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International Banking sector Linkages: Did the Global Financial Crisis Strengthen or Weaken the Linkages?

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INTERNATIONAL BANKING SECTOR LINKAGES: DID THE GLOBAL FINANCIAL CRISIS STRENGTHEN OR WEAKEN THE LINKAGES?

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ABSTRACT

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This dissertation examines the interactions or linkages between the U.S. banking sector and the other eight major banking center countries around the globe. I use the national banking sector index for each country over a ten year period as a proxy for reactions to external shocks and examine whether these shocks spillover from the U.S. to the other major banking center countries as measured through their respective indices. I examine both daily residual returns as well as return volatility to measure these interactions between indices.

This study uses a vector auto-regression moving average (VARMA) as well as Granger-causality Wald test to examine the linkages among the major banking sectors in the international markets. For robustness I use a State Space analysis to test the linkages among the nine major banking sector countries. My findings show that the U.S. national banking sector has directional influence over the eight other major national banking sectors including: France, Germany, Switzerland, U.K., Australia, Hong Kong, Japan, and Canada. Furthermore, I find that the influence that the U.S. national banking sector exerts on the other major banking sectors appears to diminish after the financial crisis occurred on September 15, 2008.

Members of Dissertation Committee: Dr. Larry Filer
Dr. Licheng Sun

This dissertation is dedicated to my mother who surely watched over my shoulder every step of the way, encouraging me to never give up no matter the cost, my dad who taught me that anything is possible with hard work, and my wife Carrie and children Sydney and Charlie who stood by me throughout the entire process with their tremendous support and love.

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TABLE OF CONTENTS

Page

LIST OF TABLES ix

Chapter

1. INTRODUCTION 1

2. THEORETICAL BACKGROUND..4

3. HYPOTHESIS DEVELOPMENT 9

4. METHODOLOGY AND DATA..11

   4.1 EMPIRICAL MODELS..11
   4.2 DATA SAMPLES..14

5. EMPIRICAL RESULTS...19

   5.1 RESIDUAL RESULTS 19
   5.2 CAUSATION AND DIRECTIONAL INFLUENCE OF RESIDUAL RETURNS..21
   5.3 PERSISTENCE OF LINKAGE AND DYNAMIC RESPONSE OF RESIDUAL RETURNS...25
   5.4 STATE SPACE ANALYSIS OF RESIDUAL RETURNS...............28
   5.5 RETURNS VOLATILITY..29
   5.6 CAUSATION AND DIRECTIONAL INFLUENCE OF RETURNS VOLATILITY..31
   5.7 PERSISTENCE OF LINKAGE AND DYNAMIC RESPONSE OF RETURNS VOLATILITY..35
   5.8 STATE SPACE ANALYSIS OF RETURNS VOLATILITY.........39

6. DISCUSSION AND CONCLUSION..41

BIBLIOGRAPHY..43

TABLES 47

VITA 79

LIST OF TABLES

Table Page

1. Summary Statistics for Residual Returns....47

2. Summary Statistics for Returns Volatility....48

3. Correlation Matrix of Residual Returns....49

4. Granger-Causality Wald Test of Residual Returns, Pacific Rim Countries....50

5. Granger-Causality Wald Test of Residual Returns, European Countries....51

6. Granger-Causality Wald Test of Residual Returns, North America....53

7. Model Parameter Estimates of Residual Returns for Overall Period, Pacific Rim Countries....54

8. Model Parameter Estimates of Residual Returns for Period Prior to the Financial Crisis, Pacific Rim Countries....55

9. Model Parameter Estimates of Residual Returns for Period After the Financial Crisis, Pacific Rim Countries....56

10. Model Parameter Estimates of Residual Returns for Overall Period, European Countries....57

11. Model Parameter Estimates of Residual Returns for Period Prior to the Financial Crisis, European Countries....58

12. Model Parameter Estimates of Residual Returns for Period After the Financial Crisis, European Countries....60

13. Model Parameter Estimates of Residual Returns, North America......................62

14. State Space Estimates of Linkages Among Banks Returns for the Overall Period......................63

15. Correlation Matrix of Volatility......................64

16. Granger-Causality Wald Test for Returns Volatility, Pacific Rim Countries......................65

17. Granger-Causality Wald Test for Returns Volatility, European Countries......................66

18. Granger-Causality Wald Test for Returns Volatility, North America......................68

19. Model Parameter Estimates of Returns Volatility for Overall Period, Pacific Rim Countries......................69

20. Model Parameter Estimates of Returns Volatility for Period Prior to Financial Crisis, Pacific Rim Countries......................70

21. Model Parameter Estimates of Returns Volatility for Period after Financial Crisis, Pacific Rim Countries......................71

22. Model Parameter Estimates of Returns Volatility for Overall Period, European Countries......................72

23. Model Parameter Estimates of Returns Volatility for Period Prior to Financial Crisis, European Countries......................73

24. Model Parameter Estimates of Returns Volatility for Period after Financial Crisis, European Countries......................75

25. Model Parameter Estimates of Returns Volatility, North America......................77

26. State Space Estimates of Linkages Among Banks Returns Volatitlity

for the Overall Period..78

CHAPTER 1

INTRODUCTION

September 2008 marks a point in history that no one who studies and works in the financial arena will soon forget. It will always be remembered as the "financial crisis", the point that saw many financial institutions close their doors and others surrendering to low priced buyouts. A plethora of consolidations over the next couple of months with enormous governmental intervention from around the world left many with a chill about the financial future of many financial institutions if not the countries themselves and the financial world as we know it.

The popular business news outlets then as well as now have made many speculations as to the cause of this financial crisis as well as its effects on individual firms and industries to whole economies. One such often stated effect is that U.S. banks in general and the U.S. banking industry as a whole became much more volatile because of the securitized mortgage backed securities that many U.S. banks held on their books. Additionally, often cited is the impact that the U.S. banking industry had on the other banking centers around the world. As the U.S. banking industry goes, so goes the rest of the world banking community. The goal of this paper is to examine whether this popular claim of U.S. banks and the U.S. banking sector specifically has more influence over the banks and banking sectors of other industrialized countries during this time frame as well as examining any linkages between the U.S. banking sector and the banking sectors of other banking center economies.

The developed nations that are the major banking centers of the world already have taken actions in recognition of the real or perceived linkages of the worldwide banking system through the Basel Accords. The Basel Accords are an affirmative acknowledgement by the nine major banking countries of the world that the banking industry is interconnected and truly global in nature and therefore, all banks need to be governed by the same set of capital requirement rules.

The Basel Accords are agreements by participating countries regarding banking regulations that are applied to all banks worldwide of those signatory countries. More specifically, Basel I, II, 2.5, and III are agreements by the signatory countries regarding the capital requirements by the banks within their countries. Basel I started the process and was a very simplistic capital requirements agreement. Each subsequent Basel accord has become more complex in the analysis of capital requirements with Basel III, the most current accord, taking into consideration risk assessments and management of assets held by the respective banks. Basel III accord made changes that are a direct result of the financial crisis of 2008.

All nine of the countries in this study are signatory countries of all of the Basel accords. Therefore, all banks within the nine counties of this study are required to meet the minimum capital requirements of Basel I, II, and 2.5 with Basel III accord in various stages of implementation in all nine countries. However, each country has the capabilities of exerting influence over its own banking sector through various mechanisms individually.

To empirically test the popular claim that the U.S. banking sector has an overwhelming influence on the rest of the global banking sectors I analyze the banking sectors of the nine largest industrialized economies via their respective banking sector indices to determine the causal linkages, speed or timing of these linkages as well as the strengths of any linkages. This study provides evidence that the U.S. national banking sector does exert influence over the other major national banking sectors around the globe. This influence is consistent over the entire period of the study but it's persistence on the other major national banking sectors changed in various ways, depending on the respective national banking sector, since the financial crisis occurred on September 15, 2008. These results have far reaching policy implications for bankers, investors and researchers worldwide. They may also provide indications of things to come in the future regarding the U.S. influence in the global banking system.

The rest of this paper is organized as follows. Section II reviews the literature and ideas that form the background for this study. Section III describes the research design and data used. Section IV presents my empirical results while section V provides a discussion and conclusion.

CHAPTER 2

THEORETICAL BACKGROUND

There are two main streams of research that provides the theoretical support for this research study design. The first research stream is focused on international transmission of stock market movements, international stock market linkages, international stock market integration, and financial contagion. Over thirty years have passed since the groundbreaking study by Eun and Shim (1989) documenting a substantial degree of interdependence among national stock markets. Previous research focused on intra-country stock price movement versus inter-country stock price movement among national stock markets.

The popular financial media often over uses the phrase "financial contagion", most recently regarding the Greek and European Union financial situation and its impact on other countries in the European Union. However, they often fail to define what "financial contagion" even means. They further fail to distinguish financial contagion from "interdependence of financial markets" or "linkages of financial markets". This was the focus of Karolyi (2003) in his survey article examining the various definitions, taxonomies, and previous academic research in the area of International financial contagion, interdependence and linkages.

Karolyi (2003) defines international financial linkages as co-movement of international financial asset prices due to a natural free flow of investor-capital flows or fundamental based co-movement. Karolyi (2003) further found two varying degrees of what is termed "contagion". Fundamental contagion which is the absence of strong linkages but where rational investment decisions made by financial agents or rational investor based co-movements. In other words, fundamental contagion is the investors' reactions to financial opportunities and/or risks in the global markets. Additionally, there is an irrational contagion that is sometimes seen as an increase in risk aversion, loss of confidence, herd behavior, and/or full blown financial panic. He noted that both degrees of contagion are more of a phenomenon when markets such as exchange rates or stock prices turn down. In other words, contagion is more of a panic on the downside rather than on the upside. (Karolyi, 2003).

Prior to the late 1980s, academic research of international stock market linkages were thought to be weak linkages at best. Despite the various empirical techniques employed, numerous studies generally found that (i) correlations among returns to national stock markets were surprisingly low and (ii) national, not international, factors play an important role in the return-generating process. (Eun and Shim, 1989)

Eun and Shim (1989) used a vector autoregression (VAR) methodology to examine how much of the movements in one national stock market could be explained by another, whether the United States stock market influenced other national stock markets, and if one national stock market did influence another, how quickly the price movements get transmitted to the other markets.

Since Eun and Shim (1989), the focus has shifted to studies regarding inter-country stock price co-movements among national stock markets. Eun and Shim (1989) found that all of the eight largest European and Pacific Rim national securities markets responded most strongly to U.S. shocks with a 1 day lag with most of the markets responses to U.S. shocks completed within 2 trading days at most.

Arshanapalli and Doukas (1993) examined stock market linkages similar to Eun and Ship (1989) but with a twist. Their analysis was limited to only five major stock markets instead of nine, they used a cointegration methodology to analyze linkages among the markets and they were able to examine any changes of these linkages after a major shock. Using a new technique at the time that followed a well specified error correction model of cointegration by Engle and Granger (1987), they were able to avoid filtering out potentially important information regarding long-run common trends among non-stationary stock indices. (Arshanapalli and Doukas, 1993).

Arshanapolli and Doukas (1993) used the new cointegration technique to examine the interdependence or linkage among five international stock markets: the U.S., the U.K., France, Germany, and Japan both prior to as well as after the 1987 U.S. stock market crash. They found a fairly weak interdependence among the five stock markets pre-1987 crash and increased international co-movements among stock indices post-1987 crash. They also found that the U.S. stock market had considerable impact on the European stock markets of the U.K., France and Germany but not on the Japanese stock market.

Masih and Masih (2002) later used both a VAR as well as cointegration methodologies while adding the Granger-causality test to examine a post globalization period of causal price transmission among national stock markets. Their results were similar to Eun and Shim (1989) as well as Arshanapolli and Doukas (1993), the U.S. stock market does influence the other major stock markets around the world.

The second stream of research is the interaction of major banking sectors or individual banks and how financial shocks in one country, one major banking group, or a number of major banks can spillover into other country banks, major banks, or banking sectors.

Peek and Rosengren (1996) examined the financial shock transmission from Japanese banks into the US banking system. Although their study did examine two major banking center countries it was limited to examining stock market impacts, the financial shock, on banking operations. This study is focused on the banking centers themselves across all nine countries as well as the linkages among the banking centers.

Jokipii and Lucey (2006) examined the banking sector co-movement between the three largest Central/Eastern European countries (CEEC) to determine if there were any interdependence or linkages. Although they found some limited linkages, they used a simple unadjusted correlation analysis and their study was limited to three intra-regional small national banking sectors. What they were lacking in methodology and samples they made up for in thought for an empirical study.

Chan-Lau, et al (2012) used an extreme value theory approach to examine contagion risk across the international banking sectors. They did find that contagion risk among the major global banks appears to have increased over time and that banks tend to be more vulnerable to financial shocks during more volatile financial times than when times are calm which support previous literature regarding contagion in general. However, their study focuses on very large individual banks, 24 of the largest banking groups around the world, rather then an aggregate approach by specific country banking sectors.

Hsiao (2012) used an extremal dependence model to identify and measure financial shocks across international markets as well as country banking sectors. Hsiao (2012) did use daily banking equity indices as I do but excluded several of the largest banking center countries such as Japan and Switzerland. Additionally, Hsiao (2012) limited the period to an overall four year window.

Ongean, et al (2013) examined cross-border spillover affects through the banking activities of large multinational banks. They focused on 155 banks located in sixteen different countries. They focused on the examining and measuring the changes of bank lending behavior after the financial crisis. Although this examined cross-border reactions it focused only on the banks and not the banking sectors as a whole in the different countries.

Although there is a plethora of research studies focusing on contagion, linkages, and/or interdependence among national stock markets either globally or regionally as well as various research studies examining banking contagion and linkages in general, there is a shortage of academic research examining similar linkages/interdependence among individual industries or sectors within the national stock markets. Especially of interest is the study of co-movements or interdependence among the largest national banking centers in the world. In other words, empirical research to address the financial media's speculation of contagion or interdependence/linkages among the largest banking sectors around the world and the ripple effects that may take place when a major financial meltdown occurs. This study is an attempt to begin filling in this gap in the research.

CHAPTER 3

HYPOTHESIS DEVELOPMENT

I used the proven theory that the U.S. stock market influences the other major stock markets around the world with the expanding research stream of banking linkages. Although the U.S. national stock market theory is more developed and empirically tested, the banking linkages stream is still developing and is more regional in nature at this point in time. Using similar empirical methodologies as the national stock market linkage literature and adding an additional cutting edge methodology of State Space analysis, I apply them to the interaction and influence transmission between the U.S. national banking sector to the other major banking sectors around the world. From these two streams of research I propose three empirically testable hypotheses.

My first testable hypothesis stems from the question of what appears to happen to the whole happening to the individual parts. In other words, if there is interdependence among national stock markets does it hold that those same relationships will also be evident in the underlying segments of the national stock markets as well? Here I look at the largest sector of the respective national stock markets, the banking sectors.

> Hypothesis 1: Given the proven linkages among national stock markets, would banking sectors exhibit similar linkages as well?

As in Eun and Shim (1989) as well as Arshanapalli and Doukas (1993) that found in their respective studies that the US stock market influences other major national stock markets around the globe but they do not have a reciprocal effect on the US stock market. Here I propose a second testable hypothesis to examine whether the US banking sector has a similar influence over the other major banking sectors around the globe. Is the US a clear leader, follower or neither with regards to the other large banking center countries around the globe.

> Hypothesis 2: If there are linkages among national banking sectors then what role does the U.S. banking sector play; does it lead, lag, or exhibit contemporaneous moves with the other major banking sector countries?

Lastly, as in Arshanapalli and Doukas (1993) my third hypothesis centers around change after a financial or market shock. I propose a third testable hypothesis of whether the interdependence and influence among the national banking sectors, if any, that was noted prior to the 2008 financial meltdown changes post 2008 financial meltdown.

> Hypothesis 3: All else being equal if there is a linkage of national banking sectors among the largest national banking sector countries, how did the intensity of this linkage change after the global financial crisis that occurred on September 15, 2008?

These three empirically testable hypotheses should give a clear indication as to the global linkages between the U.S. national banking sector and the eight other global banking center countries, what role the U.S. national banking sector plays, that of a leader, laggard or contemporaneous member, and whether there is a noticeable change if any in the linkages immediately following the financial crisis.

CHAPTER 4

METHODOLOGY & DATA

4.1 EMPIRICAL MODELS

To fully test and evaluate the hypotheses articulated previously, I estimate a nine-nation banking sector vector-autoregressive moving average (VARMA) using the log of the daily rates of return on the respective national banking indices from January 4, 1999 through September 26, 2010. Additionally, I estimate a nine-nation banking VARMA pairwise analysis using the log of the daily rates of return squared to evaluate the volatility over the same periods. Lastly, as a robustness test, I run a state space model of the daily rates of return as well as the volatility over the same time periods. The nine national banking indices included in this study are four representing European countries: France, Germany, Switzerland, and the United Kingdom; three representing Pacific Rim countries: Australia, Hong Kong, and Japan; and two representing North American countries: Canada and the United States.

The vector-autoregressive moving average (VARMA) analysis estimates unrestricted reduce form equations that have uniform sets of lagged dependent variables of every equation as regressors. The VARMA thus estimates a dynamic simultaneous equation system, free from *a priori* restrictions on the structure of relationships. Since no restrictions are imposed on the structural relationships among variables, the VARMA can be viewed as a flexible approximation to the reduced form of the correctly specified but unknown model of the actual economic structure. Considering that the large-scale structural models are very often misspecified, it seems to be appealing to use the

VARMA for the purpose of stylizing empirical regularities among time-series data. VARMA models forecasting time-series variables have recently been shown to be much more accurate than the more simple VAR (vector autoregressive) models alone. Athanasopoulos (2008). A VAR model was used by Eun and Shim (1989).

The VARMA procedure provides a Granger-Causality test to determine the Granger-causal relationships between two distinct groups of variables. It also provides

- infinite order AR representation
- impulse response function (or infinite order MA representation)
- decomposition of the predicted error covariances
- roots of the characteristic functions for both the AR and MA parts to evaluate the proximity of the roots to the unit circle
- contemporaneous relationships among the components of the vector time series

The Granger-Causality test provides a clear directional linkage between the national banking sector indices with the main focus being on the causal linkage between the United State banking index and the other eight national banking sector indices. Once the nine-nation banking sector VARMA system is estimated, I can trace out the dynamic responses of each of the nine indices to innovations in a particular index using the simulated responses of the estimated VARMA system. This provides a persistence or strength of the linkage among the linkages.

The state space procedure is a suitable methodology for finding the best (in the Granger causality sense) relationship among the above variables. The procedure has two important attributes found lacking in similar methodologies. One advantage is that the state space procedure makes no *a priori* assumptions about variable relationships, but relies upon the data in identifying causal relationships. Stated differently, the procedure allows a test of the hypothesized relationships without imposing a structural model on the data prior to estimation. In contrast, autoregressive moving average (ARMA) and vector autoregressive moving average (VARMA) models developed by Tiao and Box (1981) require the researcher to tentatively specify the model before estimation. As compared to the state space procedure, VARMA is unnecessarily restrictive when the direction of causal relationships is uncertain.

A second advantage of the procedure is that it can be used to obtain the minimum number of parameters necessary to span the state space of the time invariant linear relationship, which best describes a given set of observations. In other words, state space models are parsimonious. Additionally, Watson (1989) argues that, in state space modeling, the constraint that the model places on the data is transparent. He also asserts that in state space modeling, an algebraic solution to the model is unnecessary since the model is easily solved recursively by Kalman filter. Aoki and Havenner (1989) maintain that the state space modeling is superior since there is no need for the judgmental model-selection rules employed by other methods (e.g. ARMA).

The methodology for constructing state space models consists of three steps (see Aoki and Havenner 1991). The first step is fitting a multivariate autoregressive (AR) model with k lags (AR(k)). This study uses the Akaike Information Criterion (AIC) with k=1,...10 to find a definitive starting point for the Yule-Walker equations.[1]

[1] The Akaike Information Criterion considers the relationship between k-lags in the initial Yule-Walker equations, where k=1,...n, and the resulting autocovariances in selecting an optimal starting point for the initial sample period [See Akaike (1976)]. The optimal k-lag structure is that which minimizes the equations' prediction error relative to the number of parameters used.

The initial measurement equation relates an *m* x *1* state space vector, ς_t, to the multivariate time series, $\mathbf{y}_t$:

$$\mathbf{y}_t = \mathbf{H}_t\varsigma_t + \mathbf{d}_t + \omega_t\varepsilon_t \quad t=1,..,T \tag{1}$$

where $\mathbf{H}_t$ is an *n* x *m* transition matrix , $\mathbf{d}_t$ is an *n* x *1* vector, and ω_t is an *n* x *1* vector of serially uncorrelated disturbances, $E(\varepsilon_t) = 0$. While the state vector ς_t spans the time series, the distributional properties of $\mathbf{y}_t$ are largely unknown, making parameter estimation difficult. Some properties may be ascertained by decomposing the state vector's prediction error.

In the final step of the methodology, the Kalman filter (i.e., forward recursion algorithms) is used to compute the one-step-ahead prediction error, ω_t, and its corresponding covariance matrix. This information is used in constructing an appropriate likelihood function (see Diebold (1989) for a more complete discussion of this approach). Maximum likelihood estimation (MLE) is then used to derive final parameter estimates for the state space model. The state space estimates are then converted to VARMA form to facilitate interpretation of the results.[2]

4.2 DATA SAMPLE

Keeping in the spirit of the core study of linkages as examined in Eun and Shim (1989), this study concentrates on a number of the world's largest banking sectors as

[2] All vector ARMA models can be expressed in state space form. Aoki and Havenner (1991) show that the Cayley-Hamilton theorem can be invoked to eliminate states and convert state space models to ARMA models. The method involves recursive substitution of the lag (back shift) operator matrix and produces a number of lags in all parameters.

determined by Thomson Reuters which is based on aggregate bank assets within the respective countries. In Eun and Shim (1989), they selected and analyzed the nine countries with the largest stock market indices based on market capitalization at the time.

Using The Banker magazine published by Thomson Reuters I selected the same nine countries for this study. Eight of the nine countries from Eun and Shim (1989) are the largest banking sector countries today with Canada being the lone exception. Canada is still included due to its close ties to the US banking sector and strong intra-regional ties. Here, as in Eun and Shim (1989), I use the major banking indices traded in each country as a proxy for the banking sector from the respective country. This is to minimize the individual banking requirements that are imposed in the various banking jurisdictions, as well as focusing on the overall sectors instead of individual banks.

These banking sectors are: U.K., Germany, France and Switzerland representing Europe; Japan, Hong Kong and Australia representing the Pacific Rim; and Canada and the U.S. representing North America. Each country banking sector is represented by a equity banking index as a proxy for that country specific banking sector. U.K. (FTSE All-Share Bank Index), Germany (Germany CDAX Banks Price Index), France (Euronex Paris CAC Bank 8350), Switzerland (SWXICB Bank Price Index), Japan (Japan TOPIX Banks), Hong Kong (Hang Seng Financial Index), Australia (S&P/ASX 200 Banking Index), Canada (Canada S&P/TSX Banks), and the U.S. (S&P 500 Banks).

The database used in this study consists of time series of daily national banking sector indices at closing time, in terms of local currency units. The nine national banking sector indices daily closing data were obtained from the Global Financial Data database for the entire period beginning January 4, 1999 and ending September 24, 2010. The sample was limited to the time frame in which all of the nine national banking sector indices were in existence and traded in a public market. There were a total of 3,054 daily closes for each of the national banking sector indices for the inclusive period of January 4, 1999 through September 24, 2010.

Additionally, the data samples were broken down to include the entire period prior to the financial crisis on September 15, 2008 and the two-year time frame after the financial crisis. The time frame included prior to the financial crisis date of September 15, 2008 runs from January 4, 1999 through September 12, 2008 (September 12, 2008 was a Friday). This first time frame consisted of 2,525 daily closes for each of the national banking sector indices. The second time frame included the two years after the financial crisis date of September 15, 2008 which included September 15, 2008 through September 14, 2010. The second time frame consisted of 529 daily closes for each of the national banking sector indices. The statistical analysis of the immediate two-year time frame prior to the financial crisis was substantially similar to the inclusive time period prior to the financial crisis. Although this inclusive time frame is much larger in comparison to the limited two-year time frame that followed the financial crisis, this only adds robustness to the analysis.

One issue that was addressed regarding the daily close across nine different national banking sector indices was differing trading days. In other words, not all national banking sector indices or national securities markets in which they are traded are traded on a daily basis due to varying national holiday schedules. Therefore, to provide for adequate comparisons of indices in this study there were some minor transformations made to the raw daily close data of the national banking sector indices included in the inclusive periods. For any day that any of the national banking sector indices was traded and therefore provided a daily close, then all of the other indices must also have a daily close. This was to ensure the same number of daily closes across all nine national banking sector indices.

In other words, when national stock exchanges were closed due to national holiday, banking holiday, severe weather, or other national emergency or event, the national banking sector index was assumed to remain the same as the previous active trading day close.

For example, the U.S. national securities markets as well as various other national securities markets are closed on December 25 of each year but the Japanese national securities markets are open. Therefore, since the national banking sector index for Japan has an actual daily close for December 25th the other national banking sector indices must also have a daily close for December 25th. The solution is to assume the daily close for the US national banking sector index on December 24th and use that daily close for the following day of December 25th.

These national banking sector indices are then transformed to log of daily rates of return as well as log of return volatility (daily returns squared), which are then used in our VARMA, Granger-Causality, and State Space analysis. Any potential problems associated with non-stationarity in the original banking sector indices can be alleviated by using the transformed data. There is a non-synchronous trading problem. Differences in trading times, whether national securities markets are open and trading in contrast with other national securities markets, and crossing of various time zones.

Insert Table 1 here, Summary Statistics for Residual Returns

Table 1 provides a listing of the nine national banking sector indices by country, a detailed description of the nine indices variables as well as the summary statistics of the residual returns variables for the nine indices that were used for the empirical test using Granger-Causality, VARMA and State Space modeling in this study. As can be clearly seen in this table, the U.S. national banking sector index for residual daily returns exhibited the lowest mean return while Canada exhibited the highest mean return during the overall period of this study.

Insert Table 2 here, Summary Statistics for Returns Volatility

Table 2 provides a listing of the nine national banking sector indices by country, a detailed description of the nine indices variables as well as the summary statistics of the returns volatility variables for the nine indices that were used for the empirical test using Granger-Causality, VARMA and State Space modeling in this study. As can be clearly seen in this table, the U.S. national banking sector index for daily return volatility exhibited the highest daily return volatility while Australia exhibited the lowest daily return volatility during the overall period of this study.

CHAPTER 5

EMPIRICAL RESULTS

I limited the lag length of this empirical VARMA analysis in this study to three lags or three trading days. Although this study of national banking sector indices is not an exact comparison of Eun and Shim (1989) its striking similarity noted in the lag length is evident. Eun and Shim (1989) found evidence of feedback to current stock market index returns of up to 3 trading days or 3 lags. Here, over 30 years later, although analyzing a different set of indices, I found no significant feedback of returns between indices greater than 3 lags or 3 trading days. Therefore, all of the statistical analysis and results are based on the VARMA with lag of 3 trading days. This in and of itself is something to be noted.

5.1 RESIDUAL RETURNS

I empirically test here the residual returns time series on a pairwise basis between the U.S. national banking sector index and the other eight major banking center countries respectively.

Insert Table 3 here, Correlation Matrix for Residual Returns

Table 3 shows the results of the contemporaneous correlations of the residual returns among the nine national banking sector indices. There are no surprises here. Table 3 shows, as in Eun and Shim (1989) regarding national stock markets, the intra-regional pairwise correlation of the nine country indices of returns tend to be much higher than those of inter-regional correlations. The four European country national banking indices consisting of France, Germany, Switzerland, and the U.K., exhibit very high pairwise contemporaneous correlations ranging from .67842 to .73978. Also the respective Pacific Rim national banking sector indices of Australia, Hong Kong and Japan exhibit likewise, very high pairwise contemporaneous correlations ranging from .34301 to .43532. Although the correlations of the Pacific Rim countries are lower than those of the European countries, they are still statistically significant.

As was also expected, the Canadian and the U.S. national banking sector indices for returns showed a higher contemporaneous correlation of .53147. Additionally, the U.S. national banking sector index had a much higher contemporaneous correlation with the four European countries in this study ranging from .35757 to .40695 compared to the correlations with the three Pacific Rim countries which ranged from .0317 with Japan to .09045 of Australia. This could be attributed to several factors such as correspondingly similar trading times due to common time zones as well as closeness or integration of the intra-regional economies.

The pairwise contemporaneous correlations of the nine country national banking sector indices for returns of this study are much higher than was found in the study of the linkages of the national stock markets by Eun and Shim (1989). This indicates that the banking sectors are highly correlated on a global scale. This provides initial evidence that the global banking community is linked and is influenced by as well as influences other national banking sectors. This lends initial support to hypothesis one in this study that there are linkages among the nine largest national banking sectors regardless of differences in national banking regulations.

5.2 CAUSATION AND DIRECTIONAL INFLUENCE OF RESIDUAL RETURNS

The Granger-Causality Wald test is used in this study to provide evidence of causal connections between the U.S. national banking sector and the other eight country national banking sectors. This test of directional causation or influence is used as a pairwise analysis, comparing the U.S. national banking sector index to the other country national banking sector indices individually. This analysis provides evidence supporting the second hypothesis of whether the U.S. national banking sector is a leader, follower or contemporaneously influenced sector compared to the other major national banking sectors respectively. Table 4 through table 6 show the results of the Granger-Causality Wald test as a part of the VARMA analysis.

Insert Table 4 here, Granger-Causality Wald Test for Residual Returns, Pacific Rim Countries

Table 4 shows the Granger-Causality Wald test results between the U.S. national banking sector index for returns and the three respective Pacific Rim countries of Australia, Hong Kong, and Japan respectively. The null hypothesis for Granger-Causality test is that the first variable (Australia) is influenced by itself not by the second variable (U.S.). The null hypothesis is rejected for all cases in this table. Panel A indicates that the U.S. national banking sector index influences each of the respective Pacific Rim country national banking sector indices as evidenced by the extremely high Chi-Square for each country for the entire period of this study all of which were statistically significant, January 4, 1999 through September 24, 2010. Panel B also shows similar results for the period prior to the financial crisis. This period is from the beginning of the data sample of January 4, 1999 through September 12, 2008. The entire period prior to the financial crises date of September 15, 2008 and not just the two years prior was used since the time period provided similar results as the two years only and using the entire period therefore increase the robustness of the statistical results.

Continuing with Table 4, I compare the Granger-Causality test results in Panel B, results for the entire period prior to the financial crisis, to Panel C results for the period after the financial crisis from September 15, 2008 through September 14, 2010. Although the directional evidence is the same throughout the three periods showing that the US national banking sector index for returns influence over the three respective Pacific Rim country national banking sector indices, they in turn fail to show any reciprocal feedback influence over the U.S. banking sector. The directional influence of the U.S. national banking sector index over the three Pacific Rim country national banking sector indices also appears to be weaker after the financial crisis as indicated by the substantially lower Chi-Square.

The Chi-square for testing Granger-Causality between the U.S. national banking sector index for returns and the Australian counterpart went from 490.08 for the period prior to the financial crisis down to 118.45 for the period after the financial crisis, both are statistically significant. There is a similar change in the Chi-square seen for testing Granger-Causality between the U.S. national banking sector index for returns and Hong Kong dropping from 502.81 prior to the financial crisis to 98.97 afterwards as well as Japan dropping from 152.30 prior to the financial crisis down to 88.97 afterwards. Both of these remain statistically significant.

Insert Table 5 here, Granger-Causality Wald Test for Residual Returns, European Countries

Table 5 shows the Granger-Causality Wald test results between the U.S. national banking sector index and the four respective European countries of France, Germany, Switzerland, and the U.K. As with prior analysis above, Panel A provides the results for the inclusive period, Panel B provides the results for the entire period prior to the financial crisis, and Panel C provides the results regarding the two-year period immediately after the financial crisis. The evidence of the U.S. national banking sector directional influence over the four European national banking sector is supported by the extremely large Chi-Square for all by the Granger-Causality tests in both Panel A, the entire study period as well as Panel B, the entire period prior to the financial crisis. Also of note, as with the Pacific Rim country national banking sectors, none of the four European country national banking sectors indicate directional influence over the US national banking sector. However, as seen in the previous analysis of the Pacific Rim countries, the U.S. directional influence is still evident during the two-years after the financial crisis and as with the prior analysis, the U.S. national banking sector influence over the four European national banking sectors appears to weaken during this period.

As observed with the change in Chi-square for the Granger-Causality test between the US national banking sector index for returns and the Pacific Rim countries, there is a notable change in the Chi-square in the Granger-Causality measure between the US national banking sector index for returns and the four European banking center countries in this study. The Chi-square dropped from the period prior to the financial crisis as compared to the period observed after the financial crisis for all four European countries.

France dropped from 409.20 down to 33.21, Germany from 176.91 down to 26.78, Switzerland down from 349.88 down to 29.80 and the U.K. from 307.31 down to 37.90. All remained statistically significant however.

Insert Table 6 here, Granger-Causality Wald Test for Residual Returns, North America

Table 6 shows the results of the Granger-Causality Wald test between the U.S. national banking sector index for returns and the national banking sector index for returns of Canada. There is no surprise here due to their close intra-regional ties. The U.S. national banking sector index clearly influences the Canadian national banking sector index for the inclusive data sample period, the entire period prior to the financial crisis as well as the period after the financial crisis as seen in Panel A, B, and C in Table 6 respectively. The Chi-Square was visibly lower as seen in Panel C of table 4 and table 5 after the financial crisis for the U.S. national banking sector influence over the three Pacific Rim countries as well as the four European countries national banking sectors respectively. However, Panel C of table 6 shows that the Chi-Square indicating causation of the U.S. national banking sector influence on the Canadian national banking sector increases after the financial crisis. These results also show that the Canadian national banking sector does not influence the U.S. national banking sector.

Hypothesis 2 is clearly supported from the evidence found in the Granger-Causality tests above. The U.S. national banking sector has a statistically significant directional influence on all eight of the other national banking center country sector indices for returns in this study. Although it appears that the strength of this directional influence does dramatically weaken over the three Pacific Rim and four European countries after the financial crisis occurs, evidence shows that it increases over the Canadian banking sector.

5.3 PERSISTENCE OF LINKAGE AND DYNAMIC RESPONSE OF RESIDUAL RETURNS

After determining the causal influence, the next step is to analyze the persistence of actual strength of the causal influence the U.S. national banking sector has over the other eight national banking center country sectors in this study. Table 7 and Table 10 are included for additional information for the inclusive period of analysis and are not significantly different from that of those of the inclusive period prior to the financial crisis. Therefore, I will focus on the comparison between the strength of influence prior to the financial crisis to that after the financial crisis and evaluate the changes between these two periods.

Insert Table 7 here, Model Parameter Estimates of Residual Returns for Overall Period, Asia-Pacific Countries

Findings provided in Table 7 of the U.S. national banking sector influence over the Pacific Rim national banking center countries for the entire period of my study. The U.S. exerts influence for a full three days over Australia, two days over Hong Kong but only one day over Japan. These findings are all statistically significant.

Insert Table 8 here, Model Parameter Estimates of Residual Returns for Period Prior to Financial Crisis, Pacific Rim Countries

Table 8 indicates that the U.S. national banking sector persistence of influence over the Australian and Hong Kong national banking sectors lasts for a full three trading days for the period prior to the financial crisis. This is statistically significant out to three trading days prior to the financial crisis but lasts only one trading day for the Japanese national banking sector. These findings are very similar to the findings in Table 7 for the entire period of this study.

Insert Table 9 here, Model Parameter Estimates of Residual Returns for Period after Financial Crisis, Pacific Rim Countries

In Table 9, the findings indicate significant changes regarding the strength of influence by the U.S. national banking sector over the Pacific Rim countries after the financial crisis. The U.S. national banking sector strength persists for only one trading day over the Australian national banking sector for the period after the financial crisis, down from three trading days prior to the financial crisis. The U.S. national banking sector persistence over the Hong Kong national banking sector drops to two trading days for the period after the financial crisis compared to three trading days for the period prior to the financial crisis. Lastly, the U.S. national banking sector remained unchanged at one trading day of influence over the Japanese national banking sector for the period after the financial crisis.

Insert Table 10 here, Model Parameter Estimates of Residual Returns for Overall Period, European Countries

The findings in Table 10 provides evidence that the U.S. national banking sectors influence over the four European national banking center countries for the entire period of the study. The U.S. exerts a full two days of influence over all four of the European countries in this study for the inclusive period of this study.

Insert Table 11 here, Model Parameter Estimates of Residual Returns for Period Prior to Financial Crisis, European Countries

Table 11 indicates that the U.S. national banking sector influence persists for two trading days over the French and the U.K. national banking sectors but only for one trading day over the Swiss and German national banking sectors prior to the financial crisis. This is significantly similar to the results for the inclusive period of this study. However, the U.S. national banking sector influence is down to only one trading day for all four European country national banking sectors as indicated from the results in Table 12.

Insert Table 12 here, Model Parameter Estimates of Residual Returns for Period after the Financial Crisis, European Countries

The U.S. national banking sector persistence or influence over the three Pacific Rim country and four European country national banking sectors appears to either remain unchanged from the period prior to the financial crisis compared to the period after the financial crisis such as for Japan, France, and Switzerland or decreases in influence in the case of Australia, Hong Kong, Germany, and the U.K. Canada, however, appears to be an entirely different story.

Insert Table 13 here, Model Parameter Estimates of Residual Returns, North American Countries

The findings in Table 13 provides evidence of the persistence or influence of the U.S. national banking sector over the Canadian national banking sector for the inclusive period of the study, the entire period prior to the financial crisis and the period after the financial crisis as can be seen in Panel, A, B, and C respectively. Panel B shows that the influence that the U.S. national banking sector has over the Canadian national banking sector for the entire period prior to the financial crisis as merely one trading day. However, this influence increases dramatically to three trading days for the period immediately after the financial crisis. This is opposite from the reaction that occurred with the Pacific Rim and European country national banking sectors. The U.S. national banking sector appears to exert more influence over the Canadian national banking sector after the financial meltdown occurred on September 15, 2008.

5.4 STATE SPACE ANALYSIS OF RESIDUAL RETURNS

Insert Table 14 here, State Space Estimates of Linkages Among Banks Returns for the Overall Period

VARMA converted state space results for returns for the overall period are reported in Table 14. Equation (1) indicates that Switzerland banks' return is influenced at lag one by Australia, Switzerland, France, United States, Canada, and Japan and contemporaneously by Australia. A quick glance at Tables 14 indicates that the U.S. bank returns exert the most influence on all of other countries, while in turn, it is influenced by Canada and to a small degree by France.

To conserve space, the results for the period before financial crisis are very similar to the overall results and thus not reported here. Again, the U.S. is found to exert the most influence on all other countries while it is influenced only by a small degree by France and Germany.

The results for after the financial crisis indicate that the link between banks stock returns have weakened dramatically as the governments took steps to protect their financial systems. For instance – Switzerland, France, the United Kingdom, the United States, Canada, Japan, and Australia were rarely influenced by the returns of other countries – while Germany and Hong Kong experienced more pronounced influence by other countries.[3]

5.5 RETURNS VOLATILITY

I empirically test here the returns volatility time series on a pairwise basis between the US national banking sector index and the other eight major banking center countries respectively.

Insert Table 15 here, Correlation Matrix for Returns Volatility

In Table 15 I provide the results of the contemporaneous correlations for the returns volatility among the nine national banking sector indices. There are some noted

[3] Results are available upon request.

differences from my previous findings for residual returns. Table 16 shows, as in Eun and Shim (1989) regarding national stock markets and my previous findings for residual returns, the intra-regional pairwise correlation of this nine country indices for return volatility tend to be much higher than those of inter-regional correlations. The four European country national banking indices consisting of France, Germany, Switzerland, and the U.K., exhibit very high pairwise contemporaneous correlations for return volatility ranging from .61601 to .65721. Also the respective Pacific Rim national banking sector indices of Australia, Hong Kong and Japan exhibit likewise, very high pairwise contemporaneous correlations for return volatility ranging from .30882 to .33724. Although the correlations of the Pacific Rim countries are lower than those of the European countries, they are still statistically significant as was seen for the correlation of the residual returns.

As was also expected, the Canadian and the U.S. national banking sector indices for return volatility show a high contemporaneous correlation of .38523. This is much lower than the returns correlation but is still statistically significant. Additionally, the U.S. national banking sector index for return volatility had a much higher contemporaneous correlation with the four European countries in this study ranging from .33850 to .44023 compared to the correlations with the three Pacific Rim countries which ranged from .10573 with Japan to .21347 of Australia. This range is significantly higher than that noted for the U.S. and Pacific Rim countries and their contemporaneous correlation of returns and is statistically significant. This could be attributed to several factors as noted with the contemporaneous correlation of returns such as correspondingly similar trading times due to common time zones as well as closeness or integration of the intra-regional economies.

The pairwise contemporaneous correlations of the nine country national banking sector indices for return volatility as with the returns of this study are much higher than was found in the study of the linkages of the national stock markets by Eun and Shim (1989). This indicates that the banking sectors are highly correlated on a global scale. This provides further evidence that the global banking community is linked and is influenced by as well as influences other national banking sectors. This lends initial support to hypothesis one in this study that there are linkages among the nine largest national banking sectors regardless of differences in national banking regulations.

5.6 CAUSATION AND DIRECTIONAL INFLUENCE OF RETURNS VOLATILITY

The Granger-Causality Wald test is used in this study to provide evidence of causal connections between the U.S. national banking sector volatility and the other eight country national banking sectors return volatility. This test of directional causation or influence is used as a pairwise analysis, comparing the U.S. national banking sector index for return volatility to the other country national banking sector indices for volatility individually. This analysis provides evidence supporting the second hypothesis of whether the U.S. national banking sector is a leader, a laggard or contemporaneously influenced sector compared to the other major national banking sectors respectively. Table 17 through table 19 provides the results of the Granger-Causality Wald test as a part of the VARMA analysis.

Insert Table 16 here, Granger-Causality Wald Test for Returns Volatility, Pacific Rim Countries

The findings in Table 16 shows the Granger-Causality Wald test results between the U.S. national banking sector index for returns volatility and the three respective Pacific Rim countries of Australia, Hong Kong, and Japan respectively. Panel A provides evidence that the U.S. national banking sector index for return volatility influences each of the respective Pacific Rim country national banking sector indices for return volatility as noted by the Chi-Square for each country, all of which are statistically significant for the entire period of this study, January 4, 1999 through September 24, 2010.

It is interesting to note that the findings for return volatility that all three Pacific Rim countries also influence the U.S. return volatility. Unlike the returns alone where the US national banking sector influenced these countries but not vice versa, here I find that the return volatility is a complete feedback loop, a reciprocity of influence with return volatility.

Panel B also shows similar results for the period prior to the financial crisis. This period is from the beginning of the data sample of January 4, 1999 through September 12, 2008. The entire period prior to the financial crises date of September 15, 2008 and not just the two years prior was used since the time period provided similar results as the two years only and using the entire period therefore increase the robustness of the statistical results.

Continuing with Table 16, I compare the Granger-Causality Wald test results for return volatility in Panel B, results for return volatility of the entire period prior to the financial crisis, to Panel C results for the period after the financial crisis from September 15, 2008 through September 14, 2010. Although the directional evidence is the same throughout the overall period as well as the period showing that the U.S. national banking sector index influence over the three respective Pacific Rim country national banking sector indices and vice versa, the three Pacific Rim countries exerting directional influence over the U.S. return volatility. The directional influence of the U.S. national banking sector index for return volatility over the three Pacific Rim country national banking sector indices appears to disappear after the financial crisis except for its directional influence over Australia. Any directional influence by the three Pacific Rim countries over the U.S. national banking sector regarding return volatility has completely disappeared.

Insert Table 17 here, Granger-Causality Wald Test for Return Volatility, European Countries

The findings in Table 17 shows the Granger-Causality Wald test results between the U.S. national banking sector index return volatility and the four respective European countries of France, Germany, Switzerland, and the U.K. As with prior analysis above, Panel A provides the results for the inclusive period, Panel B provides the results for the entire period prior to the financial crisis, and Panel C provides the results regarding the two-year period immediately after the financial crisis. The evidence of the U.S. national banking sector return volatility directional influence over the other four European national banking sector is evidenced by the Granger-Causality tests Chi-Square that is statistically significant for all in both Panel A, the entire study period as well as Panel B, the entire period prior to the financial crisis. Also noted, as with the Pacific Rim country national banking sectors return volatility, all four of the European country national banking sectors indicate directional influence over the U.S. national banking sector as well. This indicates a more contemporaneous influence of return volatility among the U.S. and European countries as I found among the U.S. and Pacific Rim countires. However, as seen in the previous analysis of the Pacific Rim countries, the U.S. directional influence as well as the European countries directional influence over the U.S. all but disappears during the period immediately after the financial crisis. The exception is the U.S. still has some direction influence over France and the U.K. while the U.K. still has directional influence over the U.S.

Insert Table 18 here, Granger-Causality Wald Test for Returns Volatility, North America

The findings in Table 18 show the results of the Granger-Causality Wald test between the U.S. national banking sector index of return volatility and the national banking sector index of return volatility for Canada. There is no surprise here due to their close intra-regional ties. As noted regarding directional influences between the U.S. and the Pacific Rim countries along with the U.S. and the European countries, the U.S. national banking sector index of return volatility clearly influences the Canadian national banking sector index of return volatility as well as vice versa, a contemporaneous directional influence if you will, for the inclusive data sample period, the entire period prior to the financial crisis as well as the period after the financial crisis as seen in Panel

A, B, and C in Table 18 respectively.

The directional influence of the U.S. diminished greatly as seen in Panel C of table 16 and table 17 after the financial crisis for the U.S. national banking sector influence over the three Pacific Rim countries as well as the four European countries national banking sectors respectively. However, Panel C of table 18 shows that the Chi-Square indicating causation of the U.S. national banking sector influence on the Canadian national banking sector remains statistically significant after the financial crisis. These results also show that the Canadian national banking sector index of return volatility does influence the U.S. national banking sector during all three periods of observation.

Hypothesis 2 is clearly supported from the evidence found in the Granger-Causality tests above. The U.S. national banking sector has a statistically significant directional influence on all eight of the other national banking sectors in this study. Although it appears that the strength of this directional influence does dramatically weaken against the three Pacific Rim and four European countries after the financial crisis occurs, evidence shows that it remains statistically significant over the Canadian banking sector.

5.7 PERSISTENCE OF LINKAGE AND DYNAMIC RESPONSE OF RETURNS VOLATILITY

After determining the causal influence, the next step is to analyze the persistence of actual strength of the causal influence the U.S. national banking sector has over the other eight national banking sectors in this study. Table 19 and Table 22 are included for additional information for the inclusive period of analysis. However, I will focus on the comparison between the strength of influence prior to the financial crisis to that after the financial crisis and evaluate the changes between these two periods.

Insert Table 19 here, Model Parameter Estimates of Returns Volatility for Overall Period, Pacific Rim Countries

Table 19 provides evidence that the U.S. national banking sector index of return volatility has influence over Australia and Japan that is statistically significant for one day and three days but only for one day over Hong Kong for the overall period of this study. This is slightly different from the observed findings when evaluating only the period prior to the financial crisis. These results are similar to the results found for the VARMA pariwise analysis between the U.S. national banking sector index for return volatility and the three respective Pacific Rim countries.

Insert Table 20 here, Model Parameter Estimates of Returns Volatility for Period Prior to Financial Crisis, Pacific Rim Countries

Table 20 indicates that the U.S. national banking sector index for return volatility persistence of influence over the Hong Kong and Japan national banking sectors lasts a full trading day. This is statistically significant out to three trading days prior to the financial crisis but has statistically significant influence over Australia for one and three trading days, but not for the second trading day.

Insert Table 21 here, Model Parameter Estimates of Returns Volatility for Period after Financial Crisis, Pacific Rim Countries

The findings in Table 21 show significant changes regarding the strength of influence by the U.S. national banking sector for return volatility over the Pacific Rim countries after the financial crisis. The U.S. national banking sector index for return volatility strength persists for only one trading day over the Australian national banking sector for the period after the financial crisis, down from two trading days prior to the financial crisis. The U.S. national banking sector index for return volatility persistence over the Hong Kong and Japan national banking sectors disappears altogether for the period after the financial crisis compared to one trading day for the period prior to the financial crisis.

Insert Table 22 here, Model Parameter Estimates of Returns Volatility for Overall Period, European Countries

Table 22 provides results for the entire period of study for the VARMA pairwise analysis between the U.S. national banking sector index for return volatility and the four European countries respectively. Unlike the pairwise analysis between the U.S. national banking sector and the three Pacific Rim countries where there was little significant differences between the overall period and the less inclusive period prior to the financial crisis. Here there are some differences that appear between the US national banking sector index for return volatility and the four European countries when comparing the overall period of observation and the period prior to the financial crisis.

During the overall period, the U.S. national banking sector index for return volatility has a statistically significant influence over France, Switzerland, and the U.K. for one trading period as well as the third trading day but not for the second trading day. I observed that the U.S. national banking sector index for return volatility has no measurable influence over the German banking sector during this same time frame.

Insert Table 23, Model Parameter Estimates of Returns Volatility for Period Prior to Financial Crisis, European Countries

Table 23 indicates that the U.S. national banking sector index for return volatility statistically significantly influence persists for two trading days over the French and the U.K. national banking sectors but only for one trading day for the Swiss and German national banking sectors prior to the financial crisis. However, the U.S. national banking sector index for return volatility greatly diminishes influence down to only one trading day for the U.K. national banking sector and has completely disappeared over Germany, France, and Switzerland as can be seen from the results in Table 24.

Insert Table 24 here, Model Parameter Estimates of Returns Volatility for Period after Financial Crisis, European Countries

The U.S. national banking sector persistence or influence over the three Pacific Rim country and four European country national banking sectors appears to either diminish substantially from the period prior to the financial crisis compared to the period after the financial crisis such as for Australia and the U.K. or completely disappears in the case of Hong Kong, Japan, Germany, France, and Switzerland. Canada, however, appears to be an entirely different story.

Insert Table 25 here, Model Parameter Estimates of Returns Volatility, North America

Table 25 provides the results of the persistence or influence of the U.S. national banking sector index for return volatility over the Canadian national banking sector for the inclusive period of the study, the entire period prior to the financial crisis and the period after the financial crisis as can be seen in Panel, A, B, and C respectively. It should be noted that the U.S. national banking sector index for return volatility influence over the Canadian banking sector for the overall period as seen in Panel A is similar to what was found with three of the European country banking sector, where the U.S. has statistically significant influence over Canada for one and three trading days but not the second trading day.

Panel B shows that the influence that the U.S. national banking sector index for return volatility has over the Canadian national banking sector for the entire period prior to the financial crisis as merely one trading day. This influence remains one trading day for the period immediately after the financial crisis also. The U.S. national banking sector index for return volatility appears to exert the same influence over the Canadian national banking sector after the financial crisis occurred on September 15, 2008. I can only speculate that this is due to the extremely close ties of the U.S. and Canadian banking sectors.

5.8 STATE SPACE ANALYSIS OF RETURNS VOLATILITY

Insert Table 26, State Space Estimates of Linkages Among Banks Returns Volatility for the Overall Period

VARMA converted state space results for returns volatility for the overall period are reported in Table 26. The results reported in this table indicate extensive volatility spillovers from countries studied here. For instance, equation (5) indicates that the U.S. bank returns volatility is influenced at lag one by Australia, Switzerland, the U.K., Canada, Hong Kong, and contemporaneously by Australia. The results for the period before financial crisis are very similar to the overall results and thus not reported here. Again, we observe extensive volatility spillovers among the countries for this period. However, the results for after the financial crisis are quite different. The volatility spillovers are very much contained during this period. For instance, the U.S. bank returns volatility was not affected by any other countries. We observe the same phenomenon for all countries except Germany and Hong Kong that experience limited volatility spillover after the financial crisis.

CHAPTER 6

DISCUSSION AND CONCLUTION

The U.S. national banking sector index for returns as well as return volatility are highly correlated with the other eight major national banking sectors around the globe. However, the highest pairwise contemporaneous correlations among national banking sectors were intra-regional as opposed to inter-regional. This could be one of a number of factors two of which could be similar time-zones that the country banking sector indices are trading in as well as a more integrated economic trading within the respective regions.

The U.S. still is the dominate player in the global financial markets exerting its influence on all eight of the major banking sectors around the globe. However, since the financial crisis occurred on September 15, 2008, there is evidence that the U.S. influence has weakened somewhat since then except the the neighbors to the north, Canada. Canada is the smallest of the banking sectors in this study as well as the closest regionally to the U.S .banking sector with extremely deep economic ties.

My findings in this study confirms as well as brings to light several interesting results. Although the major global bank sectors around the world appear to be linked as was hypothesized, the U.S. banking sector is a global leader and influences other major banking sectors around the world with regards to returns. However, risk as measured by return volatility, provides evidence of a more contemporaneous link between the U.S. and the other eight major global banking sectors.

Additionally, even though all of the nine major global banking sector countries are signatories of and in various stages of implementing the numerous Basel accords, each of these countries have the governmental power or authority to regulate their respective banking sectors. I speculate here that this autonomous authority had an impact on the changes regarding the measured impact of the U.S. national banking sector immediately following the global financial crisis.

From my findings it appears that the U.S. national banking sector has a strong and long lasting influence on the other eight major global banking sector countries as measured by returns when the financial landscape is calm. However, the U.S. influence appears to evaporate when a financial crisis occurs. Further study could measure to determine empirically whether there is a return of the U.S. banking sector influence and is there is, at what point does the U.S. banking sector influence return.

This dissertation adds to the literature in several ways as well as raising more avenues for further research. A short coming of this study is the examining the actual governmental actions and the timing of these actions that were taken immediately after the financial crisis to determine whether those governmental actions or lack of actions in some cases caused the breakdown in linkages between the U.S. national banking sector and the other major banking sectors around the globe.

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Table 1

Summary Statistics for Residual Returns

9 Variables:	au1	sw1	ge1	fr1	uk1	us1	ca1	hk1	ja1

Simple Statistics						
Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
au1	3054	0.02008	1.34117	61.31964	-8.51658	9.68931
sw1	3054	-0.00526	2.05895	-16.05838	-12.11190	19.73836
ge1	3054	-0.02266	2.36115	-69.20385	-17.74374	18.71768
fr1	3054	0.01291	2.15725	39.41894	-14.78700	19.24373
uk1	3054	-0.01298	1.98852	-39.65406	-16.97699	18.81635
us1	3054	-0.02902	2.49893	-88.61933	-23.61855	22.03786
ca1	3054	0.03035	1.43469	92.67530	-14.07116	12.13399
hk1	3054	0.02872	1.60920	87.71291	-14.53844	15.97395
ja1	3054	-0.03289	2.03163	-100.43088	-13.34982	14.19321

Note: Nine variable descriptions.

au1 = Log of daily returns for Australia (S&P/ASX 200 Banking Index)

sw1 = Log of daily returns for Switzerland (SWXICB Bank Price Index)

ge1 = Log of daily returns for Germany (Germany CDAX Banks Price Index)

fr1 = Log of daily returns for France (Euronex Paris CAC Bank 8350)

uk1 = Log of daily returns for United Kingdom (FTSE All-Share Bank Index)

us1 = Log of daily returns for United States (S&P 500 Banks)

ca1 = Log of daily returns for Canada (Canada S&P/TSX Banks)

hk1 = Log of daily returns for Hong Kong (Hang Seng Financial Index)

ja1 = Log of daily returns for Japan (Japan TOPIX Banks)

Table 2

Summary Statistics for Returns Volatility

9 Variables:	au2	sw2	ge2	fr2	uk2	us2	ca2	hk2	ja2

Simple Statistics						
Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
au2	3054	1.79856	5.13668	5493	0	93.88281
sw2	3054	4.23793	14.24099	12943	0	389.60276
ge2	3054	5.57373	19.64909	17022	0	350.35154
fr2	3054	4.65236	15.92605	14208	0	370.32098
uk2	3054	3.95307	14.09052	12073	0	354.05495
us2	3054	6.24343	27.61601	19067	0	557.83612
ca2	3054	2.05858	7.15935	6287	0	197.99744
hk2	3054	2.58950	9.50895	7908	0	255.16713
ja2	3054	4.12723	10.36484	12605	0	201.44726

Note: Nine variable descriptions.

au2 = Log of daily return volatility for Australia (S&P/ASX 200 Banking Index)

sw2 = Log of daily return volatility for Switzerland (SWXICB Bank Price Index)

ge2 = Log of daily return volatility for Germany (Germany CDAX Banks Price Index)

fr2 = Log of daily return volatility for France (Euronex Paris CAC Bank 8350)

uk2 = Log of daily return volatility for United Kingdom (FTSE All-Share Bank Index)

us2 = Log of daily return volatility for United States (S&P 500 Banks)

ca2 = Log of daily return volatility for Canada (Canada S&P/TSX Banks)

hk2 = Log of daily return volatility for Hong Kong (Hang Seng Financial Index)

ja2 = Log of daily return volatility for Japan (Japan TOPIX Banks)

Table 3

Correlation Matrix for Residual Returns

Pearson Correlation Coefficients, N = 3054 Prob > |r| under H0: Rho=0									
	au1	sw1	ge1	fr1	uk1	us1	ca1	hk1	ja1
au1	1.00000	0.31564 <.0001	0.28611 <.0001	0.32350 <.0001	0.29991 <.0001	0.09045 <.0001	0.16955 <.0001	0.43532 <.0001	0.34301 <.0001
sw1	0.31564 <.0001	1.00000	0.73978 <.0001	0.68873 <.0001	0.70730 <.0001	0.37917 <.0001	0.39448 <.0001	0.33937 <.0001	0.26951 <.0001
ge1	0.28611 <.0001	0.73978 <.0001	1.00000	0.71635 <.0001	0.69988 <.0001	0.40695 <.0001	0.38552 <.0001	0.29796 <.0001	0.24148 <.0001
fr1	0.32350 <.0001	0.68873 <.0001	0.71635 <.0001	1.00000	0.67842 <.0001	0.35757 <.0001	0.30405 <.0001	0.33196 <.0001	0.23403 <.0001
uk1	0.29991 <.0001	0.70730 <.0001	0.69988 <.0001	0.67842 <.0001	1.00000	0.38971 <.0001	0.37417 <.0001	0.37631 <.0001	0.23336 <.0001
us1	0.09045 <.0001	0.37917 <.0001	0.40695 <.0001	0.35757 <.0001	0.38971 <.0001	1.00000	0.53147 <.0001	0.07792 <.0001	0.03170 0.0798
ca1	0.16955 <.0001	0.39448 <.0001	0.38552 <.0001	0.30405 <.0001	0.37417 <.0001	0.53147 <.0001	1.00000	0.19899 <.0001	0.14057 <.0001
hk1	0.43532 <.0001	0.33937 <.0001	0.29796 <.0001	0.33196 <.0001	0.37631 <.0001	0.07792 <.0001	0.19899 <.0001	1.00000	0.39871 <.0001
ja1	0.34301 <.0001	0.26951 <.0001	0.24148 <.0001	0.23403 <.0001	0.23336 <.0001	0.03170 0.0798	0.14057 <.0001	0.39871 <.0001	1.00000

Note: Each entry in this table represents the contemporaneous correlation coefficient of the log of the daily returns between a pair of countries for the entire data set period of January 4, 1999 through September 24, 2010.

Table 4

Granger-Causality Wald Test for Residual Returns, Pacific Rim Countries

This Granger-causality test provides a directional causation test providing evidence of whether the U.S. national banking sector index is influencing or exerting directional momentum on the other respective national banking sector indices or vice versa. Each country is paired with the U.S. national banking sector index to determine whether the U.S. index influences the respective national banking sector indices or vice versa.

Country	Chi-Square	Pr > Chi-Square
Panel A: Entire Period, N = 3,054		
Australia	600.67	< .0001
U.S.	6.53	0.0884
Hong Kong	554.19	< .0001
U.S.	8.83	0.0317
Japan	262.66	< .0001
U.S.	2.73	0.4354
Panel B: Period prior to Financial Crisis, N = 2,525		
Australia	490.08	< .0001
U.S.	5.00	0.1721
Hong Kong	502.81	< .0001
U.S.	12.23	0.0066
Japan	152.30	< .0001
U.S.	7.20	0.0657
Panel C: Period after the Financial Crisis, N = 529		
Australia	118.45	< .0001
U.S.	1.60	0.6593
Hong Kong	98.97	< .0001
U.S.	1.63	0.6519
Japan	88.97	< .0001
U.S.	2.17	0.5384

Table 5

Granger-Causality Wald Test for Residual Returns, European Countries

This Granger-causality test provides a directional causation test providing evidence of whether the U.S. national banking sector index is influencing or exerting directional momentum on the other respective national banking sector indices or vice versa. Each country is paired with the U.S. national banking sector index to determine this causal connection.

Country	Chi-Square	Pr > Chi-Square
Panel A: Entire Period, N = 3,054		
France	300.33	< .0001
U.S.	2.93	0.4018
Germany	180.19	< .0001
U.S.	4.98	0.1734
Switzerland	244.84	< .0001
U.S.	6.37	0.0948
U.K.	270.38	< .0001
U.S.	6.32	0.0972
Panel B: Period prior to Financial Crisis, N = 2,525		
France	409.20	< .0001
U.S.	14.68	0.0021
Germany	176.91	< .0001
U.S.	12.20	0.0067
Switzerland	349.88	< .0001
U.S.	2.10	0.5520
U.K.	307.31	< .0001
U.S.	4.65	0.1997

Table 5 (Cont'd)

Granger-Causality Wald Test for Residual Returns, European Countries

This Granger-causality test provides a directional causation test providing evidence of whether the U.S. national banking sector index is influencing or exerting directional momentum on the other respective national banking sector indices or vice versa. Each country is paired with the U.S. national banking sector index to determine this causal connection.

Country	Chi-Square	Pr > Chi-Square
Panel C: Period after the Financial Crisis, N = 529		
France	33.21	< .0001
U.S.	0.52	0.9150
Germany	26.78	< .0001
U.S.	3.26	0.3539
Switzerland	29.80	< .0001
US	8.01	0.0457
UK	37.90	< .0001
US	5.70	0.1270

Table 6

Granger-Causality Wald Test for Residual Returns, North America

This Granger-causality test provides a directional causation test providing evidence of whether the U..S national banking sector index is influencing or exerting directional momentum on the other respective national banking sector indices or vice versa. Each country is paired with the U.S. national banking sector index to determine whether the U.S. index influences the respective national banking sector indices or vice versa.

Country	Chi-Square	Pr > Chi-Square
Panel A: Entire Period, N = 3,054		
Canada	84.85	< .0001
U.S.	10.91	0.0122
Panel B: Period prior to Financial Crisis, N = 2,525		
Canada	19.21	< .0001
U.S.	0.87	0.8328
Panel C: Period after the Financial Crisis, N = 529		
Canada	45.35	< .0001
U.S.	7.12	0.0683

Table 7

Model Parameter Estimates of Residual Returns for Overall Period, Pacific Rim Countries

Country	Lag	Estimate	Std Error	t-value (Pr > |t|)	Variable
Entire Period, N = 3,054					
Australia	1	0.21599	0.00900	23.99 (0.0001)	US1(t-1)
	2	0.03036	0.00991	3.07 (0.0022)	US1(t-2)
	3	0.04782	0.00981	4.88 (0.0001)	US1(t-3)
Hong Kong	1	0.24847	0.01085	22.91 (0 .0001)	US1(t-1)
	2	0.09676	0.01184	8.18 (0.0001)	US1(t-2)
	3	0.02707	0.01176	2.30 (0.0214)	US1(t-3)
Japan	1	0.22912	0.01418	16.16 (0.0001)	US1(t-1)
	2	0.03062	0.01485	2.06 (0.0393)	US1(t-2)
	3	0.01944	0.01476	1.32 (0.1881)	US1(t-3)

Table 8

Model Parameter Estimates of Residual Returns for Period Prior to Financial Crisis, Pacific Rim Countries

Country	Lag	Estimate	Std Error	t-value (Pr > |t|)	Variable
Period prior to Financial Crisis, N = 2,525					
Australia	1	0.25785	0.01193	21.62 (0.0001)	US1(t-1)
	2	0.02941	0.01294	2.27 (0.0231)	US1(t-2)
	3	0.06775	0.01301	5.21 (0.0001)	US1(t-3)
Hong Kong	1	0.30987	0.01422	21.80 (0 .0001)	US1(t-1)
	2	0.07507	0.01548	4.85 (0.0001)	US1(t-2)
	3	0.05218	0.01553	3.36 (0.0008)	US1(t-3)
Japan	1	0.26178	0.02148	12.19 (0.0001)	US1(t-1)
	2	0.02623	0.02207	1.19 (0.2349)	US1(t-2)
	3	0.00666	0.02214	0.30 (0.7637)	US1(t-3)

Table 9

Model Parameter Estimates of Residual Returns for Period after Financial Crisis, Pacific Rim Countries

Country	Lag	Estimate	Std Error	t-value (Pr > |t|)	Variable
Period after the Financial Crisis, N = 529					
Australia	1	0.19208	0.01848	10.39 (0.0001)	US1(t-1)
	2	0.02568	0.02082	1.23 (0.2180)	US1(t-2)
	3	0.03329	0.02028	1.64 (0.1013)	US1(t-3)
Hong Kong	1	0.21215	0.02245	9.45 (0 .0001)	US1(t-1)
	2	0.10366	0.02484	4.17 (0.0001)	US1(t-2)
	3	0.01798	0.02433	0.74 (0.4603)	US1(t-3)
Japan	1	0.20400	0.02216	9.21 (0.0001)	US1(t-1)
	2	0.04016	0.02419	1.66 (0.0975)	US1(t-2)
	3	0.04774	0.02383	2.00 (0.0457)	US1(t-3)

Table 10

Model Parameter Estimates of Residual Returns for Overall Period, European Countries

Country	Lag	Estimate	Std Error	t-value (Pr > |t|)	Variable
Entire Period, N = 3,054					
France	1	0.28056	0.01634	17.17 (0.0001)	US1(t-1)
	2	0.07302	0.01747	4.18 (0.0001)	US1(t-2)
	3	0.04885	0.01705	2.86 (0.0042)	US1(t-3)
Germany	1	0.24941	0.01862	13.40 (0 .0001)	US1(t-1)
	2	0.06674	0.01952	3.42 (0.0006)	US1(t-2)
	3	0.00999	0.01909	0.52 (0.6006)	US1(t-3)
Switzerland	1	0.24468	0.01580	15.49 (0.0001)	US1(t-1)
	2	0.07034	0.01680	4.19 (0.0001)	US1(t-2)
	3	0.04410	0.01638	2.69 (0.0071)	US1(t-3)
U.K.	1	0.25005	0.01537	16.26 (0.0001)	US1(t-1)
	2	0.05155	0.01642	3.14 (0.0017)	US1(t-2)
	3	0.04591	0.01601	2.87 (0.0042)	US1(t-3)

Table 11

Model Parameter Estimates of Residual Returns for Period Prior to Financial Crisis, European Countries

Country	Lag	Estimate	Std Error	t-value (Pr > |t|)	Variable
Period prior to Financial Crisis, N = 2,525					
France	1	0.37810	0.01889	20.02 (0.0001)	US1(t-1)
	2	0.08493	0.02036	4.17 (0.0001)	US1(t-2)
	3	0.02365	0.02036	1.16 (0.2455)	US1(t-3)
Germany	1	0.28215	0.02138	13.20 (0 .0001)	US1(t-1)
	2	0.06263	0.02210	2.83 (0.0046)	US1(t-2)
	3	0.00176	0.02216	0.08 (0.9365)	US1(t-3)
Switzerland	1	0.36015	0.01934	18.62 (0.0001)	US1(t-1)
	2	0.06210	0.02070	3.00 (0.0027)	US1(t-2)
	3	0.02030	0.02066	0.98 (0.3259)	US1(t-3)

Table 11 (Cont'd)

Model Parameter Estimates of Residual Returns for Period Prior to Financial Crisis, European Countries

Country	Lag	Estimate	Std Error	t-value (Pr > |t|)	Variable
Period prior to Financial Crisis, N = 2,525					
U.K.	1	0.32016	0.01839	17.41 (0.0001)	US1(t-1)
	2	0.07196	0.01951	3.69 (0.0002)	US1(t-2)
	3	0.02488	0.01953	1.27 (0.2028)	US1(t-3)

Table 12

Model Parameter Estimates of Residual Returns for Period after Financial Crisis, European Countries

Country	Lag	Estimate	Std Error	t-value (Pr > |t|)	Variable
Period after the Financial Crisis, N = 529					
France	1	0.20299	0.03847	5.28 (0.0001)	US1(t-1)
	2	0.05031	0.04105	1.23 (0.2209)	US1(t-2)
	3	0.07092	0.03930	1.80 (0.0717)	US1(t-3)
Germany	1	0.22182	0.04417	5.02 (0 .0001)	US1(t-1)
	2	0.08368	0.04705	1.78 (0.0759)	US1(t-2)
	3	0.02203	0.04498	0.49 (0.6246)	US1(t-3)
Switzerland	1	0.15793	0.03417	4.62 (0.0001)	US1(t-1)
	2	0.08085	0.03624	2.23 (0.0261)	US1(t-2)
	3	0.08404	0.03478	2.42 (0.0160)	US1(t-3)

Table 12 (Cont'd)

Model Parameter Estimates of Residual Returns for Period after Financial Crisis, European Countries

Country	Lag	Estimate	Std Error	t-value (Pr > |t|)	Variable
Period after the Financial Crisis, N = 529					
U.K.	1	0.19537	0.03511	5.56 (0.0001)	US1(t-1)
	2	0.03413	0.03789	0.90 (0.3682)	US1(t-2)
	3	0.05956	0.03613	1.65 (0.0998)	US1(t-3)

Table 13

Model Parameter Estimates of Residual Returns, North America

Country	Lag	Estimate	Std Error	t-value (Pr > |t|)	Variable
Panel A: Entire Period, N = 3,054					
Canada	1	0.08507	0.01230	6.92 (0.0001)	US1(t-1)
	2	0.07690	0.01254	6.13 (0.0001)	US1(t-2)
	3	0.05382	0.01238	4.35 (0.0001)	US1(t-3)
Panel B: Period prior to Financial Crisis, N = 2,525					
Canada	1	0.06513	0.01671	3.90 (0 .0001)	US1(t-1)
	2	0.01964	0.01676	1.17 (0.2414)	US1(t-2)
	3	0.03388	0.01685	2.01 (0.0444)	US1(t-3)
Panel C: Period after the Financial Crisis, N = 529					
Canada	1	0.10913	0.02460	4.44 (0.0001)	US1(t-1)
	2	0.13436	0.02560	5.25 (0.0001)	US1(t-2)
	3	0.08083	0.02502	3.23 (0.0013)	US1(t-3)

TABLE 14

State Space Estimates of Linkages Among Banks Returns for the Overall Period

(1) $SW_t = -0.1549\ Au^{***}_{t-1} + 0.2188\ SW^{***}_{t-1} - 0.0940\ FR^{**}_{t-1} + 0.5331\ US^{***}_{t-1} + 0.2695\ CA^{***}_{t-1} - 0.0897\ JA^{***}_{t-1} - 2.0596\ AU^{***}_{t} + \eta_{1,t}$

(2) $GR_t = -0.07224\ Au^{**}_{t-1} + 0.1322\ SW^{***}_{t-1} - 0.1253\ FR^{***}_{t-1} + 0.3054\ US^{***}_{t-1} + \eta_{2,t}$

(3) $FR_t = -0.0705\ Au^{***}_{t-1} + 0.0757\ SW^{**}_{t-1} - 0.2168\ FR^{***}_{t-1} + 0.0661\ UK^{***}_{t-1} + 0.1222\ US^{***}_{t-1} + 0.1308\ CA^{***}_{t-1} + \eta_{3,t}$

(4) $UK_t = -0.0818\ Au^{*}_{t-1} + 0.1675\ SW^{***}_{t-1} - 0.0846\ FR^{***}_{t-1} + 0.4560\ US^{***}_{t-1} + 0.1796\ CA^{***}_{t-1} - 0.0926\ JA^{***}_{t-1} - 1.450\ AU^{***}_{t} + \eta_{4,t}$

(5) $US_t = -0.0704\ FR^{***}_{t-1} - 0.1983\ US^{***}_{t-1} - 0.1026\ CA^{**}_{t-1} + \eta_{5,t}$

(6) $CA_t = 0.1526\ SW^{***}_{t-1} + 0.0593\ UK^{**}_{t-1} + 0.1540\ US^{***}_{t-1} - 0.0888\ HK^{***}_{t-1} - 0.6429\ AU^{***}_{t} + \eta_{6,t}$

(7) $HK_t = -.0545\ GR^{***}_{t-1} + 0.2655\ UK^{***}_{t-1} - 0.0731\ HK^{***}_{t-1} + 1.0392\ AU^{***}_{t} + \eta_{7,t}$

(8) $JA_t = -0.0803 Au^{***}_{t-1} + 0.1045\ SW^{***}_{t-1} + 0.0764\ GR^{***}_{t-1} + 0.1253\ UK^{***}_{t-1} + 0.2716\ US^{***}_{t-1} - 0.0794\ HK^{**}_{t-1} - 0.7309\ AU^{**}_{t} + \eta_{8,t}$

(9) $AU_t = -0.0187\ FR^{***}_{t-1} - 0.06693\ US^{***}_{t-1} - 0.0343\ CA^{***}_{t-1} + 0.0310\ HK^{***}_{t-1} + 0.3381\ AU^{***}_{t} + 0.0847^{***}\ \eta_{1,t} + 0.0629^{***}\ \eta_{4,t} + 0.1501^{***}\ \eta_{5,t} + 0.0744^{***}\ \eta_{6,t} - 0.0864^{***}\eta_{7,t} - 0.0353^{***}\eta_{8,t} + \eta_{9,t}$

Notes:

*** indicates that result is significant at the 1 percent level
** indicates that result is significant at the 5 percent level
SW = Switzerland bank return

Table 15

Correlation Matrix for Returns Volatility

Pearson Correlation Coefficients, N = 3054
Prob > |r| under H0: Rho=0

	au2	sw2	ge2	fr2	uk2	us2	ca2	hk2	ja2
au2	1.00000	0.47485	0.29543	0.36896	0.38325	0.21347	0.24287	0.33724	0.30882
		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
sw2	0.47485	1.00000	0.65721	0.61601	0.64074	0.33952	0.30582	0.35054	0.30935
	<.0001		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
ge2	0.29543	0.65721	1.00000	0.60134	0.56574	0.44023	0.31479	0.45152	0.30837
	<.0001	<.0001		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
fr2	0.36896	0.61601	0.60134	1.00000	0.65664	0.35212	0.19620	0.37316	0.21877
	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001	<.0001	<.0001
uk2	0.38325	0.64074	0.56574	0.65664	1.00000	0.33850	0.21113	0.31374	0.26335
	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001	<.0001
us2	0.21347	0.33952	0.44023	0.35212	0.33850	1.00000	0.38523	0.17666	0.10573
	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001
ca2	0.24287	0.30582	0.31479	0.19620	0.21113	0.38523	1.00000	0.25663	0.27356
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001
hk2	0.33724	0.35054	0.45152	0.37316	0.31374	0.17666	0.25663	1.00000	0.39396
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001
ja2	0.30882	0.30935	0.30837	0.21877	0.26335	0.10573	0.27356	0.39396	1.00000
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	

Note: Each entry in this table represents the contemporaneous correlation coefficient of the log of the daily returns volatility between a pair of countries for the entire data set period of January 4, 1999 through September 24, 2010.

Table 16

Granger-Causality Wald Test for Returns Volatility, Pacific Rim Countries

This Granger-causality test provides a directional causation test providing evidence of whether the U.S. national banking sector index is influencing or exerting directional momentum on the other respective national banking sector indices or vice versa. Each country is paired with the U.S. national banking sector index to determine whether the U.S. index influences the respective national banking sector indices or vice versa.

Country	Chi-Square	Pr > Chi-Square
Panel A: Entire Period, N = 3,054		
Australia	228.31	< .0001
U.S.	82.76	< .0001
Hong Kong	31.13	< .0001
U.S.	46.49	< .0001
Japan	68.71	< .0001
U.S.	29.52	< .0001
Panel B: Period prior to Financial Crisis, N = 2,525		
Australia	179.39	< .0001
U.S.	107.63	< .0001
Hong Kong	35.89	< .0001
U.S.	65.72	< .0001
Japan	29.57	< .0001
U.S.	15.29	0.0016
Panel C: Period after the Financial Crisis, N = 529		
Australia	37.30	< .0001
U.S.	11.80	0.0081
Hong Kong	2.38	0.4933
U.S.	5.38	0.1459
Japan	13.30	0.0040
U.S.	6.84	0.0771

Table 17

Granger-Causality Wald Test for Returns Volatility, European Countries

This Granger-causality test provides a directional causation test providing evidence of whether the U.S. national banking sector index is influencing or exerting directional momentum on the other respective national banking sector indices or vice versa. Each country is paired with the U.S. national banking sector index to determine this causal connection.

Country	Chi-Square	Pr > Chi-Square
Panel A: Entire Period, N = 3,054		
France	105.54	< .0001
U.S.	63.71	< .0001
Germany	9.40	0.0244
U.S.	80.17	< .0001
Switzerland	68.84	< .0001
U.S.	94.12	< .0001
U.K.	127.40	< .0001
U.S.	158.79	< .0001
Panel B: Period prior to Financial Crisis, N = 2,525		
France	77.95	< .0001
U.S.	58.99	< .0001
Germany	42.66	< .0001
U.S.	11.95	0.0076
Switzerland	118.82	< .0001
U.S.	49.52	< .0001
U.K.	143.42	< .0001
U.S.	64.95	< .0001

Table 17 (Cont'd)

Granger-Causality Wald Test for Returns Volatility, European Countries

This Granger-causality test provides a directional causation test providing evidence of whether the U.S. national banking sector index is influencing or exerting directional momentum on the other respective national banking sector indices or vice versa. Each country is paired with the U.S. national banking sector index to determine this causal connection.

Country	Chi-Square	Pr > Chi-Square
Panel C: Period after the Financial Crisis, N = 529		
France	17.50	0.0006
U.S.	8.39	0.0386
Germany	2.57	0.4625
U.S.	14.65	0.0021
Switzerland	12.31	0.0064
U.S.	8.83	0.0316
U.K.	17.23	0.0006
U.S.	26.26	<.0001

Table 18

Granger-Causality Wald Test for Returns Volatility, North America

This Granger-causality test provides a directional causation test providing evidence of whether the US national banking sector index is influencing or exerting directional momentum on the other respective national banking sector indices or vice versa. Each country is paired with the US national banking sector index to determine whether the US index influences the respective national banking sector indices or vice versa.

Country	Chi-Square	Pr > Chi-Square
Panel A: Entire Period, N = 3,054		
Canada	110.20	<.0001
U.S.	70.04	<.0001
Panel B: Period prior to Financial Crisis, N = 2,525		
Canada	16.37	0.0008
U.S.	36.37	<.0001
Panel C: Period after the Financial Crisis, N = 529		
Canada	18.79	0.0003
U.S.	13.63	0.0035

Table 19

Model Parameter Estimates of Returns Volatility for Overall Period, Pacific Rim Countries

Country	Lag	Estimate	Std Error	t-value (Pr > |t|)	Variable
Entire Period, N = 3,054					
Australia	1	0.04143	0.00313	13.22 (0.0001)	US2(t-1)
	2	-0.00118	0.00324	-0.37 (0.7146)	US2(t-2)
	3	0.01684	0.00321	5.24 (0.0001)	US2(t-3)
Hong Kong	1	0.02667	0.00579	4.61 (0 .0001)	US2(t-1)
	2	0.00203	0.00583	0.35 (0.7279)	US2(t-2)
	3	0.01142	0.00578	1.79 (0.0488)	US2(t-3)
Japan	1	0.04564	0.00671	6.80 (0.0001)	US2(t-1)
	2	-0.00607	0.00680	-0.89 (0.3720)	US2(t-2)
	3	0.02370	0.00674	3.52 (0.0004)	US2(t-3)

Table 20

Model Parameter Estimates of Returns Volatility for Period Prior to Financial Crisis, Pacific Rim Countries

Country	Lag	Estimate	Std Error	t-value (Pr > |t|)	Variable
Period prior to Financial Crisis, N = 2,525					
Australia	1	0.06949	0.00597	11.65 (0.0001)	US2(t-1)
	2	-0.00922	0.00616	-1.50 (0.1347)	US2(t-2)
	3	0.02935	0.00606	4.84 (0.0001)	US2(t-3)
Hong Kong	1	0.04774	0.00933	5.12 (0 .0001)	US2(t-1)
	2	-0.00346	0.00938	-0.37 (0.7123)	US2(t-2)
	3	0.01810	0.00931	1.94 (0.0520)	US2(t-3)
Japan	1	0.06963	0.01416	4.92 (0.0001)	US2(t-1)
	2	0.01711	0.01421	1.20 (0.2287)	US2(t-2)
	3	-0.00728	0.01425	-0.51 (0.6092)	US2(t-3)

Table 21

Model Parameter Estimates of Returns Volatility for Period after Financial Crisis, Pacific Rim Countries

Country	Lag	Estimate	Std Error	t-value (Pr > |t|)	Variable
Period after the Financial Crisis, N = 529					
Australia	1	0.03480	0.00639	5.45 (0.0001)	US2 (t-1)
	2	-0.00159	0.00657	-0.24 (0.8088)	US2(t-2)
	3	0.01437	0.00655	2.19 (0.0286)	US2(t-3)
Hong Kong	1	0.01759	0.01280	1.37 (0 .1700)	US2(t-1)
	2	-0.00218	0.01284	-0.17 (0.8654)	US2(t-2)
	3	0.00699	0.01278	0.55 (0.5848)	US2(t-3)
Japan	1	0.03727	0.01217	3.06 (0.0023)	US2(t-1)
	2	-0.01152	0.01233	-0.93 (0.3505)	US2(t-2)
	3	0.02040	0.01225	1.66 (0.0966)	US2(t-3)

Table 22

Model Parameter Estimates of Returns Volatility for Overall Period, European Countries

Country	Lag	Estimate	Std Error	t-value (Pr > |t|)	Variable
Entire Period, N = 3,054					
France	1	0.05984	0.01098	5.45 (0.0001)	US2(t-1)
	2	0.00374	0.01100	0.34 (0.7342)	US2(t-2)
	3	0.08553	0.01092	7.83 (0.0001)	US2(t-3)
Germany	1	0.02486	0.01341	1.85 (0 .0638)	US2(t-1)
	2	-0.02933	0.01337	-2.19 (0.0283)	US2(t-2)
	3	0.01802	0.01329	1.36 (0.1752)	US2(t-3)
Switzerland	1	0.07007	0.00938	7.47 (0.0001)	US2(t-1)
	2	0.00985	0.00946	1.04 (0.2977)	US2(t-2)
	3	0.04630	0.00940	4.93 (0.0001)	US2(t-3)
U.K.	1	0.09782	0.00950	10.29 (0.0001)	US2(t-1)
	2	-0.00136	0.00926	-0.14 (0.8874)	US2(t-2)
	3	0.03578	0.00946	3.78 (0.0002)	US2(t-3)

Table 23

Model Parameter Estimates of Returns Volatility for Period Prior to Financial Crisis, European Countries

Country	Lag	Estimate	Std Error	t-value (Pr > |t|)	Variable
Period prior to Financial Crisis, N = 2,525					
France	1	0.10200	0.01440	7.08 (0.0001)	US2(t-1)
	2	0.05520	0.01450	3.81 (0.0001)	US2(t-2)
	3	-0.01136	0.014668	-0.78 (0.4382)	US2(t-3)
Germany	1	0.08910	0.01354	6.05 (0 .0001)	US2(t-1)
	2	0.01831	0.01360	1.35 (0.1785)	US2(t-2)
	3	-0.01515	0.01370	-1.11 (0.2689)	US2(t-3)
Switzerland	1	0.12403	0.01201	10.32 (0.0001)	US2(t-1)
	2	0.01836	0.01224	1.50 (0.1338)	US2(t-2)
	3	-0.00486	0.01224	-0.40 (0.6914)	US2(t-3)

Table 23 (Cont'd)

Model Parameter Estimates of Returns Volatility for Period Prior to Financial Crisis, European Countries

Country	Lag	Estimate	Std Error	t-value (Pr > |t|)	Variable
Period prior to Financial Crisis, N = 2,525					
U.K.	1	0.10713	0.01013	10.57 (0.0001)	US2(t-1)
	2	0.03714	0.01033	3.79 (0.0002)	US2(t-2)
	3	-0.009680	0.01042	-0.93 (0.3526)	US2(t-3)

Table 24

Model Parameter Estimates of Returns Volatility for Period after Financial Crisis, European Countries

Country	Lag	Estimate	Std Error	t-value (Pr > |t|)	Variable
Period after the Financial Crisis, N = 529					
France	1	0.04729	0.02549	1.86 (0.0642)	US2(t-1)
	2	-0.01370	0.02548	-0.54 (0.5911)	US2(t-2)
	3	0.09081	0.02528	3.59 (0.0004)	US2(t-3)
Germany	1	0.00055	0.03304	0.02 (0 .9866)	US2(t-1)
	2	-0.05266	0.03293	-1.60 (0.1104)	US2(t-2)
	3	0.00218	0.03279	0.07 (0.9469)	US2(t-3)
Switzerland	1	0.05715	0.02171	2.63 (0.0087)	US2(t-1)
	2	0.00210	0.02185	0.10 (0.9234)	US2(t-2)
	3	0.04561	0.02172	2.10 (0.0362)	US2(t-3)

Table 24 (Cont'd)

Model Parameter Estimates of Returns Volatility for Period after Financial Crisis, European Countries

Country	Lag	Estimate	Std Error	t-value (Pr > |t|)	Variable
Period after the Financial Crisis, N = 529					
U.K.	1	0.08853	0.02326	3.81 (0.0002)	US2(t-1)
	2	-0.01514	0.02345	-0.65 (0.5188)	US2(t-2)
	3	0.03261	0.02305	1.41 (0.1578)	US2(t-3)

Table 25

Model Parameter Estimates of Returns Volatility, North America

Country	Lag	Estimate	Std Error	t-value (Pr > |t|)	Variable
Panel A: Entire Period, N = 3,054					
Canada	1	0.04511	0.00498	9.05 (0.0001)	US2(t-1)
	2	0.00366	0.00502	0.73 (0.4664)	US2(t-2)
	3	0.02058	0.00498	4.13 (0.0001)	US2(t-3)
Panel B: Period prior to Financial Crisis, N = 2,525					
Canada	1	0.02699	0.00692	3.90 (0 .0001)	US2(t-1)
	2	0.00478	0.00692	0.69 (0.4896)	US2(t-2)
	3	-0.00320	0.00696	-0.46 (0.6458)	US2(t-3)
Panel C: Period after the Financial Crisis, N = 529					
Canada	1	0.04474	0.01165	3.84 (0.0001)	US2(t-1)
	2	-0.00139	0.01175	-0.12 (0.9059)	US2(t-2)
	3	0.02077	0.01164	1.78 (0.0751)	US2(t-3)

TABLE 26

State Space Estimates of Linkages Among Banks Returns Volatility for the Overall Period

(1) $SW2_t = -0.1127\ AU2^{**}_{t-1} - 0.1013\ SW2^{***}_{t-1} - 0.0326\ GR2^{**}_{t-1} + 0.1464\ CA2^{***}_{t-1} + 0.2370\ HK2^{***}_{t-1} - 0.0897\ JA2^{***}_{t-1} + 2.464\ AU2^{***}_{t} + \varsigma_{1,t}$

(2) $GR2_t = -1.2248\ AU2^{**}_{t-1} - 0.3397\ SW2^{***}_{t-1} - 0.1484\ GR2^{***}_{t-1} + 0.1380\ UK2^{***}_{t-1} - 0.1810\ US2^{***}_{t-1} + 0.4755\ HK2^{***}_{t-1} + 0.2406\ JA2^{***}_{t-1} + 6.5321\ AU2^{***}_{t} + \varsigma_{2,t}$

(3) $FR2_t = -0.4673\ AU2^{***}_{t-1} - 0.2832\ SW2^{**}_{t-1} - 0.0802\ FR2^{**}_{t-1} + 0.1444\ UK2^{***}_{t-1} - 0.0551\ US2^{***}_{t-1} + 0.1720\ CA2^{***}_{t-1} + 0.2710\ HK2^{***}_{t-1} + 3.1182\ AU2^{***}_{t} + \varsigma_{3,t}$

(4) $UK2_t = -0.4992\ AU2^{***}_{t-1} - 0.1983\ SW2^{***}_{t-1} - 0.1260\ GR2^{***}_{t-1} + 0.0520\ FR2^{***}_{t-1} + 0.0872\ UK2^{***}_{t-1} + 0.0912\ CA2^{***}_{t-1} + 0.2333\ HK2^{***}_{t-1} - 0.0926\ JA2^{***}_{t-1} + 2.795\ AU2^{***}_{t} + \varsigma_{4,t}$

(5) $US2_t = -0.4559\ AU2^{***}_{t-1} - 0.2651\ SW2^{***}_{t-1} + 0.3279\ UK2^{***}_{t-1} - 0.0603\ US2^{***}_{t-1} + 0.1574\ CA2^{**}_{t-1} + 0.2871\ HK2^{***}_{t-1} + 4.7166\ AU2^{***}_{t} + \varsigma_{5,t}$

(6) $CA2_t = 0.0785\ SW2^{***}_{t-1} + 0.0204\ FR2^{**}_{t-1} - 0.0366\ CA2^{**}_{t-1} + 0.1137\ HK2^{***}_{t-1} - 0.0324\ JA2^{***}_{t-1} + 0.9263\ AU2^{***}_{t} + \varsigma_{6,t}$

(7) $HK_t = -0.4025\ AU2^{***}_{t-1} - 0.1459\ GR2^{***}_{t-1} - 0.0609\ FR2^{**}_{t-1} - 0.0366\ CA2^{**}_{t-1} + 0.3251\ HK2^{***}_{t-1} + 0.1507\ JA2^{***}_{t-1} + 0.9263\ AU2^{***}_{t} + \varsigma_{7,t}$

(8) $JA2_t = -0.4616\ AU2^{***}_{t-1} - 0.0533\ GR2^{***}_{t-1} + 0.0359\ UK2^{**}_{t-1} - 0.0503\ US2^{***}_{t-1} - 0.1340\ HK2^{***}_{t-1} + 0.0598\ JA2^{***}_{t-1} + 2.4050\ AU2^{**}_{t} + \varsigma_{8,t}$

(9) $AU_t = -0.1349\ AU2^{***}_{t-1} - 0.0581\ SW2^{***}_{t-1} - 0.02161\ GR2^{***}_{t-1} + 0.0186\ FR2^{***}_{t-1} - 0.0290\ US2^{***}_{t-1} - 0.0228\ CA2^{***}_{t-1} + 0.0620\ HK2^{***}_{t-1} + 0.0129\ JA2^{**}_{t-1} + 1.3445\ AU2^{***}_{t} + 0.1410^{***}\varsigma_{1,t} + 0.0580^{***}\varsigma_{2,t} + 0.0182^{***}\varsigma_{3,t} - 0.0157^{***}_{t-1}\varsigma_{4,t} + 0.0270^{***}\varsigma_{6,t} + 0.0380^{***}\varsigma_{7,t} - 0.0543^{***}\varsigma_{8,t} + \varsigma_{9,t}$

Notes:

*** indicates that result is significant at the 1 percent level
** indicates that result is significant at the 5 percent level
SW2 = Switzerland bank return volatility

VITA

James Benton received his Ph.D. in finance and his MA in economics from Old Dominion in 2013, his J.D., Masters of Science in Personal Financial Planning, and Masters of Taxation from Georgia State University in 2000, 1998, and 1997 respectively as well as his B.S. in Accounting and Finance from Northern Illinois University. His research focus includes individual and business entity taxation, retirement and estate planning topics as well as basic financial literacy issues. He is a licensed attorney in Georgia in addition to being a CPA/PFS and a CFP. He is currently an Associate Professor in the Accounting and Finance Departments in the John L. Grove College of Business at Shippensburg University where he also serves as the Director of the Personal Financial Planning Program. Additionally, he continues to work as a fee only Financial Planner in his firm, The Benton Financial Group, LLC and provide financial literacy corporate training through his other firm, The Financial Literacy Academy, LLC.