



**UNIVERSITI PUTRA MALAYSIA**

***EFFECTS OF COUNTRY DEBT RISK AND DETERMINANT INDICATORS  
ON VOLATILITY CONTAGION IN SIX SELECTED ASIAN COUNTRIES***

**LEE SEE NIE**

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**EFFECTS OF COUNTRY DEBT RISK AND DETERMINANT INDICATORS  
ON VOLATILITY CONTAGION IN SIX SELECTED ASIAN COUNTRIES**

By

**LEE SEE NIE**

**Thesis Submitted to the Graduate School of Management, Universiti Putra  
Malaysia, in Fulfillment of the Requirements for the Degree of  
Doctor of Philosophy**

**August 2016**

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the Degree of Doctor of Philosophy

## **EFFECTS OF COUNTRY DEBT RISK AND DETERMINANT INDICATORS ON VOLATILITY CONTAGION IN SIX SELECTED ASIAN COUNTRIES**

By

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**August 2016**

**Chairman : Associate Professor Cheng Fan Fah, PhD**  
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Volatility contagion has become a trend of financial crisis research ever since the outbreak of 2007 Sub-prime crisis in the US. Existing contagion studies are either too sector based, or focus on specific financial product so there is a lack of comprehensive study to incorporate multiple indicators driving the volatility contagion. This study analysed multiple sources that can be associated with volatility contagion, comprising both the financial and non-financial sectors, market information, macroeconomic financial variables, country debt risks and external factors (S&P 500) combined together as variety types of indicators driving the volatility contagion. A generalised VAR-GARCH with multivariate BEKK-GARCH approach is employed to analyse volatility contagion of daily sectorial indices of six Asian countries (Indonesia, Japan, Malaysia, South Korea, Thailand and the Philippines from 1990 until 2015). When AIC criterion information was analysed, it showed that the VAR(1)-GARCH(1,1) model benchmark was robust. This covers four financial crisis: Savings and Loan Crisis (early 1990s), Asian Financial Crisis (1997), the Internet Bubble Bursting (2002) and the Sub-prime Mortgage Crisis (2007).

The research design is partitioned into three stages. The first stage is analyse the structure of volatility contagion within the selected six Asia countries and US. The start of financial crisis, strong interconnection exists between bank credit risk and sovereign credit risk. And, a high country debt risk will lead to instability economy in a country and then slip into a contagion circumstances. However, there is lack of literature provide empirical evidence of the country debt risk on volatility contagion. Hence, in the second stage, this study measure country debt risk to explore whether the volatility contagion is driven by country debt risk fluctuation. And lastly is testing the main objective. Although many of the previous research investigated indicators of volatility contagion, but there is still a lack of comprehensive investigation on the combination of variety types of indicators. After filtering down the possible indicators of volatility contagion, this study identify the fourteen major

indicators from different sectors driving the volatility contagion, country debt risk is one of them.

The results documented statistical evidence at highly significant of volatility contagion during all the selected four financial crisis, except for South Korea and the Philippines, no volatility contagion was shown between these two countries during the period of Savings and Loan Crisis. This study further explore on a determinant of volatility contagion that receive rare attention in the literature - country debt risk with a Two-limit Tobit model. This study proxy it by debt service capacity which is measured by quarterly-ahead debt restructuring ratios. The result reveals that the country debt risk had increased for all the countries during and after six financial crisis and it is one of the important indicators driving volatility contagion. Furthermore, our findings revealed that the volatility contagion was not caused by a single factor. Rather, all volatility contagion have multiple indicators. This is contrary to previous studies which focused only on specific sectors or products.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

**BUKTI-BUKTI BERDASARKAN HUTANG RISIKO NEGARA DAN  
PETUNJUK PENENTU DALAM KETAKTENTUAN PENULARAN DALAM  
ENAM NEGARA ASIAN DIPILIH**

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Ketaktentuan penularan telah menjadi trend penyelidikan krisis kewangan sejak peletusan krisis Sub-prima 2007 di US. Kajian penularan sedia ada sama ada terlalu berasaskan sektor atau lebih spesifik kepada produk kewangan. Justeru, terdapat kekurangan kajian komprehensif yang menggabungkan pelbagai penunjuk yang memacu ketaktentuan penularan. Kajian ini menganalisis pelbagai sumber yang boleh dikaitkan dengan ketaktentuan penularan terdiri daripada sektor kewangan dan bukan kewangan, maklumat pasaran, pemboleh ubah kewangan makroekonomi, risiko negara, dan faktor luaran (SP&500) bergabung bersama menjadi pelbagai jenis penunjuk yang memacu ketaktentuan penularan. VAR-GARCH umum dengan pendekatan BEKK-GARCH multivariat digunakan untuk menganalisis ketaktentuan penularan indeks sektor harian enam negara Asia (Indonesia, Jepun, Malaysia, Korea Selatan, Thailand, dan Filipina) dari 1990 hingga 2015. Apabila kriteria AIC dianalisis, keputusan menunjukkan bahawa model penanda aras VAR(1)-GARCH(1,1) adalah teguh. Empat krisis kewangan diambil kira: Krisis Simpanan dan Pinjaman (awal 1990an), Krisis Kewangan Asia (1997), Letusan Gelembung Internet (2002), dan Krisis Gadai Janji Sub-prima (2007).

Reka bentuk kajian ini dipecah bahagi kepada tiga peringkat. Peringkat pertama ialah analisis ketaktentuan penularan antara pasaran saham bagi kepilihan enam negara Asia dan US. Risiko negara akan mambawa kepada ekonomi negara tidak stabil dan amengakibatkan letaktentuan penularan. Namun, masih tiada kajian menganalisis risiko negara sebagai faktor mengakibatkan ketaktentuan penularan. Dalam kajian ini, satu daripada empat belas penunjuk yang memacu ketaktentuan penularan ialah risiko negara. Oleh itu, dalam peringkat kedua, tujuan kajian ini adalah untuk menyelidik risiko negara. Pelbagai kajian menganalisis ketaktentuan penularan namun masih tiada kajian analisis terhadap pelbagai jenis penunjuk yang memacu ketaktentuan penularan. Oleh itu, peringkat akhir sekali adalah pengujian objektif utama iaitu menyelidik pelbagai jenis penunjuk yang memacu ketaktentuan penularan.

Hasil kajian merekodkan bukti statistik yang sangat signifikan untuk ketaktentuan penularan semasa keempat-empat krisis kewangan yang terpilih, melainkan Korea Selatan dan Filipina; ketaktentuan penularan tidak berlaku di kedua-dua buah negara ini semasa Krisis Simpanan dan Pinjaman. Kajian ini menyiasat lebih lanjut penentu untuk ketaktentuan penularan yang jarang mendapat perhatian dalam sorotan literatur – risiko negara menggunakan model Torbit Dua-had. Kami proksikannya dengan kapasiti pembiayaan hutang yang diukur dengan nisbah penstrukturan semula hutang suku tahunan hadapan. Keputusan menunjukkan bahawa risiko negara meningkat untuk kesemua negara semasa dan selepas enam krisis kewangan tersebut dan ini merupakan salah satu penunjuk penting yang memacu ketaktentuan penularan. Selain itu, hasil kajian kami mendedahkan bahawa ketaktentuan penularan bukan disebabkan oleh satu faktor sahaja. Malah, kajian menunjukkan bahawa ketaktentuan penularan disebabkan oleh pelbagai penunjuk. Hal ini bertentangan dengan dapatan kajian lepas yang hanya memfokus kepada sektor atau produk yang spesifik.

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I certify that the examination committee met on 10<sup>th</sup> August 2016 to conduct the final examination of Lee See Nie on her thesis titled “Effects of Country Debt Risk and Determinant Indicators on Volatility Contagion in Six Selected Asian Countries” in accordance with the Universities and University Colleges Act 1971 and the Constitution recommends that the student be awarded the degree of Doctor of Philosophy.

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## TABLE OF CONTENTS

		<b>Page</b>
	<b>ABSTRACT</b>	i
	<b>ABSTRAK</b>	iii
	<b>ACKNOWLEDGEMENTS</b>	v
	<b>APPROVAL</b>	vi
	<b>DECLARATION</b>	viii
	<b>LIST OF TABLES</b>	xiii
	<b>LIST OF FIGURES</b>	xvi
	<b>LIST OF APPENDICES</b>	xvii
	<b>LIST OF ABBREVIATIONS</b>	xviii
	<b>CHAPTER</b>	
<b>1</b>	<b>INTRODUCTION</b>	1
	1.1 Background of the Study	1
	1.2 Problem Statement	7
	1.3 Motivation of the Study	8
	1.4 Research Questions and Objectives of the Study	9
	1.5 Benefits of the Study	10
<b>2</b>	<b>OVERVIEW OF STOCK MARKETS IN SIX ASIA COUNTRIES</b>	12
	2.1 Introduction	12
	2.2 The Indonesia Stock Exchange (SSX)	12
	2.3 The Japan Stock Market (Nikkei 225)	14
	2.4 The Kuala Lumpur Composite Index (KLCI)	15
	2.5 The Korea Exchange (KOSPI)	17
	2.6 The Stock Exchange of Thailand Index (SET)	20
	2.7 The Philippines Stock Exchange (PSE)	22
	2.8 Chapter Summary	24
<b>3</b>	<b>LITERATURE REVIEW</b>	26
	3.1 Introduction	26
	3.2 Research on Financial Contagion	26
	3.2.1 Financial Contagion	26
	3.2.2 Volatility Contagion	28
	3.3 Financial Sectors on Financial Contagion Empirical Studies	29
	3.3.1 Herding Behavior	29
	3.4 Non-Financial Sectors on Financial Contagion Empirical Studies	29
	3.5 Macroeconomics Variables on Financial Contagion Empirical Studies	30
	3.5.1 The Effect of Inflation on Company's Performance and Share Price	30
	3.5.2 The Effect of Interest Rate on Company's Performance and Share Price	31

3.5.3	The Effect of Exchange Rate on Company's Performance and Share Price	32
3.5.4	The Effect of Capital Flow on Financial Contagion	32
3.5.5	The Effect of Money Supply on Financial Contagion	33
3.6	The Indicators on Crisis	33
3.7	Global Financial Contagion Empirical Studies	33
3.8	Domestic Financial Contagion Empirical Studies	35
3.9	Past Research of Models Applied on Financial Contagion Test	35
3.10	Debt Crisis Prediction Empirical Studies	36
3.11	Theories used in this Study	36
3.11.1	Crisis-Contingent Theories	37
3.12	Chapter Summary	38
<b>4</b>	<b>METHODOLOGY, HYPOTHESES, DATA AND RESEARCH DESIGN</b>	<b>40</b>
4.1	Introduction	40
4.2	The Models applied Indicators of the Volatility Contagion	40
4.2.1	Bivariate VAR(1)-GARCH(1,1) Model	41
4.2.2	Bivariate AR(1)-GARCH(1,1) Model	42
4.3	Country Debt Risk Assessment Model	44
4.3.1	Indicators of the Country Debt Risk Assessment Model	45
4.3.2	The Tobit Model: Censored and Truncated Regression Models	47
4.3.3	Two-limit Tobit Model	47
4.4	Regression Analysis	49
4.5	Hypothesis of the Research	51
4.5.1	The Hypothesis Test	51
4.6	Data and Preliminary Analysis	52
4.7	Research Design	62
4.8	Chapter Summary	62
<b>5</b>	<b>VOLATILITY CONTAGION ESTIMATION RESULTS</b>	<b>64</b>
5.1	Introduction	64
5.2	Volatility Contagion between Six Asia Countries During Four Crisis Periods	64
5.3	Volatility Contagion Between the US and Selected Six Asia Countries During Four Crisis Periods	78
5.4	Model Selected Based on AIC Criterion	82
5.5	Ranking of Volatility Contagion Within Selected Six Asia Countries and the US During Four Crisis Periods	87
5.6	Chapter Summary	93
<b>6</b>	<b>THE COUNTRY DEBT RISK MEASUREMENT RESULTS</b>	<b>94</b>
6.1	Introduction	94
6.2	The Parameter Estimates of the Debt Rescheduling Risk by Two-limit Tobit Model	94

6.3	The Actual and Expected Coefficient Signs of Country Debt Risk Measurement	96
6.4	Chapter Summary	99
<b>7</b>	<b>THE INDICATORS DRIVING THE VOLATILITY CONTAGION ESTIMATION RESULTS</b>	<b>101</b>
7.1	Introduction	101
7.2	The Significance of Fourteen Indicators Driving the Volatility Contagion During the Four Crisis Periods	101
7.2.1	The Significant of Fourteen Indicators Driving the Volatility Contagion During Savings and Loan Crisis	102
7.2.2	The Significant of Fourteen Indicators Driving the Volatility Contagion During Asian Financial Crisis	105
7.2.3	The Significant of Fourteen Indicators Driving the Volatility Contagion During Internet Bubble Bursting	108
7.2.4	The Significant of Fourteen Indicators Driving the Volatility Contagion During Sub-prime Mortgage Crisis	111
7.3	Chapter Summary	114
<b>8</b>	<b>CONCLUSION AND RECOMMENDATIONS</b>	<b>115</b>
8.1	Conclusions	115
8.2	Limitations of the Study	118
8.3	Contributions of the Study	118
8.4	Suggestions for Further Research	119
	<b>REFERENCES</b>	<b>120</b>
	<b>APPENDICES</b>	<b>130</b>

## LIST OF TABLES

Table		Page
2.1	The size change of the Domestic Capital Market during 1990 to 2008.	19
4.1	Variables and definitions of country debt risk estimation	46
4.2	The sample period of the study	53
4.3	Descriptive statistic of return series	54
4.4	Descriptive statistics of volatility contagion estimation	55
4.5	Descriptive statistics of fourteen indicators driving the volatility contagion during four chosen crisis periods	57
4.6	Descriptive statistics of each variable in ratio of country debt risk estimation	60
4.7	Descriptive statistics of each variable of country debt risk estimation	61
5.1a	VAR(1)-GARCH(1,1) model estimation for six Asia countries during Savings and Loan Crisis	65
5.1b	VAR(1)-GARCH(1,1) model estimation for six Asia countries during Asian Financial Crisis	68
5.1c	VAR(1)-GARCH(1,1) model estimation for six Asia countries during Internet Bubble Bursting 2002	71
5.1d	VAR(1)-GARCH(1,1) model estimation for six Asia countries during Sub-prime Mortgage Crisis	74
5.2a	VAR(1)-GARCH(1,1) model estimation for the US stock market and Asia countries during Savings and Loan Crisis	78
5.2b	VAR(1)-GARCH(1,1) model estimation for the US stock market and Asia countries during Asian Financial Crisis	79
5.2c	VAR(1)-GARCH(1,1) model estimation for the US stock market and Asia countries during Internet Bubble Bursting 2002	80
5.2d	VAR(1)-GARCH(1,1) model estimation for the US stock market and Asia countries during Sub-prime Mortgage Crisis	81



5.3a	Estimates of AIC criterion information on BEKK-GARCH and VAR-GARCH models during Savings and Loan Crisis	83
5.3b	Estimates of AIC criterion information on BEKK-GARCH and VAR-GARCH models during Asian Financial Crisis	84
5.3c	Estimates of AIC criterion information on BEKK-GARCH and VAR-GARCH models during Internet Bubble Bursting	85
5.3d	Estimates of AIC criterion information on BEKK-GARCH and VAR-GARCH models during Sub-prime Mortgage Crisis	86
5.4a	Ranking of volatility contagion in Asia countries during Savings and Loan Crisis	87
5.4b	Ranking of volatility contagion from the US to Asia country during Savings and Loan Crisis	87
5.4c	Ranking of volatility contagion from the US to Asia country after Savings and Loan Crisis	88
5.5a	Ranking of volatility contagion in Asia countries during Asian Financial Crisis	88
5.5b	Ranking of volatility contagion from the US to Asia countries during Asian Financial Crisis	89
5.5c	Ranking of volatility contagion from the US to Asia country after Asian Financial Crisis	89
5.6a	Ranking of volatility contagion in Asia countries during Internet Bubble Bursting	90
5.6b	Ranking of volatility contagion from the US to Asia country during Internet Bubble Bursting	90
5.6c	Ranking of volatility contagion from the US to Asia country after Internet Bubble Bursting	91
5.7a	Ranking of volatility contagion in Asia countries during Sub-prime Mortgage Crisis	91
5.7b	Ranking of volatility contagion from the US to Asia country during Sub-prime Mortgage Crisis	92
5.7c	Ranking of volatility contagion from the US to Asia country after Sub-prime Mortgage Crisis	92
6.1	Parameter estimates of the debt rescheduling risk by Two-limit Tobit Model	94

6.2	The actual and expected coefficient signs of country rescheduling risk	96
7.1	Estimates of correlation between fourteen variables with volatility contagion during Savings and Loan Crisis	103
7.2	Estimates of correlation between fourteen variables with volatility contagion during Asian Financial Crisis	106
7.3	Estimates of correlation between fourteen variables with volatility contagion during Internet Bubble Bursting	109
7.4	Estimates of correlation between fourteen variables with volatility contagion during Sub-prime Mortgage Crisis	112



## LIST OF FIGURES

Figure		Page
6.1	The percentage of country debt risk fluctuation in Malaysia, Indonesia and Thailand from 1Q1980 – 1Q2013	97
6.2	The percentage of country debt risk fluctuation of Philippines, Japan and South Korea from 1Q1980 – 1Q2013	98



## LIST OF APPENDICES

Appendix		Page
A1	The dependent variable use for measure country risk	130
A2	The independent variable use for measure country Risk	130
A3	Parameter Estimates of Diagnostic Test of Country Debt Risk	131
A4	The Country Debt Risk Fluctuation (%)	132
B1	Selected Asian economies: cost of crisis in the 1990s	134
B2	Percentage of firms unable to meet current debt repayment	134
B3	The financial sectors in Asia market	135
B4	The non-financial sectors in Asia market	136
C1	Regression analysis of fourteen variables on volatility contagion during four crisis periods <ul style="list-style-type: none"><li>● Estimation correlation of fourteen variables on volatility contagion during Savings and Loan Crisis</li><li>● Estimation correlation of fourteen variables on volatility contagion during Asian Financial Crisis</li><li>● Estimation correlation of fourteen variables on volatility contagion during Internet Bubble Bursting 2002</li><li>● Estimation correlation of fourteen variables on volatility contagion during Sub-prime Mortgage Crisis</li></ul>	137
D	Framework	255

## LIST OF ABBREVIATIONS

MY	Malaysia
TH	Thailand
PH	Philippines
ID	Indonesia
SK	South Korea
JP	Japan
US	United State
IT	Information Technology
CDs	Certificates of Deposit
CCC	Constant Conditional Correlation
DCC	Dynamic Conditional Correlation
QMLE	Quasi-Maximum Likelihood Estimation

## CHAPTER 1

### INTRODUCTION

#### 1.1 Background of the Study

A definition of contagion is normally used in medical terms. It is the process by which a disease is transmitted from one person or animal to another by direct or indirect contact. Whereas, financial contagion refers to a scenario in which small shocks, which initially affect only a few financial institutions or a particular economy, spread to the rest of the financial sectors and even to other countries whose economies were previously healthy, in a manner similar to the transmission of a medical disease. In other words, in a crisis period, the linkages between countries may change and a new transmission mechanism may arise. This is known as contagion. Volatility contagion is the application of the concept of contagion shifting (Forbes & Rigobon, 2002) to the analysis of inter-dependencies in second moments. Adopting the definition of contagion by Forbes & Rigobon (2002), this study defines volatility contagion as a shift in the transmission of volatility between stock markets during episodes of turbulence.

If a country experiences a crisis, it will affect other countries that have financial market and economic linkages with it. However, there are instances whereby other countries that have no financial or economic ties are also affected. It is due to this that volatility contagion tests of each financial stock market between regions should be studied in depth.

Many previous studies on contagion have made great strides in recent years; however, the overall linkages of variety types of indicators driving the volatility contagion are still poorly understood. In particular, there is still a lack of information on variety types of indicators driving the volatility contagion that occur from both the financial and non-financial channels and other determinant variables. Majority of the studies (Haworth H. et al., 2006, Philippe & Zhang, 2007 and Anderson M., 2011) have considered a particular or specific financial product (e.g. CDs) and financial sector intermediaries in investigating contagion while in fact, all the financial institutions and non-financial institutions are highly connected in different aspects, and any impact would definitely affect the efficiency of the global market. Thus, the multiple indicators triggering the volatility contagion is worth to examine in depth.

Volatility contagion can be due to the failure of risk management, asset allocation and portfolio distribution during crisis periods. It has led to huge losses to many organisations and industries. As the effects spread due to the complicated business links these organisations and industries have with each other. In fact, the effects may also be felt by investors, bankers, brokers and those in the financial and non-financial sectors. One good example is the sub-prime-mortgage crisis (2008) case that was triggered by the following factors: (i) Fed: *for keeping interest rate so*

low, (ii) White House: *for letting banking regulations become too loose*, (iii) Finance executives: *Over securitisation*, (iv) Rating agencies: *for mischaracterising paper* and (v) Short-selling hedge funds: *for betting on doomsday* (Sivasankarganesh et. al., 2015)

From 2000 to 2006, the growth rate of housing was much higher than the GDP growth, so when the mortgage rate is low, it causes the housing price to go up. In this case, sub-prime borrowing was a major contributor to an increase in home ownership rate and the demand for housing hence, creating a 'housing bubble'. Between 1994 and 2005, home ownership and housing prices in the US increased even though unemployment rates experienced a fluctuation. In addition, the growth of sub-prime mortgage resulted in homeowners' mortgages being greater than their equity. However, how did the contagion spread to others? The answer is simple. "*If companies around the globe are unable to borrow, they'll begin to cut jobs, cease investment, and default on their debt in larger numbers*" by Peter C., Oct 3, 2008. Consequently, the crisis led to huge amount of crisis cost (refer to Appendix B1, page 125). The Sub-prime-mortgage (2008) crisis has shown the importance of understanding the multiple indicators that could trigger volatility contagion as a better understanding the structure of volatility contagion would assist policy makers such as the governments, central banks and financial market regulators to amend and establish the strategy for risk management more effectively.

In the case of the Asian crisis, based on the traditional first and second generation crisis models, the Asian financial or economic crisis exhibited no signs of forecast ability. Before the crisis occurred in Asia, the government's deficits and inflation were low, unemployment rate was also low, capital inflows were kept in good progress, and credit ratings were good. However, poor supervision and lax accounting standards had led to the collapse of a speculative bubble, and the crisis had been attributed to excesses in the financial sector. For instance, the prolonged maintenance of pegged exchange rates and record of high economic growth rates had encouraged massive inflows of capital. Nevertheless, poor administration of the financial sector and fragile prudential regulations had allowed excessive loans to be directed towards stock purchases, constructions, real estates and consumer lending, resulting in the ratio of short-term debt to foreign exchange reserves to increase to tremendous levels prior to the economic turmoil. While it did not guarantee the onset of one, this denoted vulnerability to an economic turmoil. As the economy was showing high economic growth rates, these vulnerability indicators were neglected. In addition, investors' lack of confidence in the currency and economy and the ensuing depreciation and rise in interest rates had also led to bankruptcies of banks and finance companies as loans soured.

In the crisis faced by Indonesia, despite having its own internal unhealthy economic practices which included extensive crony capitalism, under-supervised banks, growing of short-term debt, corruption and monopoly power, Indonesia has had the clearest case of contagion as it had the least severe macroeconomic weakness. In 1996, Indonesia's current account deficit was the lowest of the Asian-5; whereas, its export growth rate was the second highest. In the previous four years, its budget



averaged more than one percent in excess while the credit growth was maintained at being modest. In short, the crisis in Indonesia was caused by poor traditional and economic fundamentals. The crisis appeared to relate to the shortcomings of the financial sector and problems due to political uncertainties, combined with contagion spillovers from other economies in the region.

Turning to Thai crisis experience, the 1997 crisis in Thailand had raised the question of contagion effects. For several years, the Thai economy had experienced a period of strong domestic demand associated with an appreciating real exchange rates and large account deficits, as well as financial sector problems linked to overexposure to a property market whose prices had fallen sharply. After long resisting pressures on the baht through measures that included capital controls and massive forward intervention, the Thai authorities were eventually forced to abandon the dollar exchange rate peg. The depreciation (and factors leading to it) was associated with pressures on the currencies of neighbouring countries which also attempted to keep their exchange rates against the dollar in a narrow range, especially Indonesia, Malaysia and the Philippines. These countries shared some features (including current account deficits) with Thailand and were quickly forced to accept more exchange rate flexibility. Hong Kong and Singapore, with strong current account and fiscal positions, were also briefly exposed to downward pressure on their currencies, and Korea, which was spared for several months, succumbed to contagion effects in November 1997. Generally, the currency turmoil seems to have triggered plunges in stock markets of the region and elsewhere. Based on the Asian crisis experiences, the spread of contagion can be seen leading to huge amount of debts and losses (Appendix B1, 125).

King & Wadhvani (1990), followed by Forbes & Rigobon (2002) developed a test for contagion based on a significant increase in cross-market correlations during a turmoil period and compared them with a tranquil period. If the correlation of shocks between countries involved increased in a turmoil period compared to a tranquil period, then the nature of the transmission of the financial market shocks has changed thus, providing evidence of contagion. As the policymakers' response to a crisis and the regulatory structures designed to avoid the transmission of future crisis are influenced by whether or not the crisis transmits through linkages that are understood and stable, or through contagion, understanding the nature of these shock transmissions is crucial. It will assist the governments, central banks and financial market regulators and participants to opt for optimal policy choices in portfolio management.

Financial contagion can be initiated through two fundamental linkage channels: returns and volatility (King & Wadhvani, 1990; Boyer et al., 1999; Forbes & Rigobon, 2002; Diebold & Yilmaz, 2009). To explore the co-movement of asset prices between financial stock markets, previous studies on financial contagion were carried out by considering the temporal dependence of financial returns. This linkage is not necessarily connected through asset returns although financial contagion entails a substantial change in the market linkages after a financial crash. Cheung & Ng (1996) indicated that changes in variance reflect the arrival of information, and



thus the causation in variance reflects the relationship between information flows and volatility across financial time series. Engle & Susmel (1993) reported the international stock markets that co-related through their volatilities instead of their returns. Engle et al. (1990) also tested the volatility spillovers of exchange rates across the American and Japanese foreign exchange markets by applying the GARCH model. They found the existence of volatility spillover which was indicated by the exchange rates across market segments that were present in the meteor shower phenomenon. Hong (2001) also found cross-market causality in volatility between the Yen and Deutschmark markets. Notably, Diebold & Yilmaz (2009) studied the spillovers of volatility and return on several developed and developing markets in the 1990s which covered various financial crises, as well as the recent sub-prime mortgage crisis. They found no burst in return spillovers but found evidence on volatility spillovers burst along a mild upward trend. Therefore, it is worth to examine financial contagion further from the volatility perspective since many previous empirical studies focused on the bursts in volatility spillovers.

The financial sector plays an important role in create contagion effects. Many of the existing research papers (Hong, 2001, Philippe & Zhang, 2007, Diebold & Yilmaz, 2009) define the sensitivity of the financial sector to contagion since the prevalence of financial crisis has led many to conclude that the financial sector is unusually susceptible to shocks. For example, the Sub-prime Mortgage crisis was caused by a combination of asset price bubbles, mainly in the real estate sector, and a credit bubble that led to excessive leverage. The Sub-prime Mortgage crisis became truly global because of two main transmission mechanisms: (i) the sudden rise in risk aversion (and financial market volatility) which was transmitted worldwide because financial markets are highly integrated at the global level, and (ii) the sudden drop in demand, especially for capital intensive goods, which was transmitted rapidly along the global supply chain. Therefore, analyse the sensitivity of financial sector triggering the volatility contagion is reasonable since previous crisis experiences have lead to conclude that financial sector is manipulable to shocks.

The non-financial sector also plays a crucial role on contagion testing. One theory is that small shocks, which initially only affect a few institutions or a particular region of the economy, are spread by contagion to the rest of the financial sectors which then affect the larger economy, include non-financial sector. For example, the prime back-mortgage crisis was initially triggered by the poor risk management and portfolio allocation of banks, investment companies and financial and non-financial instruments. Therefore, the non-financial sector driving the volatility contagion is worth to examine since non-financial sector is one of the major sectors dominants the worldwide economy.

Several recent papers have documented significant volatility spillovers between stock markets and crude oil prices using various specifications of Engle and Kroner (1995) multivariate BEKK-GARCH approaches (Agren, 2006; Malik & Hammoudeh, 2007; Malik & Ewing, 2009; Tansuchat et al., 2009; Mohamed El Hedi Arouri et al., 2011). Malik & Hammoudeh (2007) found that while stock market volatility spilled over into the oil markets occurred only in Saudi Arabia, it

affected the Gulf equity markets as the latter are sensitive to volatility from the crude oil markets. On the other hand, Malik & Ewing (2009) concluded in favour of significant transmission of return and volatility crashes while investigating volatility spillover between crude oil prices and five US equity sector indexes: technology, industrials, consumer services, health care and financials. Then, in firm-level analysis, Tansuchat et al. (2009) found no volatility contagion occurring between stock returns of ten worldwide oil companies and the WTI (West Texas Intermediate) crude oil futures returns. Mohamed et al. (2011) investigated the volatility cross effects between equity sector and crude oil and found evidence of significant volatility. The volatility contagion measurement between stock markets and crude oil had found by many previous empirical studies however the testing of oil prices as an indicator driving the volatility contagion between stock market is still not exist. Hence, the volatility contagion driven by oil price is worth to investigate.

In the context of the Asian crisis, Baig & Goldfajn (1999) performed cross-market correlations for exchange rates, stock market returns, interest rates and sovereign bond spread using the Forbes & Rigobon methodology. While evidence is in favour for an increase in correlation in exchange rate, stock markets and interest rates co-movements is mixed as best, the authors did find overwhelming evidence for contagion with regards to sovereign bond spreads.

Mixed evidence triggered to contagion has been very limited defined by such previous studies. Phylaktis & Xia (2004) analysed contagion of sectors within an asset pricing perspective and found mixed evidence for contagion for the period of 1990 to 2004. Despite the occurrence of contagion and financial crises, they see this as evidence that diversification is beneficial. Horta et al. (2010) analysed the Global Financial Crisis (GFC) for four European aggregate financial market returns and two sectors (industrial and financial) by using copulas model and found that contagion occurred for all sectors and markets. Kaminsky & Reinhart (2009) produced a list of indicators that can be associated with financial liberalization and a financial crisis that include: the ratio of domestic credit to nominal GDP, M2 multiplier, the ratio of lending-to-deposit interest rates and the real interest rate on deposits, the authors did find evidence that most crisis have multiple indicators. However, abounding of the transmission for volatility contagion is still poorly implied. Especially, the test of country debt risk driving the volatility contagion is still not exists. Consequently, variety types of indicators driving the volatility contagion is still need to explore widely.

The international financial crisis of the last decade have shown that financial shocks in one country could have rapid and large impacts to other countries. A small number of previous studies considered crisis and contagion in a multi-country environment, especially in Asia countries. For instance, Dungey & Martin (2007) used factor models with world, regional and country factors and defined contagion as the correlation between the residuals. Thus, the cross-country of volatility contagion testing in Asian is worth to explore since emerging countries in Asia have unique economics characteristics and system that differentiate these countries from

developed countries, accordingly, it is are expected to produce different results. Asian countries do have high possibility to affect and spread the crisis as well.

Most previous studies used data of aggregate stock market indexes on contagion estimation (Baig & Goldfajn, 1999; Forbes & Rigobon, 2002; Baele et al., 2005; Bekaert et al., 2005; Baur & Schulze, 2005; Boyer et al., 2006; Markwat et al., 2009; Chandar et al., 2009; Dungey et al., 2010 and Mohamed El Hedi Arouri, 2011). The analyse of volatility contagion by using aggregate stock market indexes is reasonable since the data conveys more information on describe a country economy conditions.

The macroeconomic financial risk, bank credit risk and political risk use to measure as indicators of country debt risk are relevant to exist of volatility contagion. And the start of financial crisis, strong interconnection exists between bank credit risk and sovereign credit risk. Added, a high country debt risk will lead to instability economy in a country and slip into a contagion circumstances. However, there is lack of literature provide empirical evidence of country debt risk on the volatility contagion after screened through most previous studies. Hence this study adds an understanding of it by adding a country debt risk on volatility contagion investigation procedure.

Country debt risk estimation models are quite advantageous for all layers of social parties if the debt crisis are accurate and capable to forecast in advance. These assessments are a crucial part of the process of credit-allocation to developing countries and, therefore, their accuracy is a matter of major importance for bankers, brokers, investors, financial managers and borrowers. Thus, many studies have been done to identify the factors of country risk. Studies have also been carried out to forecast crisis of debt and diagnose the causes responsible for debt compensation problems such as Feder et. al. (1981), Cline (1984), Edwards (1984), Kharas (1984), Beltratti (1990), Ngassam (1991), Ozler (1992), Hajivassiliou (1987 & 1994), Hernandez-Trillo (1995), Gur (1998 & 2001). Therefore, the identify of the factors used to forecast debt repayment problems is worth to examine.

The study of volatility contagion is crucial as it can contribute useful information about linkages in economic issues with regards to financial or economic crisis and provide a better understanding on the reasons for contagion. It can help policymakers to amend and enhance the global financial regulation system so that it is more resistant to shocks and contagion. Therefore, it is necessary to investigate the relationship between indicators and volatility contagion. A better understanding on volatility contagion would also help answer several pertinent questions such as do movements of single non-financial stock market index trigger global volatility contagion? or do simultaneous movements of indicators drive to volatility contagion? In addition, an estimation of the circumstance of a volatility contagion keep assist governments in providing efficient scheming stimulus packages to diminish the expenditures and uncertainty risks of a contagion of various sectors in an economy in terms of financial or economic crisis from the volatility perspective.

## 1.2 Problem Statement

For many decades, different types of economic and financial crisis involving an increase of huge amount of cost expenditures had taken place, and they are still occurring until today. For example, the 2007–09 meltdown produced a huge downshift in the path of economic output, consumption and financial wealth. The US nation as well as global has borne additional costs arising from psychological consequences, skill atrophy from extended unemployment, a reduced set of economic opportunities and increased government intervention in the economy.

The East Asian has been given the name “super-exporters” due to its success in trade and economic growth. In the last 30 years, East Asian is a region with high economic growth; therefore, it becomes one of the important destinations/targets for investors to invest and formulate their portfolio allocations. In 1997-1998 when a widespread economic crisis hit the economies of many East/Southeast Asian countries, the contagion spread sharply to the United States, the United Kingdom and the European countries as their portfolio allocations onto the East Asian region were observed to be in huge amount.

The increased liberalization and mobility of capital flows in Asian has accelerated. It complicates and tightens their global business linkage, regulation management and trade procedure, thereby boosting the risk of contagion. It also increases the systemic global financial instability in the European Union, United States and Japan, whose economies are the most affected by the current global finance crisis. From 1997 to 1998, an open market in the Asian region of half a billion people fell into financial crisis and exposed to contagion circumstances.

For example, the prime mortgage crisis in 2008 had caused many people to slip into contagion circumstance. In 2007, low interest rates and large inflows of foreign funds had created easy credit conditions that led to abnormally strong economic growth as the United States entered a sub-prime mortgage crisis. The failure of risk management, asset allocation and portfolio distribution by the mortgage lenders, banks and investment banks had led the world to fall into contagion. Complicated and tight investment link globally causes the default (debt) to spread very rapidly from one country to another and may cause domestic and cross-countries contagions.

Of course, Asian region is one of the victims which cannot avert. “The risk management capacity of banks is overwhelmed by the enormous capital inflows into the country. This fed through to banks’ lending policies, leading them to “overlend” to sectors, which they might not have done under normal circumstances,” as noted by Thirachai Phuvanatanarubala who is currently a Secretary-General of the Securities and Exchange Commission of Thailand and former Deputy Governor of Bank of Thailand. According to Peter C. (Oct 3, 2008), “If companies around the globe are unable to borrow, they’ll begin to cut jobs, cease investment and default on their debt in larger numbers.” As a consequence, the contagion would globally spread to both financial and non-financial sectors at the same time.



To diminish and avoid all these issues, it is important to find out the root of the problem as well as explore the indicators of volatility contagion. However, majority of the papers have considered the particular specific financial products (e.g. CDs) and financial sector intermediaries in terms of contagion investigation. As a result, there is still a lack of comprehensive investigation on the combination of variety types of indicators that drive volatility contagion. Especially there is lack of literature provide empirical evidence of the country debt risk on volatility contagion, even though the start of the financial crisis, strong interconnection exists between bank credit risk and sovereign credit risk. And, a high country debt risk will lead to instability economy in a country and slip into a contagion circumstances. Hence this study explore multiple indicators from different sector: financial sector, non-financial sector, market information, macro-financial variable, country debt risk and S&P 500 on the volatility contagion testing. In fact, recognising the nature of shock transmission is very important to provide optimal choices to the government, financial market regulators and central banks and portfolio management by financial market participants, as well as make it resistant to contagions.

### **1.3 Motivation of the Study**

The contagion risks in global financial markets are still going on especially in the less-developed countries. When a large region experiences a crisis, it will inevitably transmit over to other countries through financial markets, business trade and other cross-country investment linkages. As financial integration remains to increase linkages around the world, this will create links from various countries that are close to each other through periods of strengths as well as weaknesses. Therefore, this study aimed to investigate the risks of volatility contagion in order to reduce the risks of contagion in the future.

This study will enlighten our understanding on the factors and mechanisms of Asian volatility contagion which can assist policy makers to develop and enhance Asian financial regulation scheme so that it will be resistant to contagions and shocks.

The finding of variety types of indicators driving the volatility contagion is very useful for investors, bankers, brokers and government to construct their asset management, risk management and portfolio allocation to avoid slip into contagion circumstance.

Even though there have been a lot of research on the basic issue and transmission of financial or economic crisis as well as financial contagion over the last decade, no one can predict how economy in the whole world can be stable and develop in sustainable way without experiencing a greater volatility or another crisis. Therefore, advanced contagion modelling analyses and a variety indicators on volatility contagion empirical studies that witness the truth of the structure of volatility contagions are necessary. The specific detail indicators of volatility contagion from various sectors (financial sector, non-financial sector and determinant variables)

should be defined as this could enhance financial regulation scheme and bring about necessary changes in market structures and economy stabilisation.

#### **1.4 Research Questions and Objectives of the Study**

The main focus of the study is to measure the various types of indicators driving the volatility contagion in the selected Asian region, as stated in the third objective. After filtering down the possible indicators of volatility contagion, this study have identify fourteen major indicators from different sectors: both the financial and non-financial sectors, market information, macro-financial variable, country debt risk and S&P 500).

Before examine the main objective of the study (the third objective), this study first analyse the structure of volatility contagion, because the volatility contagion will then use as dependent variable for define the third objective.

After screened through the previous studies, there is totally lack of literature provide empirical evidence of country debt risk trigger the volatility contagion, even tough the macroeconomic financial risk factors, bank credit risk factors and political risk factors which use to measure as indicators of country debt risk are relevant to exist of contagious and shocks. And, a high country debt risk will lead to instability economy in a country and slip into a contagion circumstances. Hence, in the second objective, this study measure country debt risk to explore whether volatility contagion is driven by country debt risk fluctuation.

There are the research questions listed as below:

- i) Did volatility contagion occur in each pair of stock returns in Asia?
- ii) Did the country debt risk change before, during and after the selected crisis periods? Did the country debt risk play role on triggering volatility contagion?
- iii) Which of the specific sector mostly triggered volatility contagion during the selected crisis periods. Financial sector, non-financial sector, market information, macro-financial variable, country debt risk or S&P 500? Did complexity causes the volatility contagion occur?

Hence, the three specific objectives are as below:

- i) To analyse the structure of volatility contagion within the six selected Asia countries and US during the selected four crisis periods.
- ii) To estimate the fluctuation of country debt risk for exploring as one of the indicators driving volatility contagion in selected six Asia countries during four selected crisis periods.

- iii) There is still a lack of overall linkage and comprehensive study for the structure of volatility contagion. After filtering down the possible indicators of volatility contagion, this study identifies the fourteen major indicators from different sectors: both the financial and non-financial sectors, market information, macroeconomic financial variables, country debt risk and external factor (S&P 500) combined together as multiple indicators driving the volatility contagion.

## **1.5 Benefits of the Study**

This study provides some benefits for different layers of parties. For example policy makers, bankers, brokers, investors, government as well as for public. Since the understanding of the structure of volatility contagion can govern and assist them to design their portfolio allocation, financial policy and risk management to avoid slip into contagion circumstance.

Firstly, the results of the study is very useful as it increases our understanding on the mechanisms and reasons of volatility contagion. It can be used to assist policy makers in developing and enhancing the international financial regulation system, making it more resistant to contagions and shocks. In addition, a better domestic financial regulation structure can boost and enhance liquidity economy's and thus limit economy exposure to contagion. Nevertheless, a superior perceptive on the cause of volatility contagion can be conducive to complement financial reform of a country such as on how to design the financial ratio, portfolio and risk management in order to construct a balance between maximizing company earning and defending them from volatility contagions and shocks.

Next, the result contributes benefits for from financial sector, for example macro-prudential policy designing. The general view of macro prudential policy is that it is all about limiting the risks and costs of systemic crises. The proximate objective of macro-prudential policy is to limit financial system-wide distress. It could be achieved by defining the volatility contagion. Caruana (2010b) described the objective of macro prudential policy as "to reduce systemic risk by explicitly addressing the inter-linkages between, and common exposures of, all financial institutions, and the procyclicality of the financial system". Thus, investigating all of the indicators linked to volatility contagion is needed in order to achieve macro prudential policy.

In addition, the results of the study would benefit the government as they can help the government to take economic interventions in the market in the public interest to decrease the economic crisis costs, as well as prevent economic crisis. To recognise the structure of volatility contagion early on could be very important and useful to discover the truth and develop effectiveness policies to relieve and prevent the crisis risk.

Besides that, our results have important implications on risk management of portfolios of corporate debt. For example, as backing for the performance of their loan portfolios, banks retain capital at levels designed to withstand default clustering at extremely high confidence levels, such as 99.9%. Some banks do so on the basis of models in which default correlation is assumed to be captured by common risk factors determining conditional default probabilities, as stated in Gordy (2003).

Nevertheless, the investigation of the volatility contagion is important because shock transmission had raises the costs of inter-mediation and restricts credit, which in turn restrains the level of activity in the real sector, and could ultimately lead to periods of low growth and recession. In addition, there is a long tradition regarding dislocation in the financial sector as a cause of economic fluctuations as shown in the studies by Friedman and Schwartz (1963), Bernanke (1983) and Bernanke & Getler (1989). Thus, this research analysed the fourteen mixed variables as factors driving the volatility contagion to predict whether the financial/non-financial sectors, macroeconomic variables, market information, country debt risk and S&P 500 have complexity causes the volatility contagion. The result is very crucial to bring advantage to investors, bankers, brokers and government to design their portfolio allocation, financial policy and risk management to avoid slip into contagion circumstance.

This study is organised into eight Chapters. The first chapter provides the introduction, problem statement, motivation, questions, objectives and benefits of the study. The second chapter introduces the overview of stock markets in the selected six Asia countries while Chapter three presents the literature review and extensive review on crisis contingent and non-crisis-contingent theories. Next, Chapter four presents the research methodology, hypothesis, data applied and research design. The models used are VAR-GARCH, BEKK-GARCH and CCC-GARCH that can function to derive the findings of volatility contagion. This study has used the Two-limit Tobit model to measure a country debt risk. The regression analysis has been used to define the multiple indicators driven the volatility contagion. Chapter five, six and seven provide discussion on the findings. There are the result of volatility contagion estimation, the result of country debt risk measurement and the findings of variety types of indicators driven the volatility contagion. The final section, Chapter eight, provides the summary of the study, conclusion, limitation of the study, policy implications and suggestions for further research.



## REFERENCES

- Agnolucci, P. (2009). Volatility in Crude Oil Futures: A Comparison of the Predictive Ability of GARCH and Implied Volatility Models. *Energy Economics* 31, 316–321.
- Agren, M. (2006). Does oil price uncertainty transmit to stock markets? *Working Paper* 2006, p. 23. Department of Economics/Uppsala University.
- Alizadeh, S., Brandt, M.W. & Diebold, F.X., (2002). Range-Based Estimation of Stochastic Volatility Models. *Journal of Finance*, LVII (3), 1047–1091.
- Allan Drazen, (2000). Political Contagion in Currency Crises. *NBER* pages 47 - 70, National Bureau of Economic Research, Inc.
- Allen, Franklin & Douglas Gale (2001). Financial Contagion. *Journal of Political Economy* 108(1): 1-33.
- Amemiya Takeshi (1984). Tobit Models: A Survey. *Journal of Econometrics* (Impact Factor: 1.6). Feb 1984; 24(s 1–2):3–61.
- Anderson M. (2011). Contagion and Excess Correlation in Credit Default Swaps. *Social Science Research Network*, 43.
- Andrew Sheng (2009). From Asian to Global Financial Crisis. Cambridge University Press 1
- Bae Kee-Hong, G. Andrew Karolyi, & Rene M. Stulz (2003). A New Approach to Measuring Financial Contagion. *The Review of Financial Studies*, Vol. 13, No 3, pp 717 – 763 (47), Autumn.
- Baele, L. (2005). Volatility Spillover Effects in European Equity Markets. *Journal of Financial and Quantitative Analysis*, Cambridge University Press, vol.40(02), pages 373-401, June.
- Baig, T., & Goldfajn, I. (1999). Financial Market Contagion in the Asian Crises. *IMF Staff Paper*, Vol. 46, No 2 ( June 1999).
- Bartram, T., & Wang, Y. H. (2005). Another Look at the Relationship between Cross-Market Correlation and Volatility. *Finance Research Letters*, 2, 75–88.
- Baur, D., & Schulze, N., (2005). Co-Exceedances in Financial Markets: A Quantile Regression Analysis of Contagion. *Emerging Markets Review*, 6, 21–43.
- Bekaert, G., Harvey, C.R. & Ng, A. (2005). Market Integration and Contagion. *Journal of Business* 78 (1), 39–70.

- Beltratti, A. (1990). Empirical estimates of the debt capacity to repay a foreign debt: A vector autoregressive methodology. In H. O'Neil (Ed.). *Third world debt: How sustainable are current strategies and solutions?* Frank Cass, London.
- Bencivenga, Valerie R. & Bruce D. Smith (1992). Deficits, Inflation, and the Banking System in Developing Countries: The Optimal Degree of Financial Repression. *Oxford Economic Papers* 44, 767 – 790.
- Bernanke, Ben (1983). Non-monetary Effects of the Financial Crisis in the Propagation of the Great Depression. *American Economic Review* 73, 257-263.
- Bernanke, Ben & Mark Gertler (1989). Agency Costs, Net Worth and Business Fluctuations. *American Economic Review*, 79, 14-31.
- Bertero, E., & Mayer, C. (1990). Structure and performance: Global Interdependence of Stock Markets around the Crash of October 1987. *European Economic Review*, 34, 1155–1180.
- Billio, M. & Caporin, M. (2005). Multivariate Markov Switching Dynamic Conditional Correlation GARCH representations for Contagion Analysis. *Statistical Methods and Applications*, 14, 145-161.
- BIS Paper No 55 (Jan 2011). The Future of Central Banking under Post-Crisis Mandates. *Ninth BIS Annual Conference 24-25 June 2010*, Monetary and Economic Department.
- Bollerslev, T. (1990). Modelling the Coherence in Short-Run Nominal Exchange Rates: A Multivariate Generalized ARCH Approach. *Review of Economics and Statistics* 72, 498–505.
- Boyer, B.H., Gibson, M.S. & Loretan, M. (1999). Pitfalls in Tests for Changes in Correlations. *Federal Reserve Board International Finance Division*, Working Paper 597R.
- Boyer, B. H., Kumagai, T. & Yuan, K. (2006). How do Crises Spread? Evidence from Accessible and Inaccessible Stock Indices. *Journal of Finance* 61 (2), 957–1003.
- Boyd, John H., Levine, Ross & Smith, Bruce D., (2001). The Impact of Inflation on Financial Sector Performance. *Journal of Monetary Economics*, Elsevier, vol. 47(2), pages 221-248, April.
- Brandt, M.W. & Jones, C.S. (2006). Volatility Forecasting with Range-Based EGARCH Models. *Journal of Business & Economic Statistics* 24 (4), 470–486.
- Calvo, G. (1999). Contagion in Emerging Markets: When Wall Street is a Carrier. *Working Paper*, University of Maryland, Mimeo.

- Calvo, S., & Reinhart, C., (1996). Capital Flows to Latin America: Is there Evidence of Contagion Effects? In: Calvo, G., Goldstein, M., Hochreiter, E. (Eds.), *Private Capital Flows to Emerging Markets After the Mexican Crisis*. Pages 151 – 171 *Institute for International Economics*, Washington, DC.
- Carmen M. Reinhart & Sara Calvo, (1996). Capital Flows to Latin America: Is There Evidence of Contagion Effects? Peterson Institute Press: Chapters, in: Guillermo A. Calvo & Morris Goldstein & Eduard Hochreiter (ed.), *Private Capital Flows to Emerging Markets After the Mexican Crisis*, pages 151-171 *Peterson Institute for International Economics*.
- Caruana, J (2010b). Macroprudential Policy: Working towards a New Consensus. Remarks at the high-level meeting on “The Emerging Framework for Financial Regulation and Monetary Policy” jointly organised by the BIS’s Financial Stability Institute and the IMF Institute, Washington DC, 23 April.
- Chandar, N., Patro, D.K., & Yezegel, A. (2009). Crises, Contagion and Cross-Listings. *Journal of Banking & Finance* 33 (9), 1709–1729.
- Chang M. C., Jiang S. J., & Lu K. Y., (2009). Lead-lag relationship between different crude oil markets: evidence from Dubai and Brent. *Journal of Middle Eastern Finance and Economics* 5, 1450- 2889.
- Cheung, Y.W. & L.K. Ng (1996). A Causality in Variance Test and its Application to Financial Market Prices. *Journal of Econometrics*, 72, 33-48.
- Chiang M.H. & Wang L.M (2011). Volatility Contagion: A Range-Based Volatility Approach. *Journal of Economics* 165(2011) 175-189.
- Christensen, K. & Podolskij, M. (2007). Realized Range-Based estimation of Integrated Variance. *Journal of Econometrics* 141, 323–349.
- Cipollini A. & G. Kapetanios (Mar 2008). Forecasting Financial Crises and Contagion in Asia using Dynamic Factor Analysis. *Journal of Empirical Finance*, 16 (2009) 188–200.
- Cline, W. R. (1984). International debt: Systematic risk and policy responses. *Institute of International Economics, Washington D. C.*
- Corsetti, G., Pericoli, M., & Sbracia, M. (2005). Some contagion, some interdependence: More Pitfalls in Tests of Financial Contagion. *Journal of International Money and Finance*, 24, 1177–1199.
- Desislava Dimitrova (Aug 2005). The Relationship between Exchange Rates and Stock Prices: Studied in a Multivariate Model. *Issues in Political Economy*, Vol. 14.
- Diebold & Kamil Yilmaz (2009). Measuring Financial Asset Return and Volatility Spillovers, with Application to Global Equity Markets, *Economic Journal, Royal Economic Society*, vol. 119(534), pages 158-171, 01.

- Dirk G. Baur, (June 2011). Financial Contagion and the Real Economy. *Journal of Banking & Finance* 36, 2680 – 2692.
- Drazen, A. (2000). Political Contagion in Currency Crisis. University of Maryland, mimeo.
- Duffie, D., A. Eckner, G. Horel, & L. Saita (2009). Frailty Correlated Default. *The Journal of Finance*, 64, 2090-2123.
- Dungey, M., Fry, R., González-Hermosillo, B. and Martin, V.L. (2007). Contagion in Global Equity Markets in 1998: The Effects of the Russian and LTCM Crises. *North American Journal of Economics and Finance*, 18(2): 155-174.
- Dungey, M. & Martin, V.L. (2007). Unravelling Financial Market Linkages during Crises. *Journal of Applied Econometrics*, 22(1): 89-119.
- Dungey, M., Milunovich, G., & Thorp, S., (2010). Unobservable Shocks as Carriers of Contagion: A Dynamic Analysis using Identified Structural GARCH. *Journal of Banking & Finance* 34 (5), 1008–1021.
- Dunkey., Fry, F., Gonzalez-Hermosillo. B., & Martin V. L.(2005). Empirical Modeling of Contagion: A Review of Methodologies. *Quantitative Finance*, 5,1, 9-24.
- Edwards, S. (1984). LDC foreign borrowing and default risk: An empirical investigation 1976-80. *American Economic Review* 74(4).
- Edwards, S. & Susmel, R. (2001). Volatility Dependence and Contagion in Emerging Markets. *Journal of Development Economics*, 66, 505-532.
- Edwards, S. & Susmel, R. (2003). Interest-Rate Volatility in Emerging Markets. *The Review of Economics and Statistics*, 85, 328-348.
- Engle, R. F. (2002). Dynamic Conditional Correlation: a Simple Class of Multivariate GARCH Models. *Journal of Business and Economic Statistics* 20, 339–350.
- Engle, R. F., Kroner, K. F. (1995). Multivariate Simultaneous Generalized ARCH. *Econometric Theory* 11, 122–150.
- Engle, Robert F., Ng, Victor K. & Rothschild, Michael (1990). Asset Pricing with a Factor-arch Covariance Structure: Empirical Estimates for Treasury Bills. *Journal of Econometrics*, Elsevier, vol. 45(1-2), pages 213-237.
- Engle, Robert F. & Susmel, Raul, (1993). Common Volatility in International Equity Markets. *Journal of Business & Economic Statistics*, American Statistical Association, vol. 11(2), pages 167-76, April.

- Erdem K. & Veysel U. (2015). Evidence for Financial Contagion in Endogenous Volatile periods. *Review of Development Economics*, Vol. 19, Issue 1, pp. 62-74.
- Fabio Castiglionesi & Sandro Brusco (2007). Liquidity Coinsurance, Moral Hazard and Financial Contagion. *The Journal of The American Finance Association*, Vol 62, Issue 5, Oct 2007, pages 2275 - 2302.
- Feder, G., Just R. & Ross K. (1981). Projecting debt service capacity of developing countries. *Journal of Financial and Qualitative Analysis*, Vol. 16, No. 5 (Dec., 1981), pp. 651-669.
- Forbes, K. J. & R. Rigibon, (2000). Identification Through Heteroskedasticity: Measuring 'Contagion' between Argentinian and Mexican Sovereign Bonds. *National Bureau of Economic Research Working Paper No. 7493*.
- Forbes, K. J. & R. Rigibon, (2002). No Contagion, Only Interdependence: Measuring stock Market Comovements. *The Journal of Finance*, 57, 2223-2261.
- Friedman, Milton & Anna Schwartz (1963). A Monetary History of the United States 1867-1960. *Princeton: Princeton University Press*.
- Gagliardini, P. & C. Gourieroux, (2011). Correlated Risks vs Contagion in Stochastic Transition Models. *working paper, ENSAE*.
- Gordy, Michael (2003). A Risk-Factor Model Foundation for Ratings-Based Capital Rules. *Journal of Financial Intermediation* 12, 199–232.
- Granger, Clive W. J., Huang, Bwo-Nung & Yang, Chin-Wei (2000). A Bivariate Causality between Stock Prices and Exchange Rates: Evidence from recent Asian Flu. *Economics working paper series*.
- Gur, Timur Han (1998). External debt and empirical models for country risk assessment. *Capital Markets Board of Turkey (SPK)*, Pub. Number 117.
- Gur, Timur Han (2001). A Country Risk Assessment Model and the Asian Crisis. *Central Bank Review* 1(2001) 49-68.
- Haizhou Huang & Chenggang Xu (2000). Financial Institutions, Financial Contagion and Financial Crises. *Working Paper Number 316 March 2000*.
- Hajivassiliou, V. A. (1987). The external debt repayment problems of LDC's: An econometric model based on panel data. *Journal of Econometrics*, Volume 36, Issues 1–2, September–October, Pages 205–230.
- Hajivassiliou & Vassilis (1994). A simulation estimation analysis of the external debt crises of developing countries. *Journal of Applied Econometrics*, 9(2). 109-131. ISSN 1099-1255 .



- Hamao, Y., Masulis, R.W. & Ng, V. (1990). Correlations in Price Changes and Volatility across International Stock Markets. *Rev. Financial Stud.* 3, 281–307.
- Hammoudeh et al., (2009). Shock and volatility spillovers among equity sectors of the Gulf Arab stock markets. *The Quarterly Review of Economics and Finance*, 49(2009), pp. 829–842.
- Hammoudeh et al., (2010). Long memory and structural breaks in modeling the return and volatility dynamics of precious metals. *International Journal of Business, Economics and Law*, Vol. 4, Issue 1 (June), ISSN 2289 - 1552 .
- Hassan, H. & Malik, F. (2007). Multivariate GARCH Model of Sector Volatility Transmission. *Quarterly Review of Economics and Finance* 47, 470–480.
- Haworth H., Reisinger C. & Shaw W. (2006). Modelling Bonds & Credit Default Swaps using a Structural Model with Contagion. Oxford University Working Paper.
- Hernandez-Trillo, F. (1995). A model-based estimation of the probability of default in sovereign credit markets. *Journal of Development Economics*, 64, 163-179.
- Hooi Hooi Lean, Paresh Narayan, & Russell Smyth (June 2011). Exchange Rate and Stock Price Interaction Major Asian Markets: Evidence for Individual Countries and Panels allowing for Astructural Breaks. *The Singapore Economic Review*, Volume 56, Issue 02.
- Hong J. (2001). Goal Recognition through Goal Graph Analysis. Volume 15, pages 1-30.
- Horta, P., Mendes, C. & Vieira, I. (2010). Contagion Effects of the Subprime Crisis in the European NYSE Euro next Market. *Portugese Economic Journal* 9 (2), 115-140.
- Jokipii, Terhi & Lucey, Brian (2007). Contagion and Interdependence: Measuring CEE Banking Sector Co-movements. *Economic Systems*, Elsevier, vol. 31(1), pages 71-96, March.
- Kaminsky & Reinhart (2009). When the North Last Headed South: Revisiting the 1930s. *Brookings Papers on Economic Activity, Economic Studies Program*, The Brookings Institution, vol. 40(2 (Fall)), pages 251-276.
- Kang, S.H., Kang, S.M. & Yoon, S.M. (2009). Forecasting Volatility of Crude Oil Markets. *Energy Economics* 31, 119–125.
- Karolyi, G. A., & Stulz, R. M. (1996). Why do Markets Move Together? An Investigation of U.S.-Japan Stock Returns Co-movements. *Journal of Finance*, 51, 951–986.

- Kay Giesecke & Stefan Weber (2006). Credit Contagion and Aggregate Losses. *Journal of Economic Dynamics & Control* 30 (2006) 741–767.
- Khan Habibullah, Rex S. Toh & Khurrath Fathima (2001). Asian Contagion: Impact On Singapore Tourism. *Annals of Tourism Research*, Vol. 28, No. 1, pp. 224-226.
- Khan, S., Islam, F., & Ahmed, S. (2005). The Asian crisis: An Economic Analysis of the Causes. *Journal of Developing Areas*, 39(1), 169–190.
- Kharas, H. (1984). The long-run creditworthiness of developing countries: Theory and practice. *Quarterly Journal of Economics*, vol. 99, issue 3, pages 415-39.
- Kim Don H., Mico Loretan & Eli M. Remolona (2010). Contagion and Risk Premia in the Amplification of Crisis: Evidence from Asian Names in the Global CDS Market. *Journal of Asian Economics* 21 (2010) 314–326.
- King, M., Wadhvani, S., (1990). Transmission of Volatility between Stock Markets. *Rev. Financial Stud.* 3, 5–33.
- Laua Sie-Ting & Thomas H. McInish (2003). IMF Bailouts, Contagion Effects, and Bank Security Returns. *International Review of Financial Analysis* 12 (2003) 3–23.
- Lee, S.B. & Kim, K.W., (1993). Does the October 1987 Crash Strengthen the Comovements among National Stock Markets? *Rev. Financial Econom.* 3, 89–102.
- Lee See-Nie, Cheng Fan-Fah & Taufiq Hassan C. (2015). Country Risk Assessment Model for Six Asia Countries. Proceeding Paper of AAMC Conference 2015.
- Ling, S. & McAleer, M., (2003). Asymptotic Theory for a Vector ARMA-GARCH Model. *Econometric Theory* 19, 278–308.
- Loretan, M., & English, W. (2000). Evaluating Correlation Breakdowns. During Periods of Market Volatility. Board of Governors of the Federal Reserve System, *International Finance Discussion Paper* No. 658.
- Malik, F., & Ewing, B. T. (2009). Volatility transmission between oil prices and equity sector returns. *International Review of Financial Analysis*, 18, 95-100.
- Malik, F., & Hammoudeh, S. (2007). Shock and volatility transmission in the oil, US and Gulf equity markets. *International Review of Economics and Finance*, 16, 357-368.
- Marcelo Carvalho ( June 2007). A Smooth Transition Multivariate GARCH Approach to Contagion. *Working Paper*, C32, C51, G15.

- Marco Gallegati (2012). A Wavelet-Based Approach to Test for Financial Market Contagion. *Computational Statistics and Data Analysis*, 56 (2012) 3491–3497.
- Marek Raczko (2015). Volatility Contagion: New evidence from Market Pricing of Volatility Risk. *Bank of England, Staff Working Paper No.52*.
- Markwat, T., Kole, E. & van Dijk, D., (2009). Contagion as a Domino Effect in Global Stock Markets. *Journal of Banking & Finance* 33 (11), 1996–2012.
- Martens, M. & van Dijk, D., (2007). Measuring Volatility with the Realized Range. *Journal of Econometrics* 138, 181–207.
- Martin Feldstein (1983). Inflation, Tax Rules, and Capital Formation. NBER Books, *National Bureau of Economic Research, Inc*, number feld83-1, July.
- Masson, P. (1998). Contagion: Moonsoonal Effects, Spillovers, and Jumps between Multiple Equilibria. *IMF Working Paper* 98/142.
- Mohamed El Hedi Arouri, Jamel Jouini & Duc Khuong Nguyen(2011). Volatility Spillovers Between Oil Prices and Stock Sector Returns: Implications for Portfolio Management. *Journal of International Money and Finance* 30 (2011) 1387 - 1405.
- Mohd Tahir Ismail & Zaidi Bin Isa (June 2006). The Interactions of Stock Price and Exchange Rate in Malaysia. Proceedings of the 2<sup>nd</sup> IMT-GT Regional Conference on Mathematics, Statistics, and Applications.
- Mullainathan, S. (1998). A Memory Based Model of Bounded Rationality. *Quarterly Journal of Economics*. 2002;117(3):735-774.
- Ngassam, C. (1991). Factors affecting the external debt-servicing capacity of African nations: An empirical investigation. *The Review of Black Political Economy*.
- Ozler, S. (1992). The evaluation of credit terms. *Journal of Development Economics*, Pages 38.
- Paolo Emilio Mistrulli (2011). Assessing Financial Contagion in the Interbank Market: Maximum Entropy versus Observed Interbank Lending Patterns. *Journal of Banking & Finance* 35 (2011) 1114–1127.
- Parkinson, M., (1980). The Extreme Value Method for estimating the Variance of the Rate of Return. *Journal of Business* 53 (1), 61–65.
- Phylaktis, K. & Xia, L., (2004). Equity Market Comovement and Contagion: A Sectoral Perspective. *Cass Business School Working Paper*.
- Philippe J. & Zhang G., (2007). Good and Bad Credit Contagion: Evidence from Credit Default Swaps. *Journal of Financial Economics* 84 (2007), 860 - 883.



- Pindyck, Robert S., & Julio J. Rotemberg (1990). The Excess Co-Movement of Commodity Prices. *The Quarterly Journal of Economics*, 1990, C, 1173-89.
- Robert S. Pindyck & Julio J. Rotemberg (1993). The Comovement of Stock Prices. *The Quarterly Journal of Economics*, Vol. 108, No. 4. (Nov., 1993), pp. 1073-1104.
- Place, F.M. (1989). Information Quality, Country Risk Assessment, and Private Bank Lending to Less-Developed Countries. PhD. Dissertation, Dept. Of Economics, University of Wisconsin-Madison.
- Robert S. Pindyck & Julio J. Rotemberg (Dec 1990). The Excess Co-Movement of Commodity Prices. *The Economic Journal*, Vol. 100, No. 403. (Dec 1990), pp. 1173-1189.
- Rosett, R.N. & F.D. Nelson (1975). Estimation of the Two-Limit Probit Regression Model. *Econometrica*, Vol 43, No 1, 141-146.
- Saleheen Khan, Kwang Woo K. & Park (2009). Contagion in the Stock Markets: The Asian Financial Crisis Revisited. *Journal of Asian Economics* 20 (2009) 561–569.
- Sivasankarganesh, Shamma & Jacob(2015). Financial Globalization is Nothing but a Speculation and Ruin. Nep Presentation.
- Tai Chu-Sheng (2004). Contagion: Evidence from International Banking Industry. *Journal of Multinational Financial Management* 14 (2004) 353–368.
- Terhi Jokipii & Brian Lucey (2007). Contagion and Interdependence: Measuring CEE Banking Sector Co-movement. *Economic Systems* 31 (2007) 71–96.
- Tobin, J. (1958). Estimation of Relationship for Limited Dependent Variables. *Econometrica*, 26, 24-36. The World Bank, “World Debt Tables,” Washington.
- Tansuchat, R., McAleer, M. & Chang, C., (2009) Volatility Spillovers Between Crude Oil Futures Returns and Oil Company Stock Returns. 18<sup>th</sup> World IMACS/MODSIM Congress, Cairns, Australia 13-17 July 2009.
- Valdes, R. (1996). Emerging Market Contagion: Evidence and Theory. MIT Mimeo.
- Wachter, J. A. (2013). Can time-varying risk of rare disasters explain aggregate stock market volatility? *Journal of Finance* 68(3), 98-1035.
- Yacine Art-Sahalia, Julio Cacho-Diaz & Roger J.A. Laeven (Aug 2011). Modeling Financial Contagion using Mutually Exciting Jump Processes. *NBER Working Paper*, C13; G1.

Yilmaz & Kamil (2010). Return and Volatility Spillovers among the East Asian Equity Markets. *Journal of Asian Economics*, Elsevier, vol. 21(3), pages 304-313, June.



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