



Kashif Saleem

**ESSAYS ON PRICING OF RISK AND INTERNATIONAL
LINKAGE OF RUSSIAN STOCK MARKET**

Thesis for the degree of Doctor of Science (Economics and Business Administration) to be presented with due permission for the public examination and criticism in the Auditorium 1381 at Lappeenranta University of Technology, Lappeenranta, Finland, on the 16th of June, 2009, at noon.

Acta Universitatis
Lappeenrantaensis
343

Supervisor Professor Mika Vaihekoski
School of Business
Dep. of Business Economics and Law - Finance
Lappeenranta University of Technology
Finland

Reviewers Professor Gregory Koutmos
Charles F. Dolan School of Business
Fairfield University
USA

Professor Johan Knif
Department of Finance and Statistics
Hanken School of Economics
Finland

Opponent Professor Johan Knif
Department of Finance and Statistics
Hanken School of Economics
Finland

ISBN 978-952-214-750-9
ISBN 978-952-214-751-6 (PDF)
ISSN 1456-4491

Lappeenrannan teknillinen yliopisto
Digipaino 2009

ABSTRACT

Kashif Saleem

Essays on pricing of risk and international linkage of Russian stock market

Lappeenranta, 2009

136 pages

Acta Universitatis Lappeenrantaensis 343

Diss. Lappeenranta University of Technology

ISBN 978-952-214-750-9, 978-952-214-751-6 (PDF), ISSN 1456-4491

Last two decades have seen a rapid change in the global economic and financial situation; the economic conditions in many small and large underdeveloped countries started to improve and they became recognized as emerging markets. This led to growth in the amounts of global investments in these countries, partly spurred by expectations of higher returns, favorable risk-return opportunities, and better diversification alternatives to global investors. This process, however, has not been without problems and it has emphasized the need for more information on these markets. In particular, the liberalization of financial markets around the world, globalization of trade and companies, recent formation of economic and regional blocks, and the rapid development of underdeveloped countries during the last two decades have brought a major challenge to the financial world and researchers alike.

This doctoral dissertation studies one of the largest emerging markets, namely Russia. The motivation why the Russian equity market is worth investigating includes, among other factors, its sheer size, rapid and robust economic growth since the turn of the millennium, future prospect for international investors, and a number of important major financial reforms implemented since the early 1990s. Another interesting feature of the Russian economy, which gives motivation to study Russian market, is Russia's 1998 financial crisis, considered as one of the worst crisis in recent times, affecting both developed and developing economies. Therefore, special attention has been paid to Russia's 1998 financial crisis throughout this dissertation.

This thesis covers the period from the birth of the modern Russian financial markets to the present day. Special attention is given to the international linkage and the 1998 financial crisis. This study first identifies the risks associated with Russian market and then deals with their pricing issues. Finally some insights about portfolio construction within Russian market are presented.

The *first research paper* of this dissertation considers the linkage of the Russian equity market to the world equity market by examining the international transmission of the Russia's 1998 financial crisis utilizing the GARCH-BEKK model proposed by Engle and Kroner. Empirical results shows evidence of direct linkage between the Russian equity market and the world market both in regards of returns and volatility. However, the weakness of the linkage suggests that the Russian equity market was only partially integrated into the world market, even though the contagion can be clearly seen during the time of the crisis period.

The second and the third paper, co-authored with Mika Vaihekoski, investigate whether global, local and currency risks are priced in the Russian stock market from a US investors' point of view. Furthermore, the dynamics of these sources of risk are studied, i.e., whether the prices of the global and

local risk factors are constant or time-varying over time. We utilize the multivariate GARCH-M framework of De Santis and Gérard (1998). Similar to them we find price of global market risk to be time-varying. Currency risk also found to be priced and highly time varying in the Russian market. Moreover, our results suggest that the Russian market is partially segmented and local risk is also priced in the market. The model also implies that the biggest impact on the US market risk premium is coming from the world risk component whereas the Russian risk premium is on average caused mostly by the local and currency components.

The purpose of the *fourth paper* is to look at the relationship between the stock and the bond market of Russia. The objective is to examine whether the correlations between two classes of assets are time varying by using multivariate conditional volatility models. The Constant Conditional Correlation model by Bollerslev (1990), the Dynamic Conditional Correlation model by Engle (2002), and an asymmetric version of the Dynamic Conditional Correlation model by Cappiello et al. (2006) are used in the analysis. The empirical results do not support the assumption of constant conditional correlation and there was clear evidence of time varying correlations between the Russian stocks and bond market and both asset markets exhibit positive asymmetries.

The implications of the results in this dissertation are useful for both companies and international investors who are interested in investing in Russia. Our results give useful insights to those involved in minimising or managing financial risk exposures, such as, portfolio managers, international investors, risk analysts and financial researchers. When portfolio managers aim to optimize the risk-return relationship, the results indicate that at least in the case of Russia, one should account for the local market as well as currency risk when calculating the key inputs for the optimization. In addition, the pricing of exchange rate risk implies that exchange rate exposure is partly non-diversifiable and investors are compensated for bearing the risk. Likewise, international transmission of stock market volatility can profoundly influence corporate capital budgeting decisions, investors' investment decisions, and other business cycle variables. Finally, the weak integration of the Russian market and low correlations between Russian stock and bond market offers good opportunities to the international investors to diversify their portfolios

Keywords: Russia, international asset pricing models, multivariate GARCH, financial crisis, emerging market, contagion, volatility spillover, partial integration, price of risk, currency risk, time varying correlations, asymmetric

UDC 336.76 (470+571) : 339.5 : 330.131.7 : 339.9.01

To my loving parents

ACKNOWLEDGMENTS

I shall start in the name of God, the most merciful, who gave me the opportunity, resources and strength to complete this dissertation.

Writing a doctoral dissertation demands a great deal of perseverance, audacity and intellectual potency. Even though it is very lonesome work most of the time, it is not a job done alone; in fact, I have been privileged to have many people around me whenever I was in need of good advice, help and supervision.

I am deeply indebted to Professor Mika Vaihekoski, my supervisor and co-author of the second and third essay; our joint research projects have had the biggest positive impact on this thesis. Four years ago when I moved here — to a new city and a new school — he was the only source of motivation and encouragement for me. In fact he was the very first person who believed in me when I had nothing to show, even for myself. Mika always kept the door open for me to rush in, no matter if I was deeply frustrated or highly excited. His enthusiasm and interest in discussing my ideas, extensive constructive comments about my work has, truly, provided me with an environment competitive enough to bring out the best in me. Thank you, Mika. Before having you as my supervisor I was just a searcher, but you made me a researcher. I always feel fortunate for having you as my supervisor; without your kind supervision this would have been a hard and lonely journey.

I also owe my most sincere gratitude to my dissertation examiners, Professor Gregory D. Koutmos, the Charles F. Dolan School of Business at Fairfield University and Professor Johan A. Knif, Hanken School of Economics, for their detailed review and pointing out those many errors that would otherwise have been ignored, their constructive criticism and excellent advice. Both the reviewers have a special place in my academic journey: Knif was the one that fulfilled my desire to explore the world of knowledge by giving me the opportunity to start my Master's studies at Hanken, and Koutmos was the one that initially developed my passion for understanding gambling and stock markets by introducing volatility modelling years ago. Thank you both for being my mentors in academia.

This study was carried out at the Department of Business Economics and Law, School of Business, Lappeenranta University of Technology, Finland, during 2005-2009. First, I would like to take the opportunity and thank Kalevi Kyläheiko, Head of School of Business, Jaana Sandström, Vice-Dean of the faculty and Minna Martikainen, Head of Finance Section, for providing me with the facilities and opportunity to carry out this study at the department and Kaisu Puumalainen for taking care of all the administrative aspects of this dissertation. Further I wish to extend my sincere thanks to all my present and past colleagues at the department. In particular from the Finance Section, Eero Pätäri, Timo Leivo and Elena Fedorova earn special gratitude for sharing many inspiring discussions and fun moments during these years. Moreover, thanks to all my fellow doctoral students at the Graduate School of Finance (Helsinki, Vaasa and Oulu) for their good company and hospitality whenever I was there to attend a course or a seminar.

Special thanks to Terttu Hynynen, Secretary of the Dean of School of Business, for being always kind and helpful for all the secretarial work, and Ari Vehkanen from the Computer Section for excellent company and computer facilities.

Words cannot express my gratitude for Sheraz Ahmad (Hanken, Helsinki) and Ihsan Badshah (Hanken, Vaasa), my colleagues and companions both in the academic work and leisure. We started the journey together and share countless memories. I can never forget your very useful advice and inspiration, especially, when I was struggling with my graduate studies. Thanks for always being supportive and

encouraging. I would also like to thank all my friends beyond academic circles. Among many others Dr. Muhammad Ali (Helsinki University Central Hospital) was the one that was always there for me whenever I was down or, equally, in a party mood. Khalid Batthi (Hanken, Vaasa) deserves special thanks for his hospitality during my visits to Vaasa and of course gratitude to Ahmad and Khurram, my party brothers in Lappeenranta.

I wish to express my gratitude to the anonymous referees of my published work and Elsevier Ltd. for their permission to include my accepted articles in this dissertation. I owe special thanks to all the participants and in particular the discussants of my work in different national and international forums, such as in the international conference on Emerging Markets Finance & Economics, Istanbul, Turkey 2006, European Financial Management Association, Annual Conference, Athens, Greece 2008, Portuguese Finance Network, 5th Finance Conference in Coimbra, Portugal, 2008 and 5th International Finance Conference, IFC, in Hammamet, Tunisia, 2009. Thanks to Jan Antell and Niklas Ahlgren (Hanken School of Economics) for their constructive criticism during Graduate School of Finance (GSF) workshops, and Terhi Jokipii (Swiss National Bank) and Professor Michael Funke (Hamburg University) also deserve special thanks for their suggestions and comments at the Bank of Finland Institute for Economies in Transition (BOFIT) workshops.

Financial support to graduate students always works as a fuel to enhance their expertise and motivation. Generous financial support from the Academy of Finland and Liikesivistysrahasto — Foundation for Economic Education really contributed to my research and daily life. I hope that this dissertation at least to some extent fulfils their expectations. Without their support this would have been a hard journey.

I thank my mother Razia, the most loving mother a son can have — I am so proud today that I make your wish come true, your son is now DOCTOR — and my father Saleem, whose strong belief, challenging personality and visionary approach never cease to inspire me. You taught me always to consider problems, critical situations and crises as a challenge and opportunity. I hope I have not disappointed you by accomplishing this great challenge of my life. Thank you for always supporting the paths I have chosen in life.

I owe my loving gratitude to my sisters Nayyer, Faiqa, Saima, Aysha and Memoona. Your love and prayers were always with me whenever I was homesick. During all these years abroad, you have lost a lot due to my research, but I hope your brother makes you feel proud today.

Finally, I would like to thank my lovely wife Monika. I really appreciate your patience for surviving all those nights with a crazy researcher glued to the computer. Thanks for being there for me in all weathers. Last and most importantly, my lovely little son Bilal deserves a big kiss. He has really changed my life, from a free bird to a responsible papa!

Lappeenranta, May 2009

Kashif Saleem

Table of Contents

PART A: OVERVIEW OF THE DOCTORAL DISSERTATION

	Page
1 INTRODUCTION	13
1.1 Background and motivation of the study	13
1.2 Earlier research and identification of research gaps	14
1.3 Research problems /questions	17
1.4 Concept definitions	19
1.5 Structure of the study	21
2 REVIEW OF MODERN RUSSIAN ECONOMY	21
2.1 Pre-crisis era	21
2.2 Russian financial crisis	22
2.3 Post-crisis era	24
3 THEORETICAL BACKGROUND	25
3.1 Asset pricing models	25
3.2 GARCH models	27
3.2.1 <i>Overview of models</i>	27
3.2.2 <i>The univariate case</i>	29
3.2.3 <i>The multivariate case</i>	30
3.2.4 <i>Models of conditional variances and correlations</i>	32
4 SUMMERY OF ESSAYS	34
5 DISCUSSION AND CONCLUSIONS	38
5.1 Empirical contributions	38
5.1.1 <i>Contribution to the literature on international linkage of stock markets and contagiousness of financial crisis</i>	38
5.1.2 <i>Contribution to the literature on pricing of Risk and their dynamics in stock markets</i>	38
5.1.3 <i>Contribution to the literature on portfolio construction</i>	39
5.2 Applications of the study	39
5.3 Suggestions for future research	40
REFERENCES	42

PART B: THE ESSAYS

1. International linkage of Russian market and Russian financial crisis: A multivariate GARCH analysis	xx
2. Pricing of global and local sources of risk in Russian stock market	xx
3. Time-varying global and local sources of risk in Russian stock market	xx
4. Time-varying correlations between stock and bond returns: Empirical evidence from Russia	xxx

LIST OF PUBLICATIONS

Saleem, K., 2009. International linkage of the Russian market and the Russian financial crisis: A multivariate GARCH analysis. Forthcoming in *Research in International Business and Finance*, 2009.

Saleem, K. and M. Vaihekoski, 2008. Pricing of global and local sources of risk in Russian stock market. *Emerging Markets Review*, Vol. 9, No. 1, 40-56.

Saleem, K. and M. Vaihekoski (2009). Time-varying global and local sources of risk in Russian stock market. Has been accepted and to be presented at the 16th Annual Conference of the Multinational Finance Society, to be held between June 28 and July 1, 2009 in Rethymno, Crete, Greece.

Saleem, K (2008). Time varying correlations between stock and bond returns: Empirical evidence from Russia. Published in the Proceedings of Portuguese Finance Network, 5th Finance Conference in Coimbra, Portugal, 2008 and 5th International Finance Conference, IFC, in Hammamet, Tunisia, 2009.

Kashif Saleem's contribution in the publications:

1. Solely written by the present author.
2. Drew up the research plan together with the co-author. Collected the data. Analysed the data together with the co-author. Wrote most of the manuscript, with the help of co-author.
3. Drew up the research plan together with the co-author. Collected the data. Analysed the data together with the co-author. Coordinated the writing of the paper and wrote most of the manuscript, with the help of co-author.
4. Solely written by the present author.

PART A: OVERVIEW OF THE THESIS

1 INTRODUCTION

1.1 Background and motivation of the study

Liberalization of financial markets, globalization of trade and companies, recent formation of economic and regional blocks, and the rapid development of underdeveloped countries during the last two decades have brought a major challenge to the financial world and researchers alike. In Particular, emerging financial markets have received an increasing attention.¹ There are several reasons for this. Most notably, the low return on investments in companies from the developed markets have turned investors attention to emerging markets, which can offer higher returns, more favourable return-risk opportunities, and better diversification alternatives. This development has imported a lot of capital to emerging markets and in turn helped them to develop their economies. This process, however, has not been without problems, as the know-how of these markets has been inadequate. In particular, the different risk profile, market pricing, lack of transparency, poor supervision, and lower efficiency of the emerging markets has caused problems for investors.

This doctoral dissertation studies one of the largest emerging markets, namely Russia. The motivation why the Russian equity market is worth investigating includes, among other factors, its sheer size, rapid and robust economic growth since the turn of millennium, future prospective for international investors, and a number of important major financial reforms implemented during since the early 1990s, especially after the 1998 financial crisis in Russia.² Moreover, one can expect Russia to differ from other emerging markets for various reasons such as, its history, company structure, and institutional features. Furthermore, excellent performance of many Russian companies (e.g., in the oil industry) has drawn foreign investors' attention resulting in increased foreign ownership during the last decade. At the same time Russian policy makers have realized the benefits of opening the market for foreign investors and started to remove investment barriers. This generally leads to an increase in the foreign investments as well as higher aggregate market values for the affected securities. Last but not least, huge interest of many EU countries, including Finland, in Russian economy motivates us to study Russian market.

¹ Emerging financial markets refers to the countries that are in a transitional phase between developing and developed status.

² See, e.g., Anatolyev (2005) and Goriaev and Zobotkin (2006) for recent overviews of the Russian stock market development.

Another interesting feature of the Russian economy, which gives motivation to study Russian market, is Russia's 1998 financial crisis, considered as one of the worst crisis in recent times (see, e.g., Bank for International Settlements, 1999), affecting both developed and developing economies. Therefore, special attention has been paid to Russia's 1998 financial crisis throughout this dissertation. Basically, this thesis aim to cover maximum aspects of today's modern Russian market, starting with the international linkage of Russian market and transmission of Russia's 1998 financial crisis this study first identifies the risks associated with Russian market and then deals with their pricing issues. Finally some insights about portfolio construction within Russian market are presented in this thesis.

1.2 Earlier research and identification of research gaps

Examining the linkage between different markets has been one of the hot topics in academia since the early 90s. There are several studies focusing on the stock market linkage across countries. However, the bulk of research present the return and volatility linkages between developed markets. For instance, Hamao et al. (1990), Lin et al. (1994), Susmel and Engle (1994), Karolyi (1995), Theodossiou and Lee (1993) are among those who investigated the linkage between developed markets, such as USA, UK, Canada, Germany, and Japan. All the mentioned studies found a clear relationship in terms of return and volatility spillovers from one market to the other market. Further, Koutmos and Booth (1995) also incorporate the asymmetric effect in their analysis of price and volatility spillovers by investigating the New York, Tokyo and London stock markets they found strong evidence that volatility spillovers in a particular market are much more evident when the news arriving from the last market to trade is bad.

There exist some papers that explore the relationship between emerging markets of different regions even though the work is still very scare. For example, Worthington et al. (2000) look at price linkages in Asian equity markets Kasch-Haroutounian and Price (2001) examine Central Europe, Sola et al. (2002) analyze volatility links between the stock markets of Thailand, South Korea and Brazil while more recently Li and Majerowska (2007) study the linkage between Eastern European countries. Similarly, only a few papers have investigated the interrelationship between developed and emerging markets. In most studies the benchmark developed markets are USA, Western Europe and Japan and emerging markets include Pacific-Basin markets, East Asian markets, Latin American financial markets and Eastern Europe. Examples include, Liu and Pan (1997), Liu et al. (1998), Cheung et al. (2002) and Walti (2003). Surprisingly, the Russian financial market garners less attention than might be expected, given its diverse nature and investor potential.

While examining return and volatility linkage between different markets during different episodes of financial and economic crises, the Asian crisis clearly receives the lion's share of attention in the existing literature (see, e.g., Sander and Kleimeier, 2003; Jackson, 1999; Rakshit, 2002; Park and Song, 2001). There is also a sizeable body of research on Latin American financial crashes (see, e.g., Rojas-Suarez and Weisbrod, 1995; Bazdresch and Werner, 2001; Cardoso and Hedwege, 2001; Corbacho et al., 2003). In contrast, little empirical investigation of the contagion effects of the Russian financial crisis has been performed. Studies representing Russian crisis directly are limited. Empirical studies mentioning the Russian crisis to some extent include Brüggemann and Thomas (1999), Bussiere and Mulder (1999), Caramazza et al. (2000), Cartapanis et al. (1999), Feridun (2004), Gelos and Sahay (2000) and Baig and Goldfajn (2001). However, there is little consensus among these researchers as to the contagion effects of Russian turmoil. Gelos and Sahay (2000), for example, find no evidence of contagion during the crisis. Forbes (2000), using firm-level information, sees evidence of contagion only after the Russian crisis. More recently, Dungey et al. (2006, 2007) consider the fallout from the Russian and Long-Term Capital Management crises of 1998 in international bond markets and global equity markets, and using a multi-regime factor model of equity and bond markets, identify contagion from Russia to both emerging and developed countries.

Besides the transmission between financial markets, prior literature has identified two different sets of fundamental sources of risk that help in explaining the returns in international stock markets and particularly in the emerging markets, namely exposure to local and global sources of risks. Theoretically these risk sources can be defined as, for instance, if stock markets are fully segmented, the classical CAPM of Sharpe (1964), Lintner (1965) and Black (1972) suggests that the expected equity returns are a function of only the country-specific local risk. However, due to rapid structural changes in the world economy, increased global trade, introduction of new financial trading and information handling techniques, formation of regional economic groups, increased need for foreign investments, and so called globalization, most of the emerging stock markets are in the process of integration and liberalization. Hence, if markets were completely integrated (see, e.g., Grauer et al. 1976; Wheatley, 1988; Solnik, 1983; Ferson and Harvey, 1993 and 1994; Campbell and Hamao, 1992; Bekaert and Hodrick, 1992), the international version of the CAPM suggests that the only systematic source of risk is global market risk. This is due to international investors diversifying their portfolios across countries leading towards integration, where the local price is no longer priced similar to company specific non-systematic risk in the traditional CAPM.

Moreover, many studies of international asset pricing models take full integration for granted ignoring domestic sources of risk. However, results from many emerging and smaller developed markets do not

support the full integration. It seems that pricing models assuming partial segmentation (such as in Errunza and Losq, 1985) are more appropriate for these markets (see, e.g., Nummelin and Vaihekoski, 2002; Antell and Vaihekoski, 2007; Carrieri et al., 2006). Hence, local sources of risk should also be taken into account especially in the context of emerging markets and they should be at least a priori treated separately from of the local currency risk.

Besides the local and global market risk, currency risk has very important implications for the portfolio management, the cost of capital of a firm, asset pricing and currency hedging strategies, as any source of risk which is not compensated in terms of expected returns should be hedged. However, the pricing of currency risk in the international stock markets is still an open and controversial issue, as the prior empiric does not give a clear cut answer whether or not the currency risk is priced. For instance, Jorion (1991) reports that currency risk is not priced in the US market, while many researchers have later found currency risk to be priced on other markets. For example, De Santis and Gérard (1998) found the currency risk to be priced on several developed markets. They also suggest that the time variation in the risk premium could explain why the earlier unconditional models were unable to detect highly time-varying currency risk. Similar results have been derived also for smaller developed markets (see, e.g., Vaihekoski, 2007a).

There exists a few studies that focus on the exchange rate related risk in the emerging stocks markets, such as, Latin America (see, e.g., Bailey and Chung, 1995), Asia (see, e.g., De Santis and Imrohorglu, 1997; Gérard et al., 2003; Phylaktis and Ravazzolo, 2004; Tai, 2007), and Eastern Europe (see, e.g., Mateus, 2004). These studies found partial support for the pricing of currency risk using unconditional framework. Work on the Russian equity markets, on the other hand, is still very scarce. Fedorov and Sarkissian (2000) and Gorjaev and Zobotkin (2006) are rare exceptions (see also de Jong and de Roon, 2005).

Despite the importance of identification and pricing of risks, construction of the optimal portfolio has always been the primary goal of portfolio managers, risk analysts and financial researcher. Hence, examination of the co-movements between the stock and bond markets has been one of the most fundamental questions to all mentioned above. However, the question is still open and there is no general consensus among financial researchers on the dynamics of the stock–bond correlation and how it might perform in the future. For instance, Keim and Stambaugh (1986), Campbell and Ammer (1993), and Kwan (1996) empirically support the theoretical argument of positive correlation among stocks and bonds. On the other hand Gulko (2002), Connolly et al. (2005) and Baur and Lucey (2006) support the phenomenon of “flight to quality” and “flight from quality” which reflects a negative

correlation between the two assets, and additionally, Alexander et al. (2000) found mixed sign correlations.

Moreover, prior literature is divided into two distinct opinions regarding the co-movement of two assets, for example, Shiller and Beltratti (1992) and Campbell and Ammer (1993) are among those who implicitly assume that stock–bond correlation is time invariant. In contrast, Scruggs and Glabadanidis (2003) strongly reject models that impose a constant correlation restriction on the covariance matrix between stock and bond returns. Furthermore, Siegel (1998), Gulko (2002), Capiello et al. (2006), Ilmanen (2003), Connolly et al. (2005), Jones and Wilson (2004) and Li (2002) are among those who have shown that the correlation between stock and bond returns exhibits considerable time variation, whereas Barsky (1989) is of the view that stock and bond co-movements are state dependent.

Most of the studies mentioned above studies the correlation dynamics of only developed markets, while, this phenomenon has been severely ignored in the context of emerging markets, regardless of their high returns and favourable diversification opportunities.

1.3 Research problems /questions

Given the research gaps and contradictions in empirical evidences discussed above, more studies on emerging markets are warranted. Therefore, the emphasis of this thesis is to study the international linkage, identification and pricing of different sources of risks and construction of optimal portfolios in one of the most dynamic emerging market, namely, Russia. Another issue addressed in this dissertation is the choice of asset pricing models when dealing with emerging world. Several recently developed techniques, with some modifications, are used to perform empirical analysis on Russian data.

This thesis consists of four independent but related essays. The main research questions addressed in this dissertation are as follows.

Q1: How well the Russian market is integrated to the world market?

The first question deals with the international linkage of Russian market in terms of return and volatility and builds the foundation of this thesis given the rapid growth of Russia market and interest of international investors since the establishment of Russian stock market in 1995. It also inspects the controversial issues of market segmentation and integration in an emerging market setting.

Q2: Was the 1998 Russian financial crisis contagious and how it transmitted to rest of the world?

The aim of the second question is to analyze one of the common concerns of financial analysts and market participants during the crisis periods, i.e., the likelihood that a crisis will spill over resulting in an intense volatility somewhere else in the world's financial markets due to high correlation among countries and financial markets. Since, the Russian crisis of 1998, characterized by increased volatility in global securities markets has been considered as the worst crisis in recent times (see, e.g., Bank for International Settlements, 1999), the objective is to identify its contagion effects and how it was transmitted to rest of the world.

Q3: Were the global and local risk factors priced in Russian stock market?

The third question focuses on the pricing of fundamental sources of risks identified by the prior literature. For example, if the Russian market is fully integrated, the international version of the CAPM suggests that the only systematic source of risk is global market risk. On the other hand, if the Russian market is partially integrated to the world market local sources of risk should also be taken into account. Furthermore, this question studies the dynamics of above mentioned sources of risk, i.e., whether the global and local risk factors are constant or time varying over time.

Q4: Is the currency risk priced in Russian stocks, if it is priced, how large is the premium of currency risk and how it evolves over time?

One of the common features of all the financial disasters of last decade was the attack on currencies of involved economies. As a result, exchange rate risk has become the sizzling topic under discussion of an extensive economic literature, both theoretical and empirical. Question four aims to understand the issue of currency risk pricing in Russian stocks. Russia is interesting from the point of view of currency risks, since the Russian currency has undergone several currency regimes (multiple cases of devaluations and revaluations, periods of fixed and floating exchange rates, etc.). Moreover, Q4 explains how large is the premium of currency risk and how it evolves over time.

Q5: Is the co-movement between the Russian stock and bond market constant or time- varying over time and how to model the asymmetries in conditional variances, covariances, and correlations in Russian stock and bond markets?

Finally, considering the main objective of a portfolio managers, i.e., to construct a portfolio that has the largest expected return with a minimum risk, question 5 studies the relationship between the most

primary securities traded on stock exchanges and the major component of any optimal portfolio, i.e., returns on stocks and bonds.

It is our contention that all the issues discussed in this thesis have direct implications for the international investors who want to diversify their portfolios internationally, multinational corporations and portfolio managers and all who are involved in minimizing and managing their financial risk exposure, also our conclusions may impact on corporate capital budgeting decisions, investor consumption decisions and other business cycle variables.

1.4 Concept definitions

Emerging markets

Emerging markets refer to markets that have newly developed or are in the process of financial development as opposed to developed or advanced markets. The development of emerging markets started in the 1980s when a several economies, in particular in Asia (for example, China, India, Pakista), Africa, Latin America (for instance, Mexico, Brazil, Peru, Chile, Colombia, Argentina) and in Eastern Europe, started to attract investors from the developed world. As a result huge amount of capital shifted to these markets and in turn helped them to develop their economies.

In practice, defining an emerging market is rather difficult as several markets e.g. in Eastern Europe has approached developed markets. These markets belong to so-called transitional economies which is a common name to countries that are in transition from communistic regime into a market-oriented economy. In the 2008 Emerging Economy Report, the Center for Knowledge Societies defines Emerging Economies as those "regions of the world that are experiencing rapid internalization under conditions of limited or partial industrialization." Another definition is to define all non-developed countries as emerging. The World Bank defines countries on the basis of Gross National Income per capital into low income, middle income, and high income economies. Using this categorization, one could consider low and middle income countries as emerging.

A number of new terminologies have been also developed especially in the professional world to describe subgroups of the emerging markets. The most commonly used terms are BRIC and BRIMC that stand for Brazil, Russia, India, Mexico, and China.

Financial crisis

In economic terms financial crisis can be defined as the imbalance of demand and supply of money. In other words this refers to the situation when banks or companies are in short of liquidity. Moreover, within the context of asset pricing a financial crisis can broadly be defined as the sudden fall of asset prices as a result of any financial bubbles burst; a massive devaluation of the country's currency because of a speculative attack, sovereign default, i.e., not to be able to pay back its sovereign debt, a huge flight of capital due to the erosion of investor's confidence or can be associated with banking panics. Example includes .Asian financial crisis, Mexican and Russian financial crisis of the late 1990s.

Financial contagion

Financial contagion is considered as the negative effect of a troubled economy on another economy. Due to the so called globalization and market integration, financial markets of the world are highly interdependent now a day, hence, collapse of one economy cause problems in other economies dependent or linked with the effected market, in finance, these effects are called contagion effects. In other words, spread of risk from one market to another market during the crisis period is called contagion. Classical examples this can be seen during the Asian financial crisis, Mexican and Russian financial crisis of the late 1990s

Asset pricing

In finance, pricing a financial asset such as stocks, options, business enterprises, patents and trademarks or liability e.g., bonds is the process of estimating the market value of a these financial assets or liabilities. Efficient pricing of assets has always been the fundamental element of investment analysis, capital budgeting, merger and acquisition transactions and financial reporting. The basic idea in asset pricing theory is to understand the prices or values of claims to uncertain payments. According to John H. Cochrane "Asset pricing theory all stems from one simple concept, price equals expected discounted payoff". Therefore, the theory helps explaining why some assets pay higher average returns than others as low price implies a high rate of return.

Risk management

Risk management is an art to manage, avoid, minimize or eliminate the undesirable risks by formulating rational investment policies, adopting prudent procedures, such as, risk sharing or, risk transfer, or any other strategy or combination of different strategies in suitable management of prospect proceedings.

Risk sharing

A contract between two or more parties on a transaction to share the risk associated with that particular transaction. The agreement engages a tailored hedge contract entrenched in the primary transaction. Risk sharing is an important tool of risk management in the process of decision making, strategy building and disaster planning. The aim is to distribute the cost of a risk between various entities. In other words to reduce the risk of each investment, managers invest in a wide range of risky projects to compensate the risk of one investment in other.

1.5 Structure of the study

This doctoral dissertation consists of two parts. The first part presents an overview of the thesis and is divided in five sections. Section two explains the brief review of modern Russian economy with a special reference to 1998 Russian financial crisis. Section three describes theoretical background and econometric models used in the dissertation. The main results of four complementary research papers are presented in Section four. Finally, Section five summarizes the first part by discussing the main conclusions, contributions, applications and suggestions for future research. The second part of this dissertation comprises four research papers addressing the research questions formulated above.

2 REVIEW OF MODERN RUSSIAN ECONOMY

2.1 Pre-crisis era

Since the break-up of the USSR in 1991, significant efforts have been made by the government of Russian Federation to shift the economy from centrally planned one to a market economy. Notable measures include privatization of state enterprises, opening the market for foreign investors, legislation to protect investor's rights, establishment of stock markets, reforms in banking sector, etc. As a result, huge capital insurgence took place in the early years of the post-Soviet period. By that time mostly the prices were determined by the market mechanism, however, the major sectors like utilities and energy were still under government control. At first, government adopted the policy to expand the money supply; however, later it turned out as the worst strategy, when the government was unable to control the money supply. Only in the second and third quarters of 1992, the money supply had increased by 34% and 30%, respectively and by the end of 1992, the Russian money supply had increased by eighteen times. The obvious result was high inflation and a severe deterioration in the exchange rate of Russian currency.

Official data in 1992 shows the annual rate of inflation at 2600% for retail and 3400% for wholesale prices as documented by Melnicenko (1993). The 1993 annual inflation rate was around 1000%, a sharp improvement over 1992, but still very high. However, in 1994 government adopts a tight monetary policy and, therefore, first time after the soviet regime, government was able to curb inflationary pressure and the official rate by December 1994 was 16.4% far lower than the previous years. In 1995, the monthly inflation rate held almost stable below 5% in the last quarter of the year but rates climbed once again to 16.5% for the first half of 1996.

The excessive money supply in early 90's had also major effects on the internal and external value of ruble. In mid 1992, when the ruble first could be legally exchanged for United States dollars, ruble's exchange rate was fixed as 125 rubles per one USD. However, Russian economy was severely hit by the high inflation and the creditability of the external value of the ruble started to decrease. At first, the central bank tried to defend the currency. The first prominent shock suffered by the ruble was September 1993 devaluation, when ruble lost its 28% value within one week. Later in 1994, on October 11 (Black Tuesday) ruble devalued again 27.5% against USD. The first half of year 1995 ended up with further 18.1% decrease in ruble value against dollar. During the second half of the year 1995 the government of Russia introduced the so-called corridor system for the currency as a move towards stabilization of the ruble. Ruble was allowed to move between 4300 and 4900 per USD during the period from July 6 to October 1, but changed to Nov. 31 of 1995 and later extended the period to June 1996. By the end of October 1995, the ruble had stabilized and actually appreciated in inflation-adjusted terms. Ruble remained stable during the first half of 1996. In May 1996, the government allowed the ruble to depreciate gradually (crawling band). At first the exchange rate band was set to between 5000 and 5600 rubles per US \$1. However, later the band moved to 5500 and 6100. Russia also announced the full convertibility of ruble on current account basis in June 1996.

2.2 Russian financial crisis

For the first time after the collapse of soviet regime Russian economy shows some signs of improvement in the beginning of 1997. However, aftermaths of 1997 Asian financial crisis and a sharp decline in world commodity prices, especially oil, severely imbalanced the Russian foreign exchange reserves. On top of that, despite the recommendations of many economists, Russian government kept on supporting the ruble by fixing the exchange rate of ruble within a narrow band. On August 14th the exchange rate of the Russian ruble to the US dollar was still 6.29, resulting in a huge increase in the

interest payments on Russia's debt³. By August 1998, the Russian stock, bond, and currency markets were on the verge of collapse. A massive devaluation of ruble and default on domestic debt were apparent. Russian stock market had lost more than 75 percent of its value from January to August, 39 percent in the month of May alone.

While shifting from a centrally planned economy to a free market system the Russian economy experienced a tremendous pressure. Unfortunately, all the fiscal restructuring measures intended to lift up government revenues and a reliance on short-term borrowing to finance budget discrepancy led to a serious financial crisis in 1998. The Russian economic meltdown aggravated by the Asian financial turmoil in 1997, strike Russia on 17 August 1998. Among other factors, such as, constant fiscal deficit, artificially maintained high fixed exchange rate between the ruble and foreign currencies, a sharp decline in world commodity prices, for example, petroleum, natural gas, metals, timber and in particular oil, had indirect involvements in the Russian economic turmoil, whereas, the main cause was the inability to pay the taxes by Russia's major export earners mainly due to massive devaluation of ruble.

The immediate effect of Russian financial crisis was the erosion of investor confidence, resulting in a huge capital flight. Foreign investors left the market by selling rubles and Russian securities which severely hits the ruble by putting a downward pressure. In the beginning, government try to attract the foreign capital back by setting high interest rates; in fact, the authorities raise GKO⁴ interest rates to 150% in an attempt to support the currency and stop the flight of capital. However, regardless of government efforts, the debts continued to grow and the situation was worsened by irregular internal debt payments. Moreover, the Russian government announced a package of measures to cope with the crisis, including a 32.8% devaluation of the ruble's lower end of the exchange range from 7.15 rubles to the dollar to 9.5 rubles to the dollar. On September 9th, the government had to abandon the target zone. From that day, the ruble shifted to a "floating exchange rate" system. After the floating decision, ruble experienced at first further depreciations. However, after the turn of the century, the external value of the ruble started to stabilize.

The consequences of Russian crisis were felt globally, e.g., after only a couple of weeks in the United States Russian crisis almost destroyed the hedge fund Long-Term Capital Management (see, e.g., Masson, 1999). At the same time, the Baltic States, emerging markets of Central Asia and Eastern

³ For instance, in the month of July interest payments on Russia's debt rose to a figure 40 % greater than its monthly tax collection.

⁴ Domestic short-term government bond issued by the state of Russia since February 1993.

Europe observed severe contagion effects mainly due to the massive devaluation of Russian ruble and the following debt default, which ultimately increased the emerging market risk and decreases the commodity exports from these emerging markets to Russia (see, e.g., Dungey et al., 2006). Moreover, during the crisis period shocks were observed in countries with little in common in regards of the traditional definition of contagion effects⁵. For example, Baig and Goldfajn (2001) argue that the Russian crisis precipitated the Brazilian crisis.

2.3 Post-crisis era

Russia, however, recovered back from the August 1998 financial crisis with an amazing pace. Thanks to higher oil prices, which caused a steep increase in the foreign currency supply on the market due to higher export sales revenues. The external value of the ruble also started to stabilize after the turn of the century. In fact, Russia enjoyed a large trade surplus in 1999 and 2000. Moreover, local industry plays an important role in economic recovery after the crisis, as domestic industries, such as food processing, had benefited from the devaluation of ruble.

During 2000-01, the economy made real gains of an average 8% per year (2000: 10%, 2001: 5.7%). The government was not only able to pay its external debt payments but also made large advance repayments of principal on IMF loans. In FY 2002 the growth rate decline to 4.9%, however, oil and gas sector once again become the source of current account surpluses. In 2003, for the first time in the whole post-crisis period, the growth in consumer prices was within the limits set by the Government. The gold and foreign exchange reserves of the Russian Federation started to grow steadily. As a result, the situation in the monetary sphere has remained rather stable and tranquil. Official data documented a 7.3% growth in 2003, 7.1% in FY 2004, 6.5% in 2005 and 6.7% in 2006, making Russian economy as 11th largest in the world and the 7th largest economy in the world in purchasing power.

For the first time in 2007 Russia's GDP exceeded that of 1990 which means that Russia has recover the repercussions of 1998 economic meltdown and the recession period of 90s. During 2000–2007, Russian industry grew by 75%, local and foreign investments increased by 125% in aggregate, at the same time, agricultural and construction production also increased. As a result, real incomes of common people almost doubled, a 7 times increase in the middle class and a sharp decline in the number of people living below the poverty from 30% in 2000 to 14% in 2008.

⁵ See for example Lowell et. all (1998) and Goldstein (1998) for taxonomies of contagion.

Despite all the progress, inflation still remained a problem, government failed to keep the forecast ceiling during 1999–2006. However, in 2007, 8.1% increase in the real GDP, highest percentage since the fall of the Soviet Union reveal the economic boost and the stabilization of exchange rate of ruble and Russian economy. Moreover, World Bank recently declared that the Russian economy had achieved "unprecedented macroeconomic stability"

3 THEORETICAL BACKGROUND

3.1 Asset Pricing Models

If world markets are fully integrated, the expected return on all assets should be the same after adjusting for exposure to global sources of risk. Hence, in a single-factor-setting, the single relevant source of global risk is a benchmark portfolio comprised of the world equity market portfolio. If there are no restrictions on capital movements, allowing domestic investors freely to diversify internationally and foreign investors to invest in local markets, markets are said to be legally integrated. By financial market integration we understand that assets in all markets are exposed to the same set of risk factors with the risk premia on each factor being the same in all markets. In this case, e.g., Grauer et al. (1976) and Adler and Dumas (1983) have shown that the global value-weighted market portfolio is the relevant risk factor to consider.

Assuming that investors do not hedge against exchange rate risks and a riskfree asset exists; the conditional version of the world CAPM implies the following restriction for the nominal excess returns

$$(1) \quad E[r_{i,t+1} | \Omega_t] = \beta_{i,t+1}(\Omega_t) E[r_{m,t+1} | \Omega_t],$$

where $E[r_{i,t+1} | \Omega_t]$ and $E[r_{m,t+1} | \Omega_t]$ are expected returns on asset i and the global market portfolio conditional on investors' information set Ω_t available at time t . Both returns are in excess of the local riskfree rate of return r_{ft} for the period of time from t to $t+1$. The global market portfolio comprises all securities in the world in proportion to their capitalization relative to world wealth (see Stulz, 1995). All returns are measured in one numeraire currency.

Since the conditional beta is defined as $\text{Cov}(r_{i,t+1}, r_{m,t+1} | \Omega_t) \text{Var}(r_{m,t+1} | \Omega_t)^{-1}$, we can use equation (1) to define the ratio $E[r_{m,t+1} | \Omega_t] \text{Var}(r_{m,t+1} | \Omega_t)^{-1}$. It can be considered as the conditional price of global market

risk $\lambda_{m,t+1}$, conditioned on information available at time t . It measures the compensation the representative investor must receive for a unit increase in the variance of the market return (see Merton, 1980). Now the model gives the following restriction for the expected excess returns for any asset i :

$$(2) \quad E[r_{i,t+1} | \Omega_t] = \lambda_{m,t+1} \text{Cov}(r_{i,t+1}, r_{m,t+1} | \Omega_t),$$

where the price of market risk should be positive if investors are risk-averse. Since the market portfolio is also a tradable asset, the model gives the following restriction for the expected excess return of the global market portfolio

$$(3) \quad E[r_{m,t+1} | \Omega_t] = \lambda_{m,t+1} \text{Var}(r_{m,t+1} | \Omega_t).$$

As the returns are measured in the numeraire currency, the model also implies that the expected returns do not have to be the same for investors coming from different currency areas even though they do not price the currency risk. On the other hand, the price of global market risk is the same for all investors irrespective of their country of residence.

However, if some assets deviate from pricing under full integration, their risk-adjusted return will differ from the global CAPM. If this is the case, the market price of global risk should be the same for all assets everywhere, after adjusting for the costs arising from the barrier constraints. Following Errunza and Losq (1985), the pricing equation may include also the local market portfolio as a source of local market risk. The pricing equation can be written as follows:

$$(4) \quad E[r_{i,t+1} | \Omega_t] = \lambda_{m,t+1}^w \text{Cov}(r_{i,t+1}, r_{m,t+1}^w | \Omega_t) + \lambda_{m,t+1}^l \text{Cov}(r_{i,t+1}, r_{m,t+1}^l | \Omega_t),$$

where $\lambda_{m,t+1}^w$ and $\lambda_{m,t+1}^l$ are the conditional prices of world and local market risk.

However, any investment in a foreign asset is always a combination of an investment in the performance of the asset itself and in the movement of the foreign currency relative to the domestic currency. Adler and Dumas (1983) show that if the purchasing power parity (PPP) does not hold, investors view real returns differently and they want to hedge against exchange rate risks. Specifically, the risk induced by the PPP deviations is measured as the exposure to both the inflation risk and the currency risk associated with currencies. Assuming that the domestic inflation is non-stochastic over

short-period of times, the PPP risk contains only the relative change in the exchange rate between the numeraire currency and the currency of $C+1$ countries (see, e.g., De Santis and Gérard, 1998). In this case the conditional asset pricing model for partially segmented markets implies the following restriction for the expected return of asset i in the numeraire currency

$$(5) E_t[r_{i,t+1}] = \lambda_{m,t+1}^w \text{Cov}_t(r_{i,t+1}, r_{m,t+1}^w) + \sum_{c=1}^C \lambda_{c,t+1} \text{Cov}_t(r_{i,t+1}, f_{c,t+1}) + \lambda_{m,t+1}^l \text{Cov}_t(r_{i,t+1}, r_{m,t+1}^l),$$

where $\lambda_{c,t+1}$ is the conditional price of exchange rate risk for currency c . $\text{Var}_t(\cdot)$ and $\text{Cov}_t(\cdot)$ are shorthand notations for conditional variance and covariance operators, all conditional on information Ω_t . Note that the price of exchange rate risk is not restricted to be positive.

3.2 GARCH Models

Throughout this project we utilize the Autogressive Conditional Heteroscedasticity (ARCH) family models. For example, in essay one, we adopt a bi-variate GARCH (1, 1)-BEKK representation proposed by Engle and Kroner (1995). In essay two and three, following De Santis and Gérard (1998) we utilize the multivariate GARCH-M framework; their estimation process is based on Ding and Engle (2001), a special case of the BEKK model. Finally, in essay four, we employ models of conditional variances and correlations, namely, the constant correlation coefficient-GARCH (CCC-GARCH) of Bollerslev (1990), the dynamic conditional correlation (DCC) model of Engle (2002) and an asymmetric version of the dynamic conditional correlation (ADCC) proposed by Cappiello *et al.* (2006). In the following lines, a brief overview of ARCH family models is presented.

3.2.1 Overview of Models

The Autogressive Conditional Heteroscedasticity (ARCH) process proposed by Engle (1982) and the generalised ARCH (GARCH) by Bollerslev (1986) are well known in volatility modelling of stock returns, given their success to capture the stylized features of financial time series, such as, volatility clustering, excess kurtosis and fat-tailedness, and are well recognized by both academic researchers and market professionals.

In examining volatility linkages between countries, however, a multivariate GARCH approach is preferred over univariate settings. Unfortunately, such models can only be estimated by imposing

specific restrictions on the conditional variance-covariance matrix (e.g. positive definiteness). The early model proposal of Bollerslev *et al.* (1988) – ostensibly for checking the volatility linkage between countries – fails to assure the positive definiteness of the conditional variance matrix. Moreover, it does not allow cross-equation conditional variances and covariances to affect each other due to its oversimplifying restrictions. Most of these problems are avoided in the newer BEKK (Baba, Engle, Kraft and Kroner) parameterization proposed by Engle and Kroner (1995). Using quadratic forms to ensure positive definiteness, the BEKK model complies with the hypothesis of constant correlation and permits for volatility spillover across markets.

While specification of Engle and Kroner (1995) allows for rich dynamics and a positive-definite covariance matrix, the number of parameters still grows fairly large in higher-dimensional systems. Therefore, further parameter restrictions are often imposed, for example diagonality or symmetry restrictions. Hence, in order to simplify the estimation process, the covariance stationary specification of Ding and Engle (2001) has been preferred in the estimation of multivariate GARCH models (see, e.g., De Santis and Gérard, 1997, 1998)

Another direction is followed by Bollerslev (1990) who introduced the models of conditional variances and correlations. The foundation of these models is on the decomposition of the conditional covariance matrix into the conditional standard deviations and correlations. In his model, constant correlation coefficient-GARCH (CCC-GARCH), the conditional correlations are assumed to be time-invariant and only the idiosyncratic variances are time varying. However, the assumption of constant correlation is perhaps relatively uncertain and may not hold always. The dynamic conditional correlation (DCC) model of Engle (2002), a generalization of Bollerslev's CCC model, however, by relaxing this assumption capture the dynamics of conditional correlations. DCC also avoids computational complexities, estimate large conditional variance-covariance matrices and overcome the heteroskedasticity problem, since the residuals of the returns are standardized by the conditional standard deviation based on a GARCH (1, 1) process. However, it does not account for the asymmetries in conditional variances, covariances, and correlations. Thanks to Cappiello *et al.* (2006) who recently proposed an asymmetric version of the Dynamic Conditional Correlation (ADCC) model to deal with the asymmetries in conditional variances, covariances, and correlations of two assets.

3.2.2 The Univariate Case

We start explaining our empirical specification with a univariate framework of ARCH family models. Let us consider a univariate time series Y_t if Ω_{t-1} is the information set at time $t-1$, we can define its functional form as:

$$(6) \quad Y_t = E\{Y_t | \Omega_{t-1}\} + \varepsilon_t,$$

The ε_t term in the above equation is the innovation of the process with $E\{\varepsilon_t\} = 0$ and $E\{\varepsilon_t \varepsilon_j\} = 0$, for all $t \neq j$. The conditional expectation is the expectation conditional to all past information available at time $t-1$. The Autoregressive Conditional Heteroscedastic (ARCH) process of Engle (1982) is any ε_t of the form $\varepsilon_t = z_t \sigma_t$ where z_t is an independently and identically distributed (*i.i.d.*) process with $E\{z_t\} = 0$, $\text{var}\{z_t\} = 1$ and where σ_t is a time-varying, positive and measurable function of the information set at time $t-1$. By definition, ε_t is serially uncorrelated with mean zero, but its conditional variance is equals σ_t^2 and, therefore, may change over time, contrary to what is assumed in the traditional OLS estimation. Specifically, the ARCH (q) model is given by

$$(7) \quad \sigma_t^2 = w + \sum_{i=1}^q \alpha_i \varepsilon_{t-i}^2,$$

Since empirical application of ARCH (q) model require long lag length and a large number of parameters to be estimated, Bollerslev (1986) generalized the ARCH model by incorporating the squared conditional variance terms as additional explanatory variables or, in other words, volatility at time t is also assumed to be affected by p lags of past estimated volatility. If we write the residual as, $\varepsilon_t = z_t \sigma_t = v_t \sqrt{h_t}$, where σ_t^2 is written as h_t and z_t has a zero mean and variance of one, v_t stands for a sequence of independent, identically distributed (iid) random variables with zero mean and unit variance. Following Bollerslev (1986) we can then write the conditional variance as:

$$(8) \quad h_t = w + \sum_{i=1}^q \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^p \beta_i h_{t-i},$$

The primary constraints of this model is that all the expounding variables in a GARCH and therefore ARCH model must be positive i.e., $w, \alpha, \beta \geq 0$ this is known as the non-negativity restriction; clearly it is impracticable to have a negative variance, as it consists of squared variables. Further, for stationarity we require that $\alpha + \beta$ is less than unity.

A useful feature of the GARCH model is that it can effectively remove the excess kurtosis in returns but failed to model the asymmetry of the series or so called leverage effect, to cop with this problem Nelson (1991) proposed the Exponential Generalized Auto regressive Conditional Heteroscedasticity process (EGARCH). Similarly, GJR-GARCH model of Glosten et al. (1993), the asymmetric GARCH models of Engle and Ng (1993) and the quadratic GARCH of Sentana (1995) have been widely used to accommodate the asymmetry in the response. To increase the flexibility of original model, GARCH has been generalized and extended in various directions (for a detail survey see, e.g., Teräsvirta and Zhao, 2006), however, our main focus in this project is the application of multivariate GARCH models, so all the univariate extensions are not discussed here.

3.2.3 The Multivariate Case

Multivariate GARCH models are simply the generalization of univariate models. Multivariate GARCH models (MGARCH) unlike their univariate counterparts also specify equations for how the covariances move over time. In particular, these models are used to study the relations between the volatilities and co-volatilities of several markets.

The VECH model of Bollerslev et al. (1988) was the first attempt to generalize univariate GARCH. We start our empirical specification with a multivariate GARCH model that accommodates each market's returns and the returns of other markets lagged one period.

$$(9) \quad r_t = \mu_t + \varepsilon_t,$$

where $\varepsilon_t | \Omega_{t-1} \sim N(0, H_t)$ and r_t is an $n \times 1$ vector of daily returns at time t for each market. The $n \times 1$ vector of random errors ε_t represents the innovation for each market at time t with its corresponding $n \times n$ conditional variance-covariance matrix H_t . The market information available at time $t-1$ is represented by the information set Ω_{t-1} . Bollerslev et al. (1988) suggest that the conditional variance-

covariance matrix H_t is a linear function of the lagged squared errors and cross products of errors and lagged values of the elements of H_t as follows.

$$(10) \quad vech(H_t) = vech(C) + \sum_{i=1}^q A_i vech(\varepsilon_{t-1} \varepsilon'_{t-1}) \sum_{i=1}^p G_i vech(H_{t-1}),$$

where $vech(\cdot)$ is the operator that stacks the lower triangular portion of a symmetric matrix into a vector. C is an $N(N + 1)/2 \times 1$ vector, and A_i and G_i are $N(N + 1)/2 \times N(N + 1)/2$ parameter matrices. One of the main disadvantages of VEC model is that the condition of positive definiteness of H_t is only a sufficient condition rather restrictive (see, e.g., Gouri'eroux, 1997). Moreover, with this formulation the number of parameters equals to be estimated, $(p + q) (N(N + 1)/2) + N(N + 1)/2$, are large unless N is small, also estimation of the parameters is computationally complex.

Engle and Kroner (1995) propose a new parametrization for H_t by introducing a well known model, the BEKK model, to overcome the above mentioned problems. Given the above expressions, and following Engle and Kroner (1995), the conditional covariance matrix can be stated as:

$$(11) \quad H_t = C_0' C_0 + A_{11}' \varepsilon_{t-1} \varepsilon'_{t-1} A_{11} + G_{11}' H_{t-1} G_{11},$$

where the parameter matrices for the variance equation are defined as C_0 , which is restricted to be lower triangular and two unrestricted matrices A_{11} and G_{11} . Thus, the second moment can be represented by:

$$(12) \quad H_t = C_0' C_0 + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} \varepsilon_{1,t-1}^2 & \varepsilon_{1,t-1} \varepsilon_{2,t-1} \\ \varepsilon_{1,t-1} \varepsilon_{2,t-1} & \varepsilon_{2,t-1}^2 \end{bmatrix} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} + \begin{bmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{bmatrix}' H_{t-1} \begin{bmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{bmatrix},$$

While the above specification allows for rich dynamics and a positive-definite covariance matrix, the number of parameters still grows fairly large in higher-dimensional systems. Therefore, further parameter restrictions are often imposed, for example diagonality or symmetricity restrictions. In order to simplify the estimation process, earlier research (see, e.g., De Santis and Gérard (1997, 1998) adopt the covariance stationary specification of Ding and Engle (2001), which is stated as:

$$(13) \quad H_{t+1} = H_0 \times (ii' - aa' - bb') + aa' \times \varepsilon_t \varepsilon'_t + bb' \times H_t,$$

where a and b contain the diagonal elements of matrices A and B , respectively. H_0 is the unconditional variance-covariance matrix.

3.2.4 Models of conditional variances and correlations

Bollerslev (1990) proposed a model, Constant Correlation Coefficient-GARCH, where the conditional correlations are assumed to be constant and only the idiosyncratic variances are time varying. He defines the conditional variance-covariance matrix (H_t) as follows:

$$(14) \quad H_t = D_t R_t D_t,$$

with $\varepsilon_t | \Omega_{t-1} \rightarrow N(0, H_t)$ where, r_t is the $(k \times 1)$ vector of the returns; ε_t is a $(k \times 1)$ vector of zero mean return innovations conditional on the information, Ω_{t-1} , available at time $t-1$, D represents a $(k \times k)$ diagonal matrix of the conditional volatility of the returns on each asset in the sample and R_t is the $(k \times k)$ conditional correlation matrix.

However, Engle (2002) considers the assumption of constant correlation weak and generalize Bollerslev's CCC model by assuming time varying correlations framework. The new model was named as Dynamic Conditional Correlation (DCC) model. Basically, the DCC-GARCH model estimates conditional volatilities and correlations in two steps. In the first step the mean equation of each asset in the sample, nested in a univariate GARCH model of its conditional variance is estimated. Hence, we can define D_t as follows:

$$(15) \quad D_t = \text{diag}(h_{11t}^{1/2}, \dots, h_{kk t}^{1/2}),$$

where $h_{ii t}$ conditional variance of each asset is assumed to follow a univariate GARCH (p, q) process, given by the following expression:

$$(16) \quad h_{i,t+1} = \omega_i + \sum_{p=1}^{p_i} \alpha_{i,p} \varepsilon_{i,t+1-p}^2 + \sum_{q=1}^{Q_i} \beta_{i,q} h_{i,t-p},$$

However, to insure non-negativity and stationarity some restrictions, such as $\alpha_{i,p} > 0$, $\beta_{i,q} > 0$ and

$$\sum_{p=1}^{p_i} \alpha_{i,p} + \sum_{q=1}^{q_i} \beta_{i,q} < 1 \text{ should be imposed. These univariate variance estimates are then used to}$$

standardise the zero-mean return innovations for each asset. In the second step, the standardised zero mean return innovations are assumed to follow a multivariate GARCH (m, n) process to illustrate the development of the time varying correlation matrix, R_t which can be described as follows:

$$(17) \quad R_t = (\text{diag} Q_t)^{-1/2} Q_t (\text{diag} Q_t)^{-1/2},$$

where $Q_t = (1 - \alpha - \beta)\bar{Q} + \alpha\mu_{t-1}\mu'_{t-1} + \beta Q_{t-1}$ refers to a $(k \times k)$ symmetric positive definite matrix with $\mu_{it} = \varepsilon_{it} / \sqrt{h_{it}}$, \bar{Q} is the $(k \times k)$ unconditional variance matrix of u_t , and α and β are non-negative scalar parameters satisfying $\alpha + \beta < 1$. Finally, the conditional correlation coefficient ρ_{ij} between two assets i and j is then expressed by the following equation:

$$(18) \quad \rho_{ij} = \frac{(1 - \alpha - \beta)\bar{q}_{ij} + \alpha\mu_{i,t-1}\mu_{j,t-1} + \beta q_{ij,t-1}}{\left\langle (1 - \alpha - \beta)\bar{q}_{ii} + \alpha\mu_{i,t-1}^2 + \beta q_{ii,t-1} \right\rangle^{1/2} \left\langle (1 - \alpha - \beta)\bar{q}_{jj} + \alpha\mu_{j,t-1}^2 + \beta q_{jj,t-1} \right\rangle^{1/2}},$$

As DCC model does not allow for asymmetries and asset specific news impact parameter, the modified model Cappiello *et al.* (2006) for incorporating the asymmetrical effect and asset specific news impact can be written as:

$$(19) \quad Q_t = (\bar{Q} - A'\bar{Q}A - B'\bar{Q}B - G'\bar{N}G) + A'\varepsilon_{t-1}\varepsilon'_{t-1}A + B'Q_{t-1}B + G'n_{t-1}n'_{t-1}G,$$

where A, B and G are diagonal parameter matrixes, $n_t = I[\varepsilon_t < 0]o \varepsilon_t$ (with o indicating Hadamard product), $\bar{N} = E[n_t n'_t]$. For \bar{Q} and \bar{N} expectations are infeasible and are replaced with sample analogues, $T^{-1} \sum_{t=1}^T \varepsilon_t \varepsilon'_t$ and $T^{-1} \sum_{t=1}^T n_t n'_t$, respectively.

4 SUMMERY OF ESSAYS

The first essay "*International linkage of Russian market and Russian financial crisis: a multivariate GARCH analysis*" address two issues.⁶ First, we look at the international linkage of the Russian equity market. Second, we examine international transmission of the 1998 Russian financial crisis.

We estimate a bivariate GARCH model, for which a BEKK representation is adopted. While this approach has been widely used in the study of international linkage of multiple markets and interdependence of markets during crisis episodes, a GARCH-BEKK analysis has not, to the best of our knowledge, been applied specifically to the 1998 Russian crisis as we propose. In addition, following prior research, which suggests that correlation in returns between two markets notably increase during and after the crisis episodes – evidence of contagion – we employ cross-market correlation technique (see, e.g., King and Wadhvani, 1990; Lee and Kim, 1993; Calvo and Reinhart, 1995; Baig and Goldfajn, 1998). And to examine the long-term relationship among the markets we utilize Johansen cointegration test.

We examine the transmission of the Russian crisis across global financial markets, both developed and emerging, particularly, the United States, the European Union and the financial markets of Emerging Europe and Asia. These particular regions are of special interest in the post-Soviet era as all have important roles in trade with Russia.

Four pair-wise models are estimated for Russia with the USA, the European Union, Emerging Europe and Asia on the basis of daily total return indices. We find evidence of direct linkage for both returns and volatility between the Russian equity market and the other markets. This linkage is fairly weak, however, indicating only partial integration of the Russian market into the world market. This finding is in line with the conclusions of Saleem and Vaihekoski (2008). Three subsets of the Russian financial crisis are examined: the pre-crisis period (Jan. 1995–Jul. 1998), the crisis period (Aug. 1998–Dec. 1998) and the post-crisis period (Jan. 1999–Jun. 2007). Volatility spillovers are found in all cases, although the dynamics of the conditional volatilities differ. In the pre-crisis sample, the USA and Emerging Europe exhibit a bidirectional linkage, while the EU and Asia display unidirectional linkage. The post-crisis period shows bidirectional linkage with the USA and Asia, but a unidirectional linkage with Emerging Europe. Surprisingly, no statistically significant relations are found between the Russian equity market

⁶ Earlier version of this paper published in the Bank of Finland Institute for Economies in Transition (BOFIT) discussion Paper series as Saleem (2008). The latest version of this paper has been accepted for publication in *Research in International Business and Finance*.

and EU equity markets in the post-crisis sample. Finally, highly significant, but negative, shocks and volatility spillovers from Russia to the other markets are observed during the crisis period. Likewise, cross-market correlation analysis exhibit high correlations between the pairs (i.e. evidence of crisis contagion).

The second essay "*Pricing of global and local sources of risk in Russian stock market*", co-authored with Mika Vaihekoski, investigates whether global and local market risk as well as the currency risk are priced in the Russian stock market using conditional international asset pricing models.⁷ We use monthly data from 1995 to 2006. The sample period includes, for example, a gradual liberalization of the Russian financial markets and several currency regimes starting from fixed and floating currency regimes. These features make Russian stock market as an interesting test laboratory for many aspects of the international asset pricing models.

The estimation is conducted by utilizing the framework of De Santis and Gérard (1998), with the exception that we use constant price of risk specification instead of time-varying, for simplicity and to attain convergence in the estimates. The variance and covariance processes are assumed to be time-varying. To do this, following De Santis and Gérard (1998), we use a multivariate GARCH-in-Mean approach to model the conditional expectations, covariances, and variances.

Our investigation proceeds from the point of view of an US investor, investing both in the domestic stock market, and one additional, emerging economy – in this case Russia. We estimate the model originally using three test assets: world equity market and equity market indices for the US and Russia. The currency return is also modelled if the currency risk is included in the tested pricing model.

We begin our investigation by testing the international CAPM which assumes full integration between global and local stock markets. In addition, investors are assumed to diversify the currency risk away and hence the currency risk is not priced. Next we modify our model to allow for partial segmentation specification, where the US and Russia are assumed to be partially segmented to the world market. Finally we test our full model, which estimates the conditional international CAPM with constant prices of world and currency risk where the US and Russia are assumed to be partially segmented to the world market

⁷ Published in the Emerging Markets Review as Saleem and Vaihekoski (2008).

The results show that the unconditional price of world risk is positive and significant with reasonable values, which is in line with the theory and earlier studies. Our final, three factor model shows that the Russian stock market is at least partly segmented as the local market risk is priced in the Russian, but not on the US market. Positive prices of global and local market risk indicate that investors require higher compensation for higher market volatility. Finally, we also find the currency risk to be priced in the Russian stock market.

Essay 3 "*Time-varying global and local sources of risk in Russian stock market*" co-authored with Mika Vaihekoski is an extension to Saleem and Vaihekoski (2008).⁸ In this paper, we study the dynamics of risks identified in Saleem and Vaihekoski (2008) by allowing their prices to be time-varying and analyzing the size of the risk premia due to the time-varying sources of risks. In particular, we attempt to analyze the drivers behind the prices of risk and to decompose the effect of the different sources on the risk premium in the Russian equity market by taking the view of US investors. To do this, we use global and local predetermined forecasting variables to track predictable time-variation in asset returns, risk exposures, and the common rewards to risks. The instruments are chosen on the basis of parsimony, previous empirical studies and due to their relevance to the economy.

In our empirical specification, again, we utilize the multivariate GARCH-M framework of De Santis and Gérard (1998) to model the investors' conditional expectations, covariances, and variances. It allows for the time-varying variance-covariance process. However, we extend their approach to allow for conditional local influence similar to Antell and Vaihekoski (2007) by using weekly data from January 1999 to December 2006. The beginning of our sample period is after the Russian currency crises of 1998 as we believe that the period leading to the currency crisis was an extraordinary event and not typical as far as the way the currency risk is studied in this paper. Moreover, the sample period allows us to consider floating Russian Ruble during the whole time.

To represent economic risks we employ two types of risk factors in our international asset pricing model, namely global market risk and exchange rate risk. Initially, we test the partially segmented ICAPM by Errunza and Losq (1985) using two assets in addition to the global market portfolio, namely the U.S. and Russian market portfolios. US is included to compare results with the earlier studies, e.g., by De Santis and Gérard (1998). Russia is chosen as the main sample country because of its rather

⁸ Accepted for presentation at the 16th Annual Meeting of the Multinational Finance Society, to be held in Rethymno, Crete, Greece between June 28 and July 1, 2009.

unique role among the emerging markets, and then following Adler and Dumas (1983) and De Santis and Gérard (1998) we incorporate currency risk into the model.

Our results can be summarized as follows. Similar to De Santis and Gérard (1998) we find global risk to be time-varying. Currency risk also found to be priced and highly time varying in the Russian market. Our results show that Russian domestic risk is priced and time-varying, while local risk is not priced for the US market, suggesting that partially segmented asset pricing model is more suitable for the Russian market. Moreover, our model implies in-sample risk premium for the Russian equity market that is much higher than the US risk premium with three times higher amount of standard deviation. The model also implies that the biggest impact on the US market risk premium is coming from the world risk component whereas the Russian risk premium is on average caused mostly by the local and currency risk components.

Finally in the fourth essay "*Time varying correlations between stock and bond returns: Empirical evidence from Russia*" we address one of the most fundamental issue of traditional and modern portfolio management, i.e., to look at the dynamics of stock-bond correlation and how it might perform in the future⁹. Stock-bond correlation plays an important role in asset allocation, portfolio management and risk management. Despite its importance, this phenomenon has been severely ignored in the context of emerging markets, regardless of their high returns and favorable diversification opportunities. We chose Russian stock and bond market as a test laboratory due its rapid growth and attraction to both domestic and international investors.

We model the co-movements between returns on the stock and bond markets of Russia by using multivariate conditional volatility models. We start our investigation by applying Bollerslev (1990) Constant conditional correlation model to test whether varying correlations are statistically significant then we use DCC-GARCH (1, 1) model proposed by Engle (2002) to analyze the dynamics of conditional correlations between the two assets. Finally, to investigate the asymmetries in conditional variances, covariances, and correlations, we adopt an asymmetric version of the Dynamic Conditional Correlation (ADCC) model proposed by Cappiello *et al.* (2006). To conduct the analysis we use daily data from July 1994 to December 2007, covering the entire history of Russian market.

⁹ Published in the conference proceedings of the 5th International Finance Conference, IFC, in Hammamet, Tunisia, 12-14 March 2009 and the Portuguese Finance Network, 5th Finance Conference in Coimbra, Portugal , 10-12 July 2008.

Our empirical results do not support the assumption of constant conditional correlation and we found clear evidence of time varying correlations between Russian stocks and bond market. Moreover, both asset markets exhibit positive asymmetries. Our results offers a better understanding for the dynamics of the correlations between stocks and bonds in an emerging market setting which is obviously very valuable for the portfolio managers, international investors, risk analysts and financial researchers as well as for the policy implications.

5 DISCUSSION AND CONCLUSIONS

This section summarizes the research and introduces the empirical contributions and managerial implications of this study. The future avenues are also discussed.

5.1 Empirical contributions

5.1.1 Contribution to the literature on international linkage of stock markets and contagiousness of financial crisis

The existing literature on return and volatility linkage between different markets can be divided in to three groups. First, studies focusing on the linkages between developed markets. Secondly, literature on the relationship between emerging markets of different regions and finally papers exploring interrelationship between developed and emerging markets. The first two groups clearly receive the lion's share of attention in the existing literature. However, the work on the relationship between emerging and developed markets is still very scarce. This thesis fills the gap in third group of studies by examining the international linkage of the Russian market (the most dynamic and one of the largest emerging markets of the world). Another empirical contribution is the use of most advanced and well recognized set of econometric models on Russian data for the first time, as per the best of author's knowledge. Last but not least, this doctoral dissertation claims to be the first to analyze the Russian financial crisis of 1998 solely and comprehensively, at least as it has been analyzed in this thesis. The results (See Essay 1) provide empirical evidences of partial integration of Russian market into the world market and contagiousness of Russian financial crisis of 1998.

5.1.2 Contribution to the literature on pricing of Risk and their dynamics in stock markets.

Fundamental theoretical models of asset pricing such as the CAPM and the APT suggest that the high realized returns ought to be associated with high measures of risk with respect to a number of risk factors. Prior literature has suggested two different sets of basic sources of risk that help in explaining the returns in international stock markets namely exposure to local and global sources of risks.

However, Pricing of risk has always been a challenging task, especially in the context of emerging markets. This doctoral dissertation contributes to the existing literature by investigating whether global and local risks are priced and how they evolve over time in one of the largest emerging market, Russia. Another empirical contribution of this thesis is to examine an open and controversial issue, i.e., whether the currency risk is priced in international stock markets and particularly in the context of emerging market frame work, since their exchange rates mechanism often differ, e.g., for that of developed markets. Moreover, if it is priced how large is the premium of currency risk and how it evolves over time. Last but not least, the use of highly advanced and sophisticated econometric techniques on Russian data places this study quite well in the existing literature of risk pricing in emerging markets. The results (See Essay 2 & 3) show that the world market risk together with the currency and local market risks are priced on the Russian stock market. All the risk sources are found highly time varying. A partially segmented asset pricing model is found suitable for the Russian market. Moreover, the model implies in-sample risk premium for the Russian equity market that is, on average, almost thirteen times higher than that of the US with three times the volatility. Russian risk premium is on average caused mostly by its local and currency risk components.

5.1.3 Contribution to the literature on portfolio construction.

There is no doubt that futures, options and different kinds of derivative products have acquired an ever increasing importance in today's modern finance. However, stocks and bonds are still the primary securities traded on stock exchanges and the major component of any optimal portfolio, especially in emerging markets. However, despite its importance, this phenomenon has been severely ignored in the context of emerging markets, regardless of their high returns and favourable diversification opportunities. This thesis contributes to the existing literature by examining the relationship between Russian stock and bond market. Furthermore, the dynamics of that relationship were modelled by using most recently introduced econometric techniques. The empirical results (See Essay 4) show positive but very low correlation between Russian stock and bond market, do not support the assumption of constant conditional correlation and there was clear evidence of time varying correlations between the Russian stocks and bond market. Moreover, both asset markets exhibit positive asymmetries.

5.2 Applications of the study

This doctoral thesis comprised of four purely applied research papers. Each essay has direct policy implications. For example, the first essay deals with the contagion effects of Russian financial crisis of

1998 and international linkage of Russian equity market. Thus, within the context of the Russian financial crisis, the results give useful insights to those involved in minimizing or managing financial risk exposures. Likewise, international transmission of stock market volatility can profoundly influence corporate capital budgeting decisions, investor consumption decisions and other business cycle variables. Finally, the weak integration of the Russian market offers good opportunities to the international investors to diversify their portfolios.

The second and third essay deal with the pricing of risks involved in Russian stocks, results have important implications for investors, who want to diversify their portfolios internationally. When portfolio managers aim to optimize the return–risk relationship, the results indicate that at least in the case of Russia, one should account for the local market as well as currency risk when calculating the key inputs for the optimization. In addition, the pricing of exchange rate risk implies that exchange rate exposure is partly non diversifiable and investors are compensated for bearing the risk. Moreover, the results suggest that one should separate the local market and currency risk when analyzing emerging markets, especially Russia. The implications of our results are useful for both companies and international investors who are interested in investing in Russia. Finally, the results can shed light on the role of the currency risk and local risk on the pricing of stocks in countries that are currently emerging from segmentation and which are also restricting the free valuation of their currencies (e.g., Eastern European new EU members, and China).

Finally in the last essay, results offer a better understanding of the dynamics of the correlations between the stocks and bonds in an emerging market setting which is obviously very valuable for portfolio managers, international investors, risk analysts and financial researchers as well as for its policy implications.

5.3 Suggestions for future research

Overall there are several directions for further research that originate from the findings of this study. First, academics are encouraged to replicate the findings in countries that are currently emerging from segmentation and which are also restricting the free valuation of their currencies (e.g., Eastern European new EU members, and China). Another way to extend the analysis is to use industry or firm level data as in this study only country level data has been utilized or the macroeconomic data can also be tested by utilizing same econometric techniques.

Being specific, a natural extension of Essay 1 would be to estimate a k-variate model instead of bivariate analysis and examine volatility spillovers among all markets included in the sample instead of

pair wise analysis or by including more regions of the world. There are also rich opportunities to apply more recently developed econometric techniques such as constant correlation (CC), time-varying correlation (VC) or dynamic constant correlation (DCC).

There are many questions that still need further analysis in Essay 2 & 3. For example, the model employed in this study did not model specifically the variation in the level of segmentation/integration. In addition, it would be especially interesting to study asset pricing models using less aggregated data as well as their out-of-sample performance. Moreover, modelling of the currency risk in emerging stock markets needs further research as earlier studies have found that the role of the currency risk varies over time. In addition, when international asset pricing models are tested using data from countries with clear evidence of segmentation, it could be more appropriate to model the integration as a dynamic process with local influence. These questions are left for future study.

Similarly, Essay 4 can be extended by incorporating different economic factors to analyze the correlations between stock and bond markets of Russia. Additionally, the results could become more interesting by including exchange market as well in the analysis.

REFERENCES

- Adler, M., Dumas, B., 1983. International portfolio selection and corporation finance: a synthesis. *Journal of Finance* 38, 925-984.
- Alexander, G., A. Edwards, and M. Ferri. 2000. What Does NASDAQ's High-Yield Bond Market Reveal About Bondholder-Stockholder Conflicts? *Financial Management*, 23-39.
- Anatolyev, S., 2005. A ten-year retrospective of the behavior of Russian stock returns. Bank of Finland. BOFIT Discussion Papers, vol. 9.
- Antell, J., Vaihekoski, M., 2007. International asset pricing models and currency risk: evidence from Finland 1970–2004. *Journal of Banking and Finance* 31, 2571-2590.
- Baig, T., Goldfajn, I., 2001. The Russian default and the contagion to Brazil. In: S. Claessens & K. Forbes (Eds.), *International financial contagion*. Boston, Kluwer Academic Press.
- Bailey, W., Chung, Y.P., 1995. Exchange rate fluctuations, political risk, and stock returns: some evidence from an emerging market. *Journal of Financial and Quantitative Analysis* 30, 541-561.
- Baur, D., Lucey, B.M., 2006. Flight-to-quality or contagion? An empirical analysis of stockbond correlations. IHS Discussion Paper No. 122.
- Barsky, Robert B., 1989. Why Don't the Prices of Stocks and Bonds Move Together? *American Economic Review* 79, 1132-1145.
- Bazdresch, S. and A. Werner, 2001. Contagion of International Financial Crises: The Case of Mexico. *International Financial Contagion*. In: Claessens, S. and Forbes, K, Editors. Norwell, MA, Kluwer Academic Publishers.
- Bekaert, G., Hodrick, R. J., 1992. characterizing predictable components in excess returns on equity and foreign exchange markets. *Journal of Finance* 47, 467-510.
- Black, F., 1972. Capital market equilibrium with restricted borrowing. *Journal of Business* 45, 444-455.
- Bollerslev, T., 1990. Modeling the coherence in short-run nominal exchange rates: A multivariate generalized ARCH model. *Review of Economics and Statistics* 72, 498-505.
- Bollerslev T., Engle, R.F., Wooldridge, J.M., 1988. A capital asset pricing model with timevarying covariances. *Journal of Political Economy* 96, 116-131.
- Bollerslev, T., 1986. Generalized Autoregressive Conditional Heteroskedasticity. *Journal of Econometrics*, 31, 307-27.
- Brüggemann, A., Thomas, L., 1999. How Good are Leading Indicators for Currency and Banking Crises in Central and Eastern Europe? An Empirical Test. Halle Institute for Economic Research Discussion Paper, No. 95.

- Bussiere, M., Mulder, C., 1999. External Vulnerability in Emerging Market Economies: How High Liquidity Can Offset Weak Fundamentals and the Effect of Contagion. IMF Working Paper, No.99/88.
- Calvo, S., Reinhart, C., 1995. Capital Inflows to Latin America: Is There Evidence of Contagion Effects? World Bank and International Monetary Fund, Mimeo.
- Campbell, J. Y., Hamao, Y., 1992. Predictable stock returns in the United States and Japan: A study of long-term capital market integration. *Journal of Finance* 47, 43-70.
- Campbell, J., Ammer, J., 1993. What moves the stock and bond markets? A variance decomposition for long-term asset returns. *Journal of Finance*, 48, 3-37.
- Cappiello, L., Engle, R. and Sheppard, K., 2006. Asymmetric dynamics in the correlations of global equity and bond returns. *Journal of Financial Econometrics* 4, 537-572.
- Caramazza, F., Ricci, L., Salgado, R., 2000. Trade and Financial Contagion in Currency Crises. IMF Working Paper, 00/55.
- Cardoso, E. and A. Helwege, 2001. The 1990s crisis in emerging markets: the case of Brazil. *Capital Flows Without Crisis? Reconciling capital mobility and economic stability*. Dasgupta, D., Uzan, M. and Wilsom, D., Editors. New York, NY, Routledge.
- Carrieri, F., Errunza, V., Majerbi, B., 2006. Local risk factors in emerging markets: Are they separately priced? *Journal of Empirical Finance* 13, 444-461.
- Cartapanis, A., Dropsy, V., Mametz, S., 1999. Leading Indicators and Currency Crisis in Central Europe, Latin America and East Asia Countries. *Revue Economique* 50 (6), 1237-1254
- Cheung, Y.L., Cheung, Y.W., Ng, L.K., 2002. East Asian Equity Markets, Financial Crises and the Japanese Currency. *Journal of Econometrics* 72, 33-48.
- Connolly, R., Stivers, C. and Sun, L., 2005. Stock Market Uncertainty and the Stock- Bond Return Relation, *Journal of Financial and Quantitative Analysis*, 40: 161-194.
- Corbacho, A., Garcia-Escribano, M., Inchauste, G., 2003. Argentina: Macroeconomic Crisis and Household Vulnerability. IMF Working Paper WP/03/89.
- De Santis, G., Gérard, B., 1997. International asset pricing and portfolio diversification with time-varying risk. *Journal of Finance* 52, 1881-1912.
- De Santis, G., Imrohroglu, S., 1997. Stock returns and volatility in emerging financial markets. *Journal of International Money and Finance* 16, 561-579.
- De Santis, G., Gérard, B., 1998. How big is the premium for currency risk? *Journal of Financial Economics* 49, 375-412.
- De Jong, F., De Roon, F., 2005. Time-varying market integration and expected returns in emerging markets. *Journal of Financial Economics* 78, 583-613.

- Ding, Z., Engle, R.F., 2001. Large scale conditional covariance matrix modeling, estimation and testing. *Academia Economic Papers* 29, 157-184.
- Dungey, M., Fry, R. A., González-Hermosillo, B., Martin, V. L., 2006, International contagion effects from the Russian crisis and the LTCM near-collapse. *Journal of Financial Stability* 2, 1-27.
- Dungey, M., Fry, R. A., González-Hermosillo, B., 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, 155-174
- Engle, R.F., Kroner, K., 1995. Multivariate simultaneous generalized ARCH. *Econometric Theory* 11, 122–150.
- Engle, R., 2002. Dynamic Conditional Correlation – A Simple Class of Multivariate GARCH Models. *Journal of Business and Economic Statistics*, 20, 339-350
- Engle, R. F., 1982. Autoregressive conditional heteroskedasticity with estimates of the variance of United Kingdom inflation, *Econometrica*, 50, 987-1007.
- Engle, R. F., Ng, V. K., 1993. Measuring and testing the impact of news on volatility. *Journal of Finance* 48, 1749-1777.
- Errunza, V., Losq, E., 1985. Internal asset pricing under mild segmentation: theory and tests. *Journal of Finance* 40, 105-124.
- Fedorov, P., Sarkissian, S., 2000. Cross-sectional variations in the degree of global integration: The case of Russian equities. *Journal of International Financial Markets, Institutions, and Money* 102, 131-150.
- Feridun, M., 2004. Russian Financial Crisis of 1998: An Econometric Investigation. *International Journal of Applied Econometrics and Quantitative Studies* 1(4), 113-122.
- Ferson, W., Harvey, C., 1993. The risk and predictability of international equity returns. *Review of Financial Studies* 6, 527-566.
- Forbes, K., 2000. The Asian flu and Russian virus: Firm-level evidence on how crises are transmitted internationally. Working paper, National Bureau of Economic Research.
- Gelos, G., Sahay, R., 2000. Financial Market Spillover in Transition Economies. IMF Working Paper 00/71.
- Gérard, B., Thanyalakpark, K., Batten, J.A., 2003. Are the East Asian markets integrated? Evidence from the ICAPM. *Journal of Economics and Business* 55 (5-6), 585-607.
- Glosten, L., Jagannathan, R., Runkle, D., 1993. On the relation between expected value and the volatility of the nominal excess return on stocks. *Journal of Finance* 48, 1779-1801.

- Goldstein, M., 1998. The Asian financial crisis: causes, cures and systemic implications. In: Policy Analysis in International Economics, vol. 55. Institute for International Economics, Washington, DC.
- Goriaev, A., Zobotkin, A., 2006. Risks of investing in the Russian stock market: lessons of the first decade. *Emerging Markets Review* 7, 380-397.
- Grauer, F., Litzenberger, R., Stehle, R., 1976. Sharing rules and equilibrium in an international capital market under uncertainty. *Journal of Financial Economics* 3, 233-256.
- Gulko, L., 2002. Decoupling. *Journal of Portfolio Management*, 28, 59-67.
- Hamao, Y., Masulis, R., Ng, V., 1990. Correlations in Price Changes and Volatility Across International Stock Markets. *Review of Financial Studies* 3, 281-307.
- Ilmanen, A., 2003. Stock-bond correlations. *Journal of Fixed Income*, 13, 55-66.
- Jackson, K., 1999. Introduction: The Roots of the Crisis. *Asian Contagion: The Causes and Consequences of a Financial Crisis*. In: Jackson, K. Editor. Boulder, CO, USA: Westview Press, Perseus Books Group.
- Jones, C. and Wilson, J. (2004) The changing nature of stock and bond volatility. *Financial Analysts Journal*, 60, 100-113.
- Jorion, P., 1991. The pricing of exchange rate risk in the stock market. *Journal of Financial and Quantitative Analysis* 26, 363-376
- Karolyi, A.G., 1995. A Multivariate GARCH Model of International Transmissions of Stock Returns and Volatility: The Case of the United States and Canada. *Journal of Business and Economic Statistics* 11, 11-25.
- Kasch-Haroutounian, M., Price, S., 2001. Volatility in the transition markets of central Europe. *Applied Financial Economics* 11, 93-105.
- Keim, D.B., Stambaugh, E.B., 1986. Predicting returns in the stock and bond markets, *Journal of Financial Economics*, 17, 357-390
- King, M., Wadhvani, S., 1990. Transmission of Volatility Between Stock Markets. *Review of Financial Studies* 3, 5-33.
- Koutmos, G., Booth, G. G., 1995. Asymmetric Volatility Transmission in International Stock Markets. *Journal of International Money and Finance* 14, 747-762.
- Kwan, S. H., 1996. Firm-Specific Information and the Correlation between Individual Stocks and Bonds. *Journal of Financial Economics*, 40, 63-80.
- Lee, S. B., Kim, K. J., 1993. Does the October 1987 Crash Strengthen the Co-Movements Among National Stock Markets? *Review of Financial Economics* 3, 89-102.

- Li, H., Majerowska, E., 2007. Testing stock market linkages for Poland and Hungary: A multivariate GARCH approach. *Research in International Business and Finance*, Article in press.
- Li, L., 2002. Macroeconomic Factors and the Correlation of Stock and Bond Returns. Working paper, Yale International Center for Finance.
- Lin, W.L., Engle, R.F., Ito, T., 1994. Do Bulls and Bears Move Across Borders? *International Transmission of Stock Returns and Volatility. Review of Financial Studies* 7, 507-538.
- Lintner, J., 1965. The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *Review of Economics and Statistics* 47, 13-37.
- Liu, Y.A., Pan, M.S., 1997. Mean and Volatility Spillover Effects in the U.S. and Pacific- Basin Stock Markets. *Multinational Finance Journal* 1, 47-62.
- Liu, Y.A., Pan, M.S., Shieh, J.C.P., 1998. International Transmission of Stock Price Movements: Evidence from the U.S. and Five Asian-Pacific Markets. *Journal of Economics and Finance* 22, 56-69.
- Lowell, J., Neu, C.R., Tong, D., 1998. Financial Crises and Contagion in Emerging Market Countries. RAND, MR-962.
- Masson, P., 1999. Contagion: Macroeconomic Models with Multiple Equilibria. *Journal of International Money and Finance* 18, 587-602.
- Mateus, T., 2004. The risk and predictability of equity returns of the EU accession countries. *Emerging Markets Review* 5, 241-266.
- Melnikova, T., 1993. Economic reform in Russia in 1992. *MOCT-MOST: Economic Policy in Transitional Economies* 3, 145-152.
- Merton, R., 1980. On estimating the expected return on the market. *Journal of Financial Economics* 8, 323-361.
- Nelson, D. B., 1991. Conditional heteroskedasticity in asset returns: A new approach. *Econometrica* 59, 347-370.
- Nummelin, K., Vaihekoski, M., 2002. International capital markets and Finnish stock returns. *European Journal of Finance* 8, 322-343.
- Park, Y. C., Song, C.Y., 2001. Financial Contagion in the East Asian Crisis: With Special Reference to the Republic of Korea. *International Financial Contagion*. Claessens, S. and Forbes, K, Editors. Norwell, MA, Kluwer Academic Publishers.
- Phylaktis, K., Ravazzolo, F., 2004. Currency risk in emerging equity markets. *Emerging Markets Review* 5, 317-339.
- Rakshit, M., 2002. *The East Asian Currency Crisis*. New York, NY: Oxford University Press.

- Rojas-Suarez, L., Weisbrod, S., 1995. Financial Fragilities in Latin America: The 1980s and 1990s. Washington, D.C., International Monetary Fund.
- Saleem, K., 2008. International linkage of Russian market and the Russian financial crisis: A multivariate GARCH analysis. Bank of Finland Institute for Economies in Transition (BOFIT) discussion Paper series. No. 8.
- Saleem, K., Vaihekoski, M., 2008. Pricing of global and local sources of risk in Russian stock market. *Emerging Markets Review* 9, 40-56.
- Sander, H., Kleimeier, S., 2003. Contagion and Causality: An Empirical Investigation of Four Asian Crises Episodes. *International Financial Markets, Institutions and Money* 13, 171-186.
- Scruggs, J.T., Glabdanidis, P., 2003. Risk premia and the dynamic covariance between stock and bond return. *Journal of Financial and Quantitative Analysis* 38, 295-316.
- Sentana, E., 1995. Quadratic ARCH models. *Review of Economic Studies* 62, 639-661.
- Sharpe, W.F., 1964. Capital asset prices: A theory of market equilibrium under conditions of risk. *Journal of Finance* 19, 425-42.
- Shiller, R., Beltratti, A., 1992. Stock prices and bond yields. *Journal of Monetary Economics*, 30, 25-26.
- Siegel, J.J., 1998. *Stock for the Long Run: A Guide to Selecting Markets for Long- Term Growth*. IRWIN Professional Publishing.
- Sola, M., Spagnolo, F., Spagnolo N., 2002. A Test for Volatility Spillovers. *Economics Letters* 76, 77-84.
- Solnik, B., 1983. International arbitrage pricing. *Journal of Finance* 38, 449-457.
- Stulz, R.M., 1995. International portfolio choice and asset pricing: An integrative survey. In: Jarrow, R.A., Maksimovic, V., Ziemba, W.T. (Eds.), *Finance . In: Handbooks in Operations Research and Management Science*. North-Holland, 201-223.
- Susmel, R., Engle, R.F., 1994, Hourly volatility spillovers between international equity markets. *Journal of International Money and Finance* 13, 3-25.
- Tai, C-S., 2007. Market integration and currency risk in Asian emerging markets. *Research in International Business and Finance* 21, 98-117.
- Teräsvirta, T., Zhao, Z., 2006. Stylized facts of return series, robust estimates, and three popular models of volatility. Unpublished paper, Stockholm School of Economics.
- Theodossiou, P., Lee, U., 1993. Mean and Volatility Spillovers Across Major National Stock Markets: Further Empirical Evidence. *Journal of Financial Research* 16, 337-350.
- Vaihekoski, M., 2007. Global market and currency risk in Finnish stock market. *Finnish Economic Papers* 20, 72-88.

- Walti, S., 2003. Testing for Contagion in International Financial Markets: Which Way to Go? FAME Working Paper No. 92.
- Wheatley, S., 1988. Some Tests of International Equity Market Integration. *Journal of Financial Economics* 21, 177-212
- Worthington, A. C., Katsuura, M., Higgs, H., 2000. Price Linkages in Asian Equity Markets and the Asian Economic, Currency and Financial Crises. School of Economics and Finance, Queensland University of Technology, Brisbane, Queensland, Discussion Paper No. 77.