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IDENTIFYING COMOVEMENTS AMONG INTERNATIONAL FINANCIAL MARKETS DURING GLOBAL FINANCIAL CRISIS 2008-2009

Hakimzadi Wagan[1]*, . Aijaz Ali Khuharo[1], Zulfiqar Ali[2] , Shahid Hussain Abro[1], Rani Abro[1], Bakhtawar[1]

[1]Sindh Agriculture University Tando Jam 70060, Hyderabad, Sindh, Pakistan

[2]Hefei University of Technology, China

* Corresponding author E-mail : hakimzadi@gmail.com

ABSTRACT: *This study examines the Time Varying Dynamic Conditional Correlations among the returns of short term Money Market Rates (MMR), Real Effective Exchange Rates (REER), and of other asset classes, including, Stock Market Indices and Real Estate Investment Trusts (REITs) Indices during the Dot-com Bubble (2000) and Recent Global Financial Crisis (2008-2009). We employ Dynamic Conditional Correlations MGARCH (DCC MGARCH) model, proposed by Engle [1] using monthly data from January, 1999 to May, 2015 for the U.S., Canada and Germany. The estimation results reveal that correlations among these markets are dynamic and time varying. Furthermore, we show that in most of the markets the linkage is of a positive type accompanied by an evidence of extreme movements and distortions during Stock Market Crash (2000-2001) and Global Financial Crisis (2008-2009). Our findings show a degree of interdependence and volatility spillovers among these markets, suggesting that interest rate and exchange rate policies should not be implemented without taking into consideration the repercussions on the other financial markets or the other way round*.

Key words: Financial Markets**,** Global Financial Crisis, Co-movement, MGARCH

INTRODUCTION

Financial crisis, let it be of any type, are not a novel phenomenon in any case. But the main difference lies in the speed and severity with which these crises are transmitted beyond the local boundaries. The recent Global Financial Crisis (2008-2009, henceforth GFC), worst since the Great Depression, has caused unbelievable financial losses and the global recession.

Most of the economists, financial investors and policy analysts are interested in answering the questions:

1. *Has the growing financial market integration increased the general level of correlation over the last decade?*
2. *Have the correlation increased during 2000 Stock Market Bubble and the GFC?*

This study is an attempt to answer above questions.

This paper examines the impact of extreme events such as Stock Market Bubble (2000, henceforth SMB) and recent Global Financial Crisis on interest rates (Effective Federal Funds Rate henceforth EFFR and 3 month MMR), Real Estate Investment Trusts (REITs), Real Effective Exchange Rate (REER) and Stock Market Indices.

We study how the dynamic correlations among these markets have changed over the crisis period. As in the wake of recent crisis and global recessionary pressures most of the central banks of developed countries have been pursuing very loose monetary policy instance to counter recessionary trends since 2007, in this present scenario understanding how the change in instrumental rate (EFFR) leads to equity portfolio revaluation decisions by investors and exchange rate depreciation.

"The most direct and immediate effects of monetary policy actions, such as changes in the Federal funds rate, are on the financial markets; by affecting asset prices and returns, policymakers try to modify economic behavior in ways that will help to achieve their ultimate objectives." Bernanke and Kuttner [2].

Change in discount rate impacts exchange rates and short term interest rates which in turn influence borrowing costs, stock prices, investment in REITs and finally the overall economic activity. During the Recent Financial Crisis, there has been rapidly growing interest in co-movements among different financial markets, for instance among Federal Funds Rate, stock market returns, exchange rates and REITs, as relationships among these variables have financial as well as economic implications such as pricing currency options (Schleicher [3] Case et al. [4]) and for the central banks to achieve their objectives related to real economy and inflation.

We apply Dynamic Conditional Correlations Multivariate GARCH (DCC-MGARCH) using monthly data from January, 1999 to May, 2015 to estimate the degree of time-varying correlations of above mentioned variables for US and its possible spillover effect on the respective markets in other OECD member countries. Event related risk has major implications for change in stock prices, market volatility and hence has an important influence on optimal portfolio strategy. Research suggests that jump in asset prices and volatility in returns impact correlations between asset returns, in national as well as international markets by possible contagion which have important effects on optimal portfolio in terms of diversification.

This study contributes to existing literature on financial contagion in different ways. First, we study the financial contagion during the most recent crisis, i.e. US SMB and GFC, whereas most of the literature on the financial contagion focuses on East Asian Crisis (1990's). Second, by considering a large set of countries, we provide a thorough understanding of the possible contagion effects of US financial crisis. Third, this model has advantages over the other traditional methods such as Vector Auto Regression (VAR) or co-integration, which explains the hazy relationship between the discount rate and stock prices, but these techniques are unable to incorporate the characteristics of volatility itself. Our model has many advantages over the other models such as Bollerslev [5] constant conditional correlations model, where time dependent conditional correlation matrix is positive definite for each point in time and also the number of parameters grow linearly. Fourth, departing from most of the previous studies which focus on correlation between short term interest rates and stock prices based on single country data, we study the possible impact of interest rates on real effective exchange rates, stock prices

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and REITs in US and its possible spillover effects through these financial linkages on Canada and Germany.

DATA AND DESCRIPTIVE STATISTICS This study uses monthly time-series data from January, 1999 to May, 2015 for the USA, Canada, and Germany. The sample period is selected to study the Stock Market Bubble (2000) and Recent Global Financial Crisis (2008-2009). Our dataset comprising four categories of variables namely short term interest rates, exchange rates, stock market indexes and REIT Indexes is drawn from different data sources: Thomson-Datastream, official websites of Bank for International Settlements (BIS), Federal Reserve Bank of St. Louis and the FTSE Group (The Financial Times and the London Stock Exchange).

As the stance of monetary policy, we use Effective Federal Funds Rate (EFFR) for US, series is extracted from Federal Reserve Bank of St. Louis and 3 month MMR for rest of the countries which is taken from Thomson-Datastream. For exchange rates we use BIS real effective exchange rate (REER), broad indices, series is downloaded from the Bank for International Settlements (BIS) for all the countries in our dataset market indexes. The data for REITs for each country is extracted from FTSE EPRA/NAREIT Global Real Estate Index Series.

All the indices are taken in national currencies. Following the traditional approach, we compute the asset returns as the difference of natural logarithms for each price index and express returns in terms of percentages.

Table 1 highlights the descriptive statistics related to returns of variables used, which are in turn subcategorized under their respective country heading. The Jarque Bera test for normality based upon the skewness and kurtosis for the returns of all the variables and all the countries reject the hypothesis of normally distributed returns. This fact forms a strong basis for the use of Quasi Maximum

Likelihood (QML) method of Bollerslev and Wooldridge [6] to the GARCH DCC model parameters.

METHODOLOGY

To measure the degree of co-movement time-varying correlation coefficients, we apply DCC-MGARCH model. Tse and Tsui [7] attempted to model both variants and conditional correlations of several series using the DCC-MGARCH process. The multivariate model is defined as follows:

$$X_t = \mu_t + H_t^{1/2}\varepsilon_t \qquad (1)$$

With:

(2)

$$\begin{cases} H_t = D_t R_t D_t^{'} \\ R_t = (diag(Q_t))^{-1/2} Q_t (diag(Q_t))^{-1/2} \\ D_t = diag(\sqrt{h_{11,t}}, \sqrt{h_{22,t}}, \ldots, \sqrt{h_{NN,t}}) \end{cases}$$

X_t is the vector of the past observations.

μ_t is the vector of the conditional returns.

ε_t is the vector of the standardized residuals.

R_t is a symmetric dynamic correlations matrix.

D_t is a diagonal matrix of conditional standard deviations for each of the returns series.

RESULTS

Table 2 presents Pearson correlations among the variables under study. The correlation between US Federal Funds Rate and Money Market Rate is positive. In this part we study the relationship between US FFR and the REERs of all three countries. In U.S, we observe negative Pearson's correlation between US FFR and US REER with a coefficient of -0.087 which is slightly less than the average time varying dynamic conditional correlation of -0.086. The Pearson's correlation and average TV DCC between US FFR and REER of Canada remain positive whereas for Germany remain negative. The dynamic correlations coefficient between US FFR and REER reached at its lowest level (maximum negative correlation) of -0.78 for Germany during the period of global financial crisis.

In the U.S., we observe Pearson's correlation between US FFR and US REIT with a coefficient of 0.46 which is slightly more than the average time varying dynamic conditional correlation of 0.459. As expected, this correlation is highly distorted during the financial crisis where it reaches to its maximum level of 0.708 and the minimum level of 0.304. It is quite interesting to observe that the Canadian REIT is more correlated to US FFR than the U.S REIT. The average TV DCC US FFR and Canadian REIT coefficient is 0.56 which reached its maximum and minimum level of 0.842 and 0.483 respectively during the recent crisis.

Correlations between US FFR and Stock Market Indices are positive for all the countries under study. In U.S, we observe Pearson's correlation between US FFR and US Dow Jones with a coefficient of 0.205 which is slightly more than the average time varying dynamic conditional correlation of 0.204. As expected, this correlation is highly distorted during the financial crisis where it reaches to its maximum level of 0.489 and the minimum level of 0.117. It is quite interesting to observe that the stock market of Canada and Germany are more correlated to US FFR than the U.S Dow Jones. The average US FFR and Canada TSX time varying dynamic correlation DCC coefficient is 0.56 which reached its maximum and minimum level of 0.73 and 0.324 respectively during the financial crisis. The Pearson's correlation and the average time varying dynamic conditional correlations between MMR and REIT Indices are positive except Canada. There is no clear direction of the relationship between REER and REIT Indices. In the US and Germany we find a negative correlation between these variables, whereas in Canada we find positive correlations.

In the case of correlation between REER and Stock Markets we are unable to define the direction of correlation as in some countries we find a negative correlation such as in U.S and Germany whereas in the Canada we find positive correlation. The highest positive Pearson's correlation coefficient is 0.47 between Canadian REER and Canadian TSX Index, which is slightly less than the average TV DCC coefficient of 0.472, whereas the maximum negative Pearson's correlation coefficient of -0.45 is observed in U.S which is slightly more negative than the average TV DCC coefficient of -0.449. During the period of financial crisis we observe some extreme movements. For example, in Canada the TV DCC coefficient reached the highest level of 0.68 compared to any other countries. The Pearson's correlation and the average

time varying dynamic conditional correlations between REIT Indices and Stock Market Indices are positive for all the countries under study. Highest positive Pearson's correlation coefficient is 0.652 between Canadian REIT and Canadian TSX which is slightly higher than the average TV DCC coefficient of 0.650. Finally, we observe that stock markets in Canada and Germany are more correlated to the US FFR than the MMR in their own country.

CONCLUSION

This paper investigates how the increasing financial market integration has changed the general level of correlations among interest rates (EFFR and 3 month MMR), REITs, REER and Stock Market Indices and establishing an empirical linkage among these markets in the wake of SMB and GFC by modeling the evolution of correlations among the U.S., Canada and Germany. We found that correlations among these markets are changing. Second, as a novel result, we show that in most of the markets the linkage is of a positive type accompanied by an evidence of extreme movements and distortions during above extreme events. The correlation between USFFR and MMR of U.S., Canada and Germany is positive and increased significantly during 2008-2010. The Pearson's correlation and average TV DCC are positive between certain markets such as between USFFR, REIT and Stock Market Indices. A very interesting finding in this regard is that Canadian REIT is more correlated to USFFR than US REIT, whereas while describing the linkage between some markets for instance linkage between MMR and REER, REIT, Stock Market Indices is mixed ranging from positive to negative relationship.

Third we do not find clear direction of relationship between REER and REIT Indices, Stock Market Indices for which the evidence is mixed for countries under study. Our results provide useful insights into the nature of transmission channels of financial contagion during Global Financial Crisis by understanding which factors were responsible for spillover effects on international financial markets during crisis period. Our findings also have policy implications for portfolio management and policy makers too, suggesting that interest rates and exchange rate policies should be implemented while taking into consideration the repercussions on the stock markets or the other way round.

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Annexure

Table 1: Descriptive statistics of OECD Economies

United States				
	R_US_EFFR	R_US_REER	R_US_REIT	R_US_DJ
Mean	-0.03	0.00	0.00	0.00
Maximum	0.38	0.05	0.38	0.14
Minimum	-0.91	-0.04	-0.46	-0.31
Std. Dev.	0.15	0.01	0.09	0.05
Skewness	-3.17	0.34	-1.17	-1.47
Kurtosis	19.46	5.06	14.76	10.40
Jarque-Bera	1919.57***	29.01***	886.82***	391.95***
CANADA				
	R_CAN_MMR	R_CAN_REER	R_CAN_REIT	R_CAN_TSX
Mean	-0.01	0.00	0.01	0.01
Maximum	0.53	0.06	0.21	0.15
Minimum	-0.66	-0.09	-0.38	-0.19
Std. Dev.	0.14	0.02	0.07	0.05
Skewness	-1.51	-0.70	-1.86	-0.10
Kurtosis	12.50	7.98	12.50	5.19
Jarque-Bera	613.37***	165.40***	642.32***	49.69***

GERMANY				
	R_GR_MMR	R_GR_REER	R_GR_REIT	R_GR_DAX
Mean	-0.01	0.00	0.00	0.00
Maximum	0.15	0.03	0.36	0.17
Minimum	-0.33	-0.02	-0.32	-0.23
Std. Dev.	0.07	0.01	0.08	0.07
Skewness	-1.46	0.61	-0.14	-0.67
Kurtosis	7.61	3.68	6.23	3.80
Jarque-Bera	183.80***	11.98***	64.98***	14.96***

Note: ***, ** and * indicate statistical significance at 1%, 5% and 10% level in Table 1, 3, 4 and 5 respectively.

Table 2: Unconditional Correlations among OECD Economies

UNITED STATES					
	R_US_EFFR	R_US_REER	R_US_REIT	R_US_DJ	
R_US_EFFR	1				
R_US_REER	-0.09	1			
R_US_REIT	0.46	-0.08	1		
R_US_DJ	0.20	-0.45	0.34	1	
CANADA					
	R_US_EFFR	R_CAN_MMR	R_CAN_REER	R_CAN_REIT	R_CAN_TSX
R_US_EFFR	1				
R_CAN_MMR	0.19	1			
R_CAN_REER	0.32	0.06	1		
R_CAN_REIT	0.57	-0.07	0.48	1	
R_CAN_TSX	0.49	-0.08	0.47	0.65	1
GERMANY					
	R_US_EFFR	R_GR_MMR	R_GR_REER	R_GR_REIT	R_GR_DAX
R_US_EFFR	1				
R_GR_MMR	0.17	1			
R_GR_REER	-0.16	-0.08	1		
R_GR_REIT	0.37	0.08	-0.12	1	
R_GR_DAX	0.27	0.16	-0.14	0.54	1

Table 3: DCC GARCH Results for U.S

	Coeff	Std Error	T-Stat
μ_1	0.013*	(0.008)	1.617
μ_2	-0.001*	(0.001)	-1.601
μ_3	0.014***	(0.003)	4.762
μ_4	0.007***	(0.000)	141.417
ω_1	0.003***	(0.001)	2.730
ω_2	0.000***	(0.000)	8.355
ω_3	0.001***	(0.000)	8.020
ω_4	0.007***	(0.000)	83.189
α_i	1.961***	(0.374)	5.236
α_2	0.063*	(0.050)	1.263
α_3	0.220***	(0.028)	7.741
α_4	0.090***	(0.000)	44.935
β_1	0.039***	(0.010)	3.860
β_2	0.752***	(0.008)	91.600
β_3	0.720***	(0.035)	20.100
β_4	-0.505***	(0.005)	-104.624
θ_1	0.022***	(0.006)	3.416

θ_2	0.201***	(0.016)	12.588

Table 4: DCC GARCH Results for Canada

	Coeff	Std Error	T-Stat
μ_1	0.014***	0.005	2.734
μ_2	0.005***	0.001	3.549
μ_3	0.004***	0.001	3.305
μ_4	0.022***	0.003	7.645
μ_5	0.013***	0.003	5.039
ω_1	0.003***	0.0002	15.165
ω_2	0.000	0.000	1.530
ω_3	0.000***	0.000	460.744
ω_4	0.001***	0.000	16.429
ω_5	0.000***	0.000	15.036
α_i	1.239***	0.149	8.314
α_2	1.957***	0.136	14.392
α_3	0.051***	0.010	5.111
α_4	0.427***	0.059	7.189
α_5	0.201***	0.034	5.897
β_1	0.083***	0.030	2.746
β_2	0.277***	0.026	10.592
β_3	0.850***	0.011	74.587
β_4	0.370***	0.038	9.836
β_5	0.734***	0.025	29.388
θ_1	0.034***	0.017	2.023
θ_2	0.563***	0.216	2.607

Table 5: DCC GARCH Results for Germany

	Coeff	Std Error	T-Stat
μ_1	-0.062***	0.009	-6.387
μ_2	-0.013**	0.005	-2.474
μ_3	0.000	0.001	0.319
μ_4	0.014***	0.005	3.004
μ_5	0.001	0.005	0.276
ω_1	0.008***	0.001	14.031
ω_2	0.002***	0.001	9.756
ω_3	0.000***	0.000	7.597
ω_4	0.003***	0.000	11.559

ω_5	0.003***	0.000	5.979
α_i	0.145***	0.027	5.470
α_2	0.109***	0.009	11.443
α_3	0.070*	0.136	0.518
α_4	0.108***	0.009	10.976
α_5	0.346***	0.104	3.342
β_1	0.292***	0.038	7.582
β_2	0.307***	0.051	6.057
β_3	0.117*	0.105	1.118
β_4	0.304***	0.040	7.514
β_5	0.206**	0.080	2.567
θ_1	0.697***	0.006	22.860
θ_2	0.388***	0.028	5.870

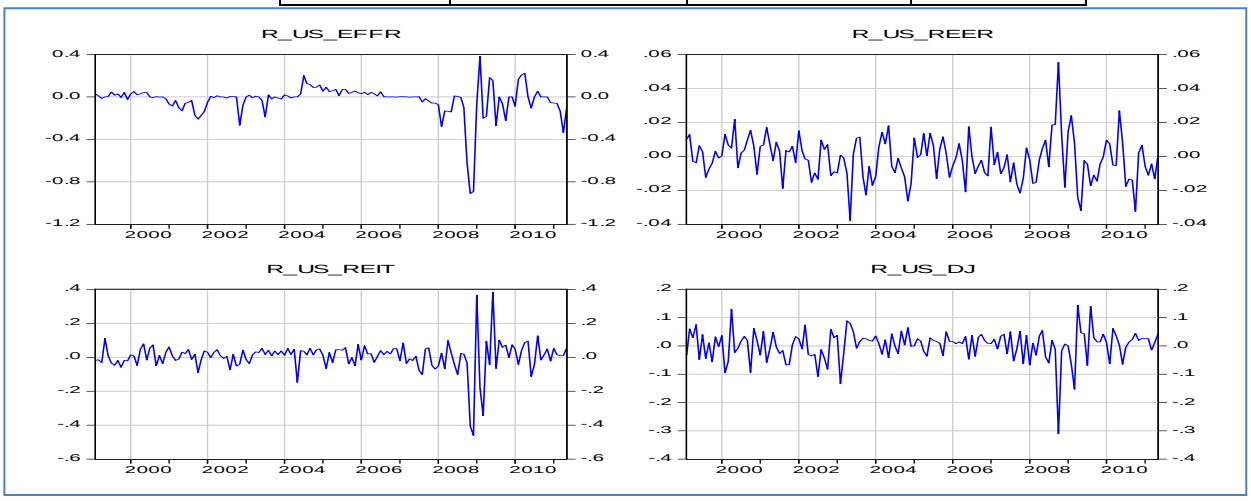

Figure 1: Returns of Variables – U.S

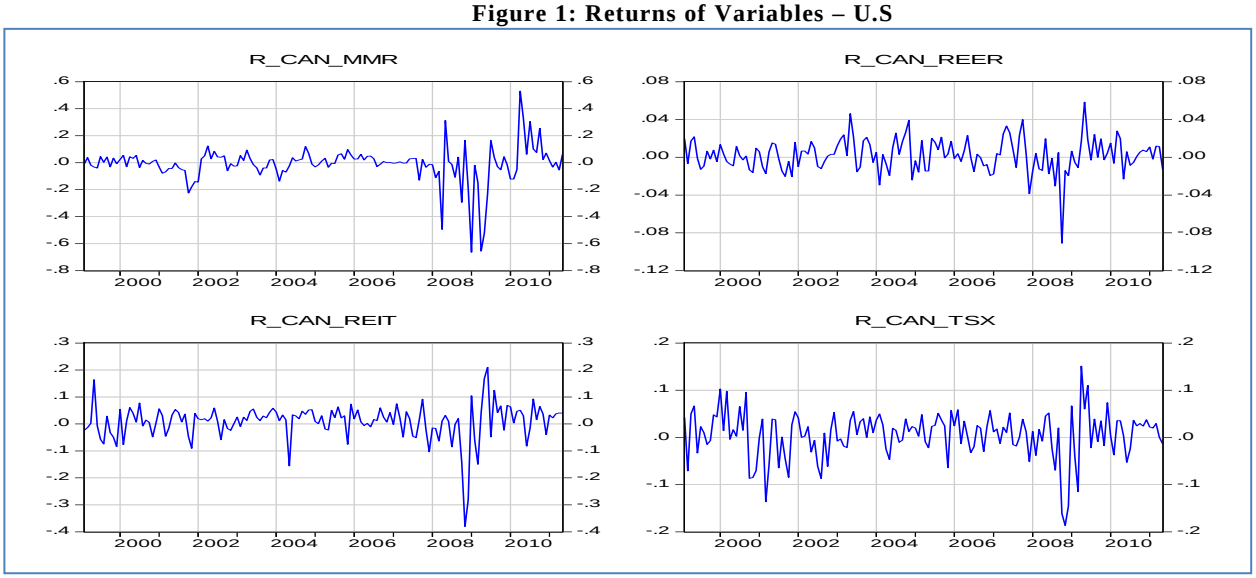

Figure 2: Returns of Variables - Canada

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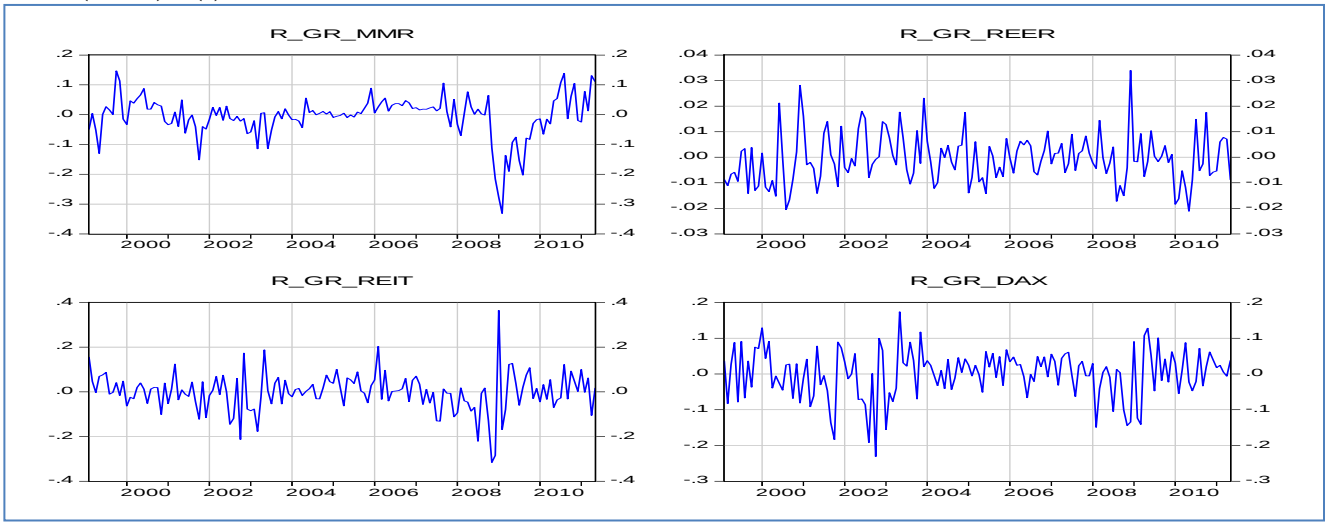

Figure 3: Returns of Variables - Germany

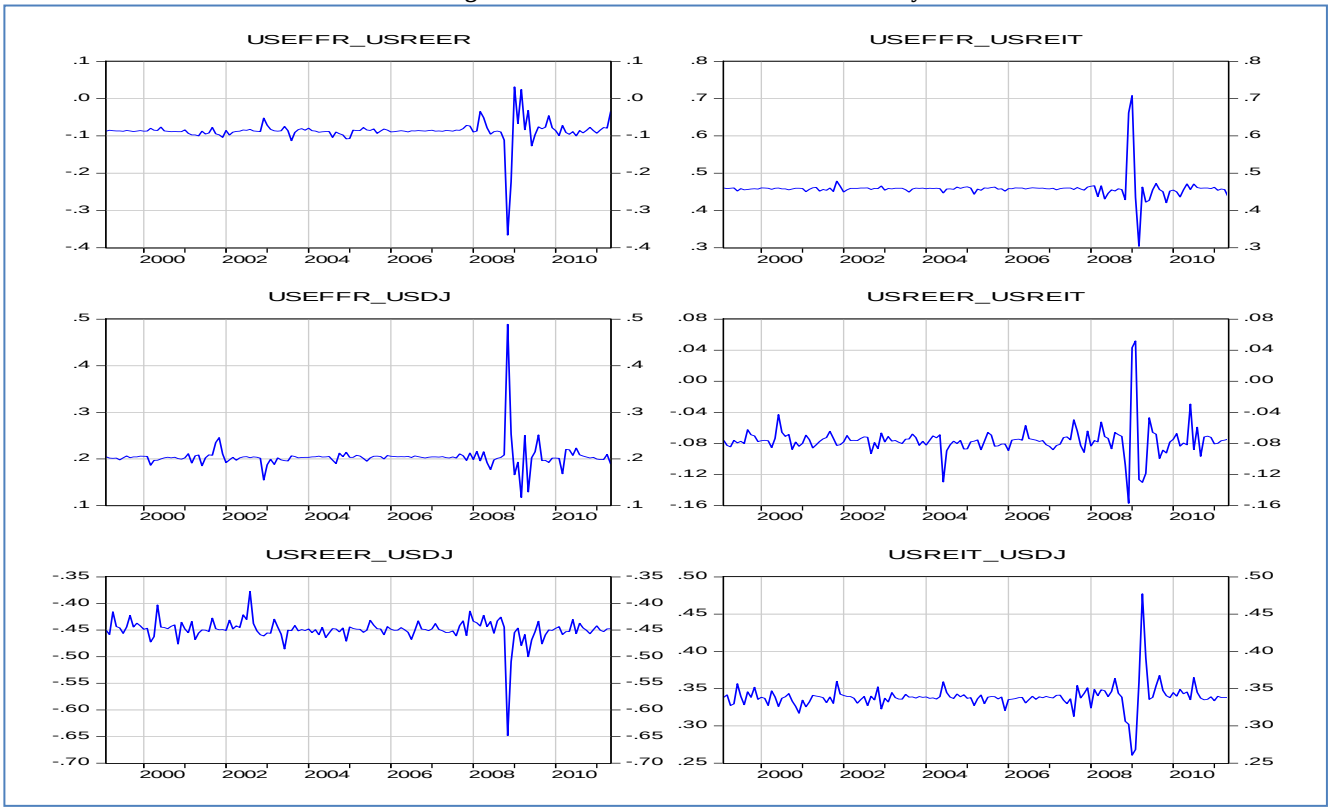

Figure 4: Time Varying Dynamic Conditional Correlations - United States

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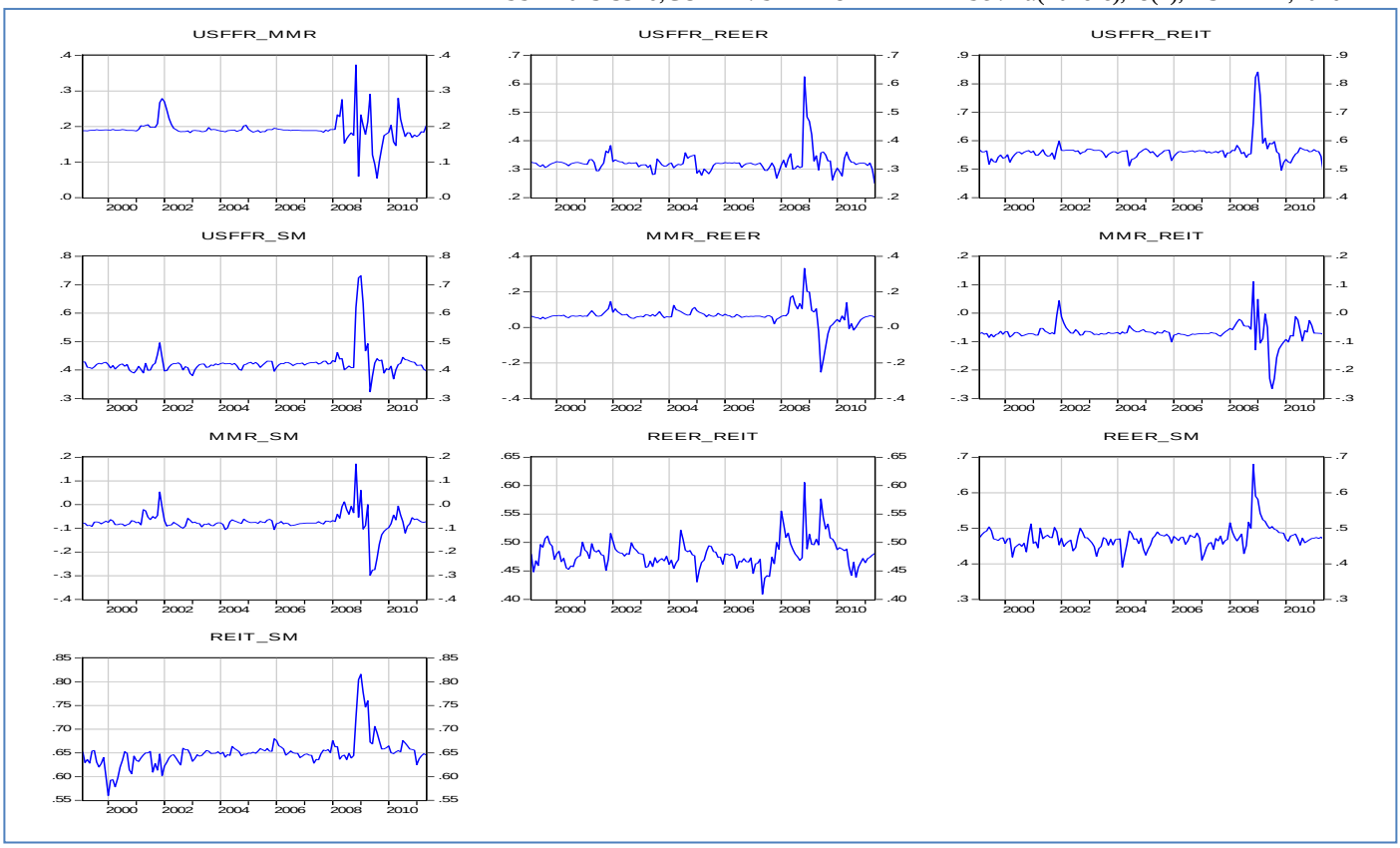

Figure 5: Time Varying Dynamic Conditional Correlations - Canada

Figure 6: Time Varying Dynamic Conditional Correlations - Germany