$\Delta y_t = \beta'.D_t + \pi.y_{t-1} + \sum_{j=1}^{p} \varphi_j.\ \Delta y_{t-1} + \varepsilon_t \qquad (1)$$

where, $D_t$ is a vector of deterministic terms (constant, trend, etc.). For any variable to be I(1) process, variable is required to be non-stationary at its level but stationary at its first differences

otherwise. The two-step residual based cointegration tests of Engle and Granger requires the estimation of long-run cointegrating equation. In our case, we consider the following as the long-run equilibrium model;

$$y_{it} = \alpha_i + \beta_i . X_{it} + e_{it} \quad (2)$$

where, we consider that a linear relationship exists among US stock market index ($y_i$) and other country stock market index and respective foreign exchange rates (as vectors of $X_i$).

### 2.3 Pedroni (2004) residual based Panel Cointegration Tests

To address the constraint of smaller span of data, we use Panel Cointegration technique provided by Pedroni (2004) by allowing more time series data from different cross-sections. As we analyze the nature of market integration between US and other markets, in Panel Cointegration Technique, we allow possible heterogeneity in the intercept and slope terms of long run relationship. Pedroni (2004) discusses the basic equation as;

$$y_{it} = \alpha_i + \delta_i . t + \beta_i . X_{it} + e_{it} \quad (3)$$

where, $y_i$, and $X_{it}$ are time series panel of observables for members i = 1, .. , N over time periods t = I,.. , T; and $X_{it}$ is an 3-dimensional column vector for each member i (a constant, foreign county stock index and foreign exchange rate). Here, a) $\alpha_i$ and $\delta_i$ as the parameters of member specific fixed effects and deterministic trends and b) $\beta_i$ parameters are allowed to vary across the members of panel. Table 04 summarizes results for Pedroni (2004) Panel Cointegration test.

## 3 EMPIRICAL EVIDENCE

### 3.1 Unit Root Tests for Stock Indexes and Foreign Exchange rates

In Table 02, we report the lag structure and Augmented-Dickey-Fuller (ADF) test statistics for unit root tests (with and without trends) for the stock market indexes and exchange rates of respective countries for both their levels and first differences. In Panel A, B and C, we present the test statistics for three sample periods; a) overall sample period starting from 2/7/2001 to 1/18/2011; b) prior financial crisis sub-sample starting from 2/7/2001 to 7/31/2007 and c) the sample period following the financial crisis starting from 8/01/2007 to 1/18/2011; respectively.

Table 01 summarizes the key results. In general, time series process for most of the stock indexes and exchange rates are non-stationary at their levels but their first differences are stationary in all the sample periods. Korean exchange and Japanese exchange rates are the exceptions. Only for pre-financial crisis period, both of them are stationary at their levels. Another exception is Hong Kong foreign exchange rate that is stationary at its level for both overall sample period and after the financial crisis sample period.

**Table 01: Unit Root Test for Stock and Foreign Exchange Index at Level and First Differences**

In this table we report, Unit Root tests for the two variables; a) log of stock index and b) log of foreign exchanges for each of the corresponding countries. We report Augmented Dickey Fuller test and Phillip and Perron test for unit root where the null Hypothesis in each case is that the variable has unit root. A rejection of the null hypothesis means that the variable is otherwise stationary. All series represent sample period of February 07, 2001 to April 15, 2011 with 2500 daily observations. [*] Notation refers to MacKinnon (1996) one-sided p-values. ADF and PP are used as abbreviation of Augmented Dickey Fuller test and Phillip and Perron test for unit root respectively.

| | | Panel A: Sample 2/7/2001 to 1/18/2011 | | | | Panel B: Sample 2/7/2001 to 1/18/2011 | | | | Panel C: Sample 2/7/2001 to 1/18/2011 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | With trend | | With trend | | With trend | | With trend | | With trend | | With trend | |
| Country | Variable | Prob. | Lag | Prob. | Lag | Prob. | Lag | Prob. | Lag | Prob. | Lag | Prob. | Lag |
| Australia | Exch | 0.382 | 0 | 0.000 | 0 | 0.41 | 0 | 0.000 | 0 | 0.904 | 1 | 0.000 | 0 |
| | Stock | 0.861 | 0 | 0.000 | 0 | 0.97 | 1 | 0.000 | 0 | 0.898 | 0 | 0.000 | 0 |
| Brazil | Exch | 0.141 | 0 | 0.000 | 0 | 0.42 | 2 | 0.000 | 1 | 0.804 | 1 | 0.000 | 0 |
| | Stock | 0.499 | 1 | 0.000 | 0 | 0.91 | 1 | 0.000 | 0 | 0.865 | 0 | 0.000 | 0 |
| Canada | Exch | 0.488 | 0 | 0.000 | 0 | 0.13 | 0 | 0.000 | 0 | 0.784 | 0 | 0.000 | 0 |
| | Stock | 0.512 | 0 | 0.000 | 0 | 0.27 | 0 | 0.000 | 0 | 0.878 | 0 | 0.000 | 0 |
| China | Exch | 0.705 | 3 | 0.000 | 2 | 1.00 | 0 | 0.000 | 0 | 0.367 | 3 | 0.000 | 2 |
| | Stock | 0.840 | 0 | 0.000 | 3 | 1.00 | 0 | 0.000 | 0 | 0.913 | 0 | 0.000 | 0 |
| EU | Exch | 0.956 | 0 | 0.000 | 0 | 0.53 | 0 | 0.000 | 0 | 0.915 | 0 | 0.000 | 0 |
| Austria | Stock | 0.924 | 0 | 0.000 | 0 | 0.75 | 1 | 0.000 | 0 | 0.928 | 0 | 0.000 | 0 |
| Belgium | Stock | 0.738 | 0 | 0.000 | 0 | 0.61 | 0 | 0.000 | 0 | 0.497 | 0 | 0.000 | 0 |
| France | Stock | 0.546 | 1 | 0.000 | 0 | 0.49 | 0 | 0.000 | 0 | 0.840 | 1 | 0.000 | 0 |
| Germany | Stock | 0.383 | 0 | 0.000 | 0 | 0.83 | 0 | 0.000 | 0 | 0.909 | 0 | 0.000 | 0 |
| Netherlands | Stock | 0.462 | 0 | 0.000 | 0 | 0.65 | 0 | 0.000 | 0 | 0.930 | 0 | 0.000 | 0 |
| Hong Kong | Exch | 0.062 | 1 | 0.000 | 0 | 0.48 | 11 | 0.000 | 10 | 0.221 | 0 | 0.000 | 0 |
| | Stock | 0.203 | 0 | 0.000 | 0 | 0.16 | 0 | 0.000 | 0 | 0.835 | 0 | 0.000 | 0 |
| USA | Stock | 0.623 | 0 | 0.00 | 0 | 0.310 | 0 | 0.00 | 0 | 0.917 | 0 | 0.00 | 0 |
| India | Exch | 0.752 | 1 | 0.000 | 0 | 0.89 | 1 | 0.000 | 0 | 0.878 | 0 | 0.000 | 0 |
| | Stock | 0.284 | 1 | 0.000 | 0 | 0.47 | 0 | 0.000 | 1 | 0.860 | 0 | 0.000 | 0 |
| Japan | Exch | 0.334 | 0 | 0.000 | 0 | 0.60 | 0 | 0.000 | 0 | 0.058 | 0 | 0.000 | 0 |
| | Stock | 0.804 | 0 | 0.000 | 0 | 0.32 | 0 | 0.000 | 0 | 0.539 | 0 | 0.000 | 0 |
| Korea | Exch | 0.661 | 12 | 0.000 | 11 | 0.04 | 0 | 0.000 | 0 | 0.776 | 0 | 0.000 | 2 |
| | Stock | 0.440 | 0 | 0.000 | 0 | 0.89 | 0 | 0.000 | 2 | 0.784 | 0 | 0.000 | 0 |
| Malaysia | Exch | 0.729 | 0 | 0.000 | 0 | 0.99 | 5 | 0.000 | 4 | 0.926 | 0 | 0.000 | 0 |
| | Stock | 0.550 | 17 | 0.000 | 16 | 0.53 | 1 | 0.000 | 0 | 0.927 | 2 | 0.000 | 1 |
| Mexico | Exch | 0.340 | 0 | 0.000 | 0 | 0.71 | 0 | 0.000 | 0 | 0.868 | 0 | 0.000 | 0 |
| | Stock | 0.499 | 1 | 0.000 | 0 | 0.91 | 1 | 0.000 | 0 | 0.865 | 0 | 0.000 | 0 |
| Norway | Exch | 0.495 | 0 | 0.000 | 0 | 0.57 | 0 | 0.000 | 0 | 0.675 | 0 | 0.000 | 0 |
| | Stock | 0.822 | 0 | 0.000 | 0 | 0.80 | 0 | 0.000 | 0 | 0.933 | 0 | 0.000 | 0 |
| Sweden | Exch | 0.664 | 0 | 0.000 | 0 | 0.69 | 0 | 0.000 | 0 | 0.794 | 0 | 0.000 | 0 |
| | Stock | 0.563 | 0 | 0.000 | 0 | 0.62 | 0 | 0.000 | 0 | 0.925 | 0 | 0.000 | 0 |
| Switzerland | Exch | 0.318 | 0 | 0.000 | 0 | 0.72 | 0 | 0.000 | 0 | 0.390 | 0 | 0.000 | 0 |
| | Stock | 0.593 | 0 | 0.000 | 0 | 0.33 | 0 | 0.000 | 0 | 0.775 | 0 | 0.000 | 1 |
| Taiwan | Exch | 0.433 | 1 | 0.000 | 0 | 0.12 | 5 | 0.000 | 0 | 0.980 | 1 | 0.000 | 0 |
| | Stock | 0.402 | 0 | 0.000 | 0 | 0.40 | 0 | 0.000 | 4 | 0.821 | 0 | 0.000 | 0 |
| UK | Exch | 0.874 | 0 | 0.000 | 0 | 0.33 | 0 | 0.000 | 0 | 0.913 | 0 | 0.000 | 0 |
| | Stock | 0.384 | 4 | 0.000 | 3 | 0.36 | 0 | 0.000 | 0 | 0.754 | 0 | 0.000 | 0 |

### 3.2 Engle and Granger (1987) residual based Cointegration Tests

Engle and Granger (1987) explain that although two or more time series may be non-stationary individually, a linear combination of them may be stationary. i.e.; they may be cointegrated. To analyze the presence of cointegration, we follow the two step residual based cointegration tests as shown in Engle and Granger (1987). First, we estimate the long-run cointegrating relationship and then save the residuals. Then, we test for unit roots of the saved residuals series. Here null hypothesis is that the saved residual series are non-stationary. If we reject the null hypothesis of non-stationarity in residuals, then we conclude that a linear relationship exists between the time series variables and hence they are cointegrated. Table 02 reports Engle Granger (1987) residual based cointegration tests results for the twenty countries for three sample periods in Panel A, B and C; estimates of the cointegrating equations and $R^2$ values and ADF t-statistics and p-values for residuals series.

From Table 02, we note that three out of four EU countries; France, Germany and Netherlands show some similarities in their patterns. All of them are cointegrated in overall and pre-crisis period but not in post-crisis period. Taiwan and UK also show exhibit similar pattern with some difference in their significance. China and Mexico exhibit changes in signs for the coefficients of exchange rate and stock index in the long-run cointegrating equation.

**Table 02: Engle Granger (1987) Residual Based Cointegration Test Results**

In this table we report two step Residual Based Cointegration Test as given by Engle Granger (1987); where we estimate the long run cointegrating equation with OLS and save the residuals. Engle Granger (1987) test requires the residuals from this long run equation be I(0) i.e. to be stationary if the variables in the equation are cointegrated. We report Augmented Dickey Fuller tests for testing the unit roots of the saved residuals. In the following three panels; we present the coefficient estimates of the long run cointegrating equation, their t-stats and p-values, R-squared values and ADF stats for saved residuals for the selected three sample periods. We do conduct and discuss the results for all the mentioned countries; because of space constraint, we only report the following results. Panel A, Panel B and Panel C report results for overall sample, pre-crisis sample and post-crisis sample respectively.

| | | **Panel A: Sample 2/7/2001 to 1/18/2011** | | | | |
|---|---|---|---|---|---|---|
| | | **Cointegrating Equation** | | | | |
| **Country** | | **C** | **stock** | **exch** | **$R^2$** | **ADF** |
| Australia | Coeff | 48.99 | 0.37 | 1044.78 | 0.92 | |
| | p value | 0.29 | 0.00 | 0.00 | | 0.00 |
| Austria | Coeff | 4.02 | 0.47 | 0.28 | 0.80 | |
| | p value | 0.00 | 0.00 | 0.00 | | 0.15 |
| Belgium | Coeff | -1386.05 | 0.42 | 1977.91 | 0.76 | |
| | p value | 0.00 | 0.00 | 0.00 | | 0.18 |
| Brazil | Coeff | 1749.92 | 0.05 | -176.09 | 0.85 | |
| | p value | 0.00 | 0.00 | 0.00 | | 0.18 |
| Canada | Coeff | -10.49 | 0.25 | -153.99 | 0.92 | |
| | p value | 0.90 | 0.00 | 0.00 | | 0.00 |
| China | Coeff | 3753.00 | 0.32 | -280.09 | 0.50 | |
| | p value | 0.00 | 0.00 | 0.00 | | 0.42 |

**Table 02: Engle Granger (1987) Residual Based Cointegration Test Results**

| | | Panel B: Sample 2/7/2001 to 7/31/2007 | | | | | Panel C: Sample 8/01/2007 to 1/18/2011 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cointegrating Equation | | | | | Cointegrating Equation | | | | |
| **Country** | | **C** | **stock** | **exch** | **$R^2$** | **ADF** | **C** | **stock** | **exch** | **$R^2$** | **ADF** |
| Australia | Coeff | -400.48 | 0.54 | 437.57 | 0.96 | | -1403.01 | 0.29 | 3179.66 | 0.84 | |
| | p value | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 |
| Austria | Coeff | 1223.09 | 0.44 | -213.08 | 0.89 | | 2167.01 | 0.55 | -704.87 | 0.68 | |
| | p value | 0.00 | 0.00 | 0.00 | | 0.32 | 0.00 | 0.00 | 0.00 | | 0.22 |
| Belgium | Coeff | -872.97 | 0.58 | 1046.19 | 0.95 | | 1326.71 | 0.44 | 116.60 | 0.46 | |
| | p value | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 | 0.49 | | 0.59 |
| Brazil | Coeff | 1699.63 | 0.07 | -199.91 | 0.96 | | 2635.31 | 0.06 | -886.81 | 0.72 | |
| | p value | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0.02 |
| Canada | Coeff | -281.56 | 0.25 | 23.21 | 0.94 | | 5188.46 | 0.12 | -3632.07 | 0.84 | |
| | p value | 0.00 | 0.00 | 0.53 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 |
| China | Coeff | 26026.49 | -0.11 | -2916.81 | 0.85 | | 701.94 | 0.33 | 139.88 | 0.44 | |
| | p value | 0.00 | 0.00 | 0.00 | | 0.12 | 0.18 | 0.00 | 0.08 | | 0.50 |

Pattern of cointegration across the twenty selected countries is not homogenous in the three sample periods. Australia and China do not exhibit enough evidence of cointegration in any of the three sample periods. However, countries like; Austria; Canada, Hong Kong, Malaysia, India, Korea, Mexico and Norway, are cointegrated in all three periods. For other countries, like; Belgium, Brazil, France, Germany, Japan, Netherland, Sweden, Switzerland, Taiwan and United Kingdom, cointegration patterns show some variations among the overall sample period, and pre-crisis and post-crisis sample period. For example; Belgium is not cointegrated in overall and post-crisis period but is cointegrated during the pre-crisis period. On the other hand, Brazil is not cointegrated in overall sample, but cointegrated in pre- and post-crisis periods. Japan is cointegrated in overall sample period but not in pre- and post-crisis periods.

### 3.3 Granger Causality Analysis

We conduct Granger Causality tests for each country in the three sample periods; a) overall sample, b) pre-crisis sample and c) post-crisis sample. For each country, we test six possible hypotheses for each sample period. However, hypotheses of; a) individual country stock index and SNP index vis-à-vis Granger cause each other and b) a) individual country stock index and exchange rates vis-à-vis Granger cause each other; are economically more meaningful to us. To summarize, SNP index and respective country Stock index vis-à-vis Granger causality is affected for Japan, Austria, Belgium, Malaysia, Brazil, Mexico, Canada, China, Norway, France, Sweden, Germany, Hong Kong during post-crisis sample period. Exchange rate and respective country stock index vis-à-vis Granger causality is affected for Austria, Korea, Canada, Netherland, France, Sweden, Germany, Switzerland, Taiwan during post-crisis sample. Due to space constraint, detailed results of Granger Causality tests are not reported.

### 3.4 Pedroni (2004) Residual based Panel Cointegration Test

Shiller and Perron (1985), Perron (1989, 1991), Pierse and Snell (1995) observe that smaller span of data, rather than frequency, is a cause of "low power of these tests". Pedroni (2004)

discusses panel cointegration approach to address this low power issue of cointegration test by bringing in additional cross-sectional data of similar relevance rather additional time periods. Panel A and B of Table 03 presents the Pedroni (2004) panel cointegration test of total eleven test statistics; a) four weighted and b) four un-weighted statistics for panel slope terms and panel intercept terms, panel ADF statistics and Panel PP statistics; and c) three group slope, PP and ADF statistics.

**Table 03: Pedroni (2004) (Engle and Granger residual based) Panel Cointegration Test**

Alternative hypothesis: common AR coeffs. (within-dimension).
Alternative hypothesis: individual AR coeffs. (between-dimension) for Group

| | **Full** | | | | **Before** | | | | **After** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Panel A: Individual Intercept** | | | | | | | | | | | |
| | **Stat.** | **Prob.** | **Wght. Stat.** | **Prob.** | **Stat.** | **Prob.** | **Wght. Stat.** | **Prob.** | **Stat.** | **Prob.** | **Wght. Stat.** | **Prob.** |
| Panel v-Stat | 7.344 | 0.000 | -5.099 | 0.000 | 6.492 | 0.000 | -5.139 | 0.000 | 1.953 | 0.059 | -5.141 | 0.000 |
| Panel rho-Stat | -6.625 | 0.000 | 1.435 | 0.143 | -7.559 | 0.000 | -1.327 | 0.165 | -2.661 | 0.012 | 1.490 | 0.131 |
| Panel PP-Stat | -4.554 | 0.000 | 1.486 | 0.132 | -5.130 | 0.000 | -1.080 | 0.223 | -2.194 | 0.036 | -0.598 | 0.334 |
| Panel ADF-Stat | -5.367 | 0.000 | 0.857 | 0.276 | -6.203 | 0.000 | -1.323 | 0.166 | -2.399 | 0.023 | -1.016 | 0.238 |
| Group rho-Stat | -8.672 | 0.000 | | | -7.232 | 0.000 | | | -4.944 | 0.000 | | |
| Group PP-Stat | -5.787 | 0.000 | | | -5.513 | 0.000 | | | -3.464 | 0.001 | | |
| Group ADF-Stat | -7.043 | 0.000 | | | -7.121 | 0.000 | | | -3.869 | 0.000 | | |
| | **Panel B: Individual Intercept and Trend** | | | | | | | | | | | |
| | **Stat.** | **Prob.** | **Wght. Stat.** | **Prob.** | **Stat.** | **Prob.** | **Wght. Stat.** | **Prob.** | **Stat.** | **Prob.** | **Wght. Stat.** | **Prob.** |
| Panel v-Stat | 8.347 | 0.000 | -7.466 | 0.000 | 4.426 | 0.000 | -7.475 | 0.000 | 2.677 | 0.011 | -7.476 | 0.000 |
| Panel rho-Stat | -11.859 | 0.000 | -5.037 | 0.000 | -5.121 | 0.000 | -6.658 | 0.000 | -9.446 | 0.000 | 1.482 | 0.133 |
| Panel PP-Stat | -8.513 | 0.000 | -4.600 | 0.000 | -3.701 | 0.000 | -5.616 | 0.000 | -7.331 | 0.000 | 0.004 | 0.399 |
| Panel ADF-Stat | -8.740 | 0.000 | -4.837 | 0.000 | -5.423 | 0.000 | -4.493 | 0.000 | -7.194 | 0.000 | -0.755 | 0.300 |
| Group rho-Stat | -11.618 | 0.000 | | | -5.245 | 0.000 | | | -10.55 | 0.000 | | |
| Group PP-Stat | -8.781 | 0.000 | | | -3.936 | 0.000 | | | -8.133 | 0.000 | | |
| Group ADF-Stat | -9.226 | 0.000 | | | -5.828 | 0.000 | | | -8.141 | 0.000 | | |

Tests results in Panel A in overall sample and pre-crisis sample period are generally similar. Three weighted panel statistics are insignificant in contrast to the remaining eight tests favoring a rejection of the null hypothesis of no cointegration. For post-crisis sample, four of the eleven statistics are insignificant and we conclude that unlike the other two sample period, there is weaker evidence of cointegration in the panel data. Interpretation of Panel B is pretty straightforward. For both overall and pre-crisis sample periods, all the eleven test statistics are significant implying strong evidence of cointegration in the panel data. However, in post-crisis sample, three weighted group statistics are insignificant. Results are generally consistent with the heterogeneous patterns of two step residual based cointegration tests of Engle and Granger (1987) for each of the twenty countries over the three sample periods that we discuss in earlier section.

## 4 CONCLUSION

Using daily stock index and foreign index data from July 02, 2001 to January 18, 2011, we analyze the nature of global market integration. To analyze the impact of global financial crisis

of 2007, we consider three samples: a) a pre-crisis sample from July 02, 2001 to July 31, 2007; b) a post-crisis sample from August 1, 2007 to January 18, 2011; and c) the overall sample. Results show that, in general, time series process for most of the stock indexes and exchange rates are non-stationary at their levels but their first differences are stationary, i.e. I(1) process in all the sample periods. Only Korean exchange and Japanese exchange rates are the exceptions. Both of them are stationary at their levels only for pre-financial crisis period.

Results from Granger (1987) two-step residual based cointegration tests show that pattern of cointegration across the twenty selected countries is not homogenous in the three sample periods. Eight out of the twenty countries (Austria; Canada, Hong Kong, Malaysia, India, Korea, Mexico and Norway) are cointegrated in all the three periods while two countries (Australia and China) are not cointegrated in any period. The remaining ten countries (Belgium, Brazil, France, Germany, Japan, Netherland, Sweden, Switzerland, Taiwan and United Kingdom) show variations in the cointegrating patterns among the overall sample period, and the pre-financial crisis and the post-financial crisis sample period. Three out of four EU countries; France, Germany and Netherlands show some similarities in their patterns. All of them are cointegrated in overall and pre-crisis period but not in post-crisis period.

Results from Pedroni (2004) Panel cointegration tests are consistent with the country-wise patterns in market cointegration. Among the three sample periods, four out of the eleven panel cointegration test statistics are not statistically significant compared to all otherwise significant in overall and pre-crisis period. We conclude that unlike in the overall and pre-crisis sample periods, evidence of cointegration in the panel data is weaker for post-crisis sample period. Although such results are anecdotal considering the trend of increasing market integration among global markets, evidence of weak integration may be explained by the variant monetary impact imparted by individual countries that can be explored in future research.

## LIST OF REFERENCE


Pedoroni, P., 2004, Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series with and Application to the PPP Hypothesis, Econometric Theory, 597-625

Jeron, T, B. N., and Li, H., 2007, Dynamic correlation analysis of financial contagion: Evidence from Asian markets, Journal of International Money and Finance, 1206-1228

Piazzesi, M. and Eric Swanson, 2008, Futures prices as risk-adjusted forecasts of monetary policy, Journal of Monetary Economics, 677-691

Lucey, B. M., and Voronkova, S., 2008, Russian equity market linkages before and after the 1998 crisis: Evidence from stochastic and regime-switching cointegration tests, Journal of International Money and Finance, 1303–1324

Forbes, K. J., and Chinn, M. D., 2003, A decomposition of global linkages In financial markets over time, NBER Working Paper 9555

Narayan, P.K., Narayan, S., and Mishra, S., 2011, Do market capitalization and stocks traded converge? New global evidence, Journal of Banking & Finance

Yu, J., and Hassan, M.K., 2008, Global and regional integration of the Middle East and North African (MENA) stock markets, The Quarterly Review of Economics and Finance, 482–504