MYKOLAS ROMERIS UNIVERSITY – MIDDLESEX UNIVERSITY

BUSINESS AND MEDIA SCHOOL

ARVYDAS MARCINKEVIČIUS

ASSESSMENT OF CO-MOVEMENT OF EUROPEAN AND ASIAN STOCK MARKETS

A master’s thesis

Supervisor

Assoc. prof. dr. Marius Lanskoronskis

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ABBREVIATIONS

DAX – German stock index. Stock market index consisting of the 30 major German companies trading on the Frankfurt Stock Exchange.

FTSE100 – The Financial Times Stock Exchange 100 Index. Share index of the 100 companies listed on the London Stock Exchange with the highest market capitalization.

CAC40 – French stock market index. Share index of the 40 companies listed on the Euronext Paris exchange with the highest market capitalization.

FTSEMIB – Primary benchmark Index for the Italian equity markets. Represents 40 companies listed on Italy's main stock exchange.

HSI – The Hang Seng Index. Index of the 50 companies listed on the Hong Kong Stock Exchange.

STI – Straits Times Index. Index of the 30 companies listed on the Singapore Exchange with the highest market capitalization.

TAIEX – Taiwan Capitalization Weighted Stock Index.

GARCH – generalized autoregressive conditional heteroscedasticity model.

DCC – GARCH – Dynamic conditional correlation GARCH.

U.S. – United States of America.

U.K. – United Kingdom.

VECM – Vector Error Correction Model.

IMF – International Monetary fund.

NAFTA – The North American Free Trade Agreement.

EU – European union.

FTAA – The Free Trade Area of the Americas.

MERCOSUR – South American sub-regional bloc.

UNCTAD – United Nations Conference on Trade and Development.

OTC – Other the counter.

GDP – Gross domestic product.

FDI – Foreign direct investment.

INTRODUCTION

Relevance of the research. In a last few decades the pace of globalization increased substantially. Corporates operate in multiple countries and their products are well known around the globe. Liberalizations of capital and financial innovation in recent decades spurred rapid international growth of business and financial markets. Increasing interest in international diversification comes with stock markets liberalization, access to new capital markets. International diversification would improve return to risk ratio and provide investors to hold foreign securities. Of course all these benefits would be limited in the long run if international stock markets were interdependent and co-moved together. Last Global Financial Crisis of 2007-2009 during which almost all equity markets experienced sever down turn, would suggest that equity markets are integrated around the globe. However, to assess actual degree of co-movements between some equity markets empirical research over a short and long period on day-to-day basis is necessary.

A lot of researches have been done in this area, especially after the 1987 “Black Monday” crash. Number of papers investigates contagion, but some of them research certain areas (e.g. Asian - American markets, Europe – American markets), other look only in to emerging markets.

King & Wadhwani (1990) try to explain how world markets fell in October 1987 after the U.S. market crashed. They argue that simultaneous declines in different markets cannot be attributable to fundamentals and contagion occurs during turmoil period as a result of rational investors inferring information from different markets for their home market. Using cross market correlation coefficients, they find evidence for contagion in the Japan, US and UK during the period from July 1987 to February 1988. They conclude that higher volatility generally implies higher correlation and market links.

Hamao et al. (1990) investigate the U.S., U.K., and Japan markets from April 1985 till March 1988. He used GARCH model (generalized autoregressive conditional heteroskedastic model). Hamao et al. (1990) found statistically significant volatility spillovers from the U.S. to Japan and from the U.K. to Japan. Spillovers from Japan to the other two markets are much weaker.

Johnson & Soenen (2003) use daily data from 1989 to 1999 to investigate integration of equity markets in Argentina, Brazil, Chile, Mexico, Canada, Colombia, Peru, and Venezuela with the U.S. market. They also examine how economic and equity market integration are connected. First, they find statistically significant co-movements of returns between the U.S. market and the eight other markets. Second, the degree of co-movements varies over time. They declined over the period from 1988 to 1994; then were increasing until 1997 when they peaked and in 1999 they declined considerably.

Worthington & Higgs (2004) examine spillovers among nine Asian stock markets over the period 1988 to 2000. They find that all the markets are highly integrated.

Some recent studies focus on international stock market co-movements during the recent global financial crisis. A lot of research is devoted to impacts of the crisis on financial systems in emerging markets (see e.g. Hesse & Frank 2009) or co-movements of different asset classes such as equity, foreign exchanges, and commodities (see e.g. Frank 2009).

Sun & Zhang (2009) examine impacts of the U.S. credit crisis on stock markets in China and Hong Kong (the period starts in January 2005 and ends on October 31, 2008). First, they find that China is not immune to the recent turmoil in the U.S., although the price and volatility spillovers from the U.S. to Hong Kong are more significant than those to China. Second, the impact of volatility shocks originating in the U.S. on Hong Kong stock markets is more persistent than on China, the impact of own volatility, however, is more persistent for China than for Hong Kong. They attribute this fact to Hong Kong being a financial center and the Unites States being the source of the subprime crisis.

Some recent studies that examine stock market co-movements in Central Europe during the period of 2001 – 2011, suggest that a correlation between Central Europe and the euro area is strong. Correlation increased over time, especially after the EU entry. (Gjika, D., Horváth R, 2012).

S. Mollah, G. Zafirov, M, Quoreshi (2014) in their study of contagion phenomena around financial market for the period 2006 – 2010 also suggest existence of contagion in financial markets during most recent financial crises.

With this large number of studies, focusing on particular regions and markets or certain period of time or crisis there is little focus on Asian – European markets and their co-movement during wider period of time (e.g. 15 years).

Problem of the research. The research is important for a few reasons:

1. Investors, fund managers or portfolio managers are concerned with following questions. How international portfolio is affected if markets move together?

2. It can help answer the questions for international businesses and investors: How shocks from abroad affect national stock markets?

The object of the research. Equity returns in European and Asian Stock markets.

The aim of the research. To assess the co-movement between particular Asian and European equity markets.

Objectives of the research.

1) To analyze background and outcome of financial globalization;
2) Present methodological design selected to assess co-movement of markets.
3) To describe and evaluate statistical data;
4) To evaluate empirical results.

Methods of the research: systemic and comparative analysis of the scientific literature, Spearman’s correlation coefficient, dynamic conditional correlation generalized autoregressive conditional heteroskedasticity model (DCC - GARCH), generalized impulse response analysis, co-integration testing, vector error correction model (VECM).

Structure of the work. Section 1 analyzes financial globalization. Section 2 discusses the data employed in the analysis and presents the econometric methods used to estimate co-movements. Section 3 deals and presents the empirical results. The paper ends with some concluding remarks.

1. FINANCIAL GLOBALIZATION

1.1. Over view of globalization

The most important era of globalization occurred between 1880 and 1914. It has been studied by many scholars, e.g. Bordo and Williamson (2003); Obstfeld and Taylor (2004); and Mauro, Sussman, and Yafeh (2006). After 1914 financial globalization took a halt, international trade and financial trade flows declined as a result of the distrust and pending war. After 1945, economies began to reform their policies and cooperated in the "Bretton -Woods" system. Despite the fall of the Bretton-Woods exchange rate in 1973, IMF and World Bank stayed very powerful and active helping various economies achieve a healthy and stable economy so international trade and international capital flows from and towards other countries increase.

During the past few decades, financial markets around the world have become increasingly interconnected. The end of the 20th Century has witnessed the rising importance of globalization with the formation of economic blocks like NAFTA, EU, FTAA, MERCOSURE, etc.

Financial integration is generally thought to create several benefits: market and institutional development, more effective price discovery. This will lead to higher savings, investments and economics progress (Raj and Dhal, 2008). Furthermore, investor can diversify more effectively by understanding the degree of integration between markets. Hence, international capital market relationships have important implications for portfolio diversification, macroeconomic policies that influence trade and fiscal balances of countries and the financial polices of different agents within the capital improving economy (Chittedi, 2008).

With benefits of financial globalization came new market structure creating new challenges and risks for investors and policy makers.

1.2. Forces behind financial globalization

Main factors that has driven the financial globalization presented by IMF (2002):

Advances in information and computer technologies have made it easier for market participants and country authorities to collect and process the information they need to measure, monitor, and manage financial risk; to price and trade the complex new financial instruments that have been developed in recent years; and to manage large books of transactions spread across international financial centers in Asia, Europe, and the Western Hemisphere. (IMF, 2002)

Beginning with *The Industrial Revolution* in England, towards the end of the 18th Century, the capitalist economy has been transformed by five technological revolutions. Each of these revolutions has articulated a constellation of new inputs, products and industries, one or more new infrastructures, usually involving novel means of transport of goods, people and information and alternative sources of energy or ways of getting access to it. Table 1.2.1. shows the composition of the five revolutions, which have generally been identified with their most prevalent technologies. (Perez, Carlota 2002).

Table 1.2.1. Five technological revolutions in 230 years: Main industries and infrastructure.

Technological revolution	New Technologies and new or redefined industries	New or redefined infrastructures
1. The "Industrial Revolution" Britain from 1771	Mechanized cotton industry; Wrought iron; Machinery.	Canals and waterways; Turnpike roads; Water power.
2. Age of Steam and Railways in Britain and spreading to Continent and USA. From 1829	Steam engines and machinery; Iron and coal mining; Railway construction; Rolling stock production; Steam power for many industries.	Railways; Universal postal service; Telegraph; Great ports, depots and worldwide sailing ships; City gas.
3. Age of steel, Electricity and Heavy Engineering. USA and Germany overtaking Britain from 1875	Cheap steel; Full development of steam engine for steel ships; Heavy chemistry and civil engineering; Electrical equipment industry; Copper and cables; Canned and bottled food; Paper and packaging.	Worldwide shipping in rapid steel steamships; Worldwide railways; Great bridges and tunnels; Worldwide telegraph; Telephone; Electrical networks.
4. Age of Oil, the Automobile and Mass Production. In USA and spreading to Europe from 1908	Mass produced automobiles; Cheap oil and oil fuels; Petrochemicals; Internal combustion engine for automobiles, transport, tractors, airplanes, war tanks and electricity; Home electrical appliances; Refrigerated and frozen foods.	Networks of roads, highways, ports and airports; Networks of oil ducts; universal electricity; Worldwide analog telecommunications; Wire and wireless.
5. Age of information and Telecommunications. In USA spreading to Europe and Asia from 1971.	The information revolution; Cheap microelectronics; Computers, software; telecommunications; Control instruments; Computer aided biotechnology and new materials.	World digital telecommunications; Internal/ electronic mail and other e-services; Multiple source, flexible use, electricity networks; High speed physical transport links.

Source: Perez (2002) p.14.

The globalization of national economies has advanced significantly as real economic activity (production, consumption, and physical investment) has been dispersed over different countries or regions. Today, the components of a television set may be manufactured in one country and assembled in another, and the final product sold to consumers around the world. New multinational companies have been created, each producing and distributing its goods and services through networks that span the globe, while established multinationals have expanded internationally by merging with or acquiring foreign companies. Many countries have lowered barriers to international trade, and cross-border flows in goods and services have increased significantly (IMF, 2002). World exports of goods and services, which averaged $2.3 billion a year during 1983-92, have more than tripled, to an estimated $7.6 billion in 2001 and $18.6 billion in 2014. (see Figure 1.2.1)

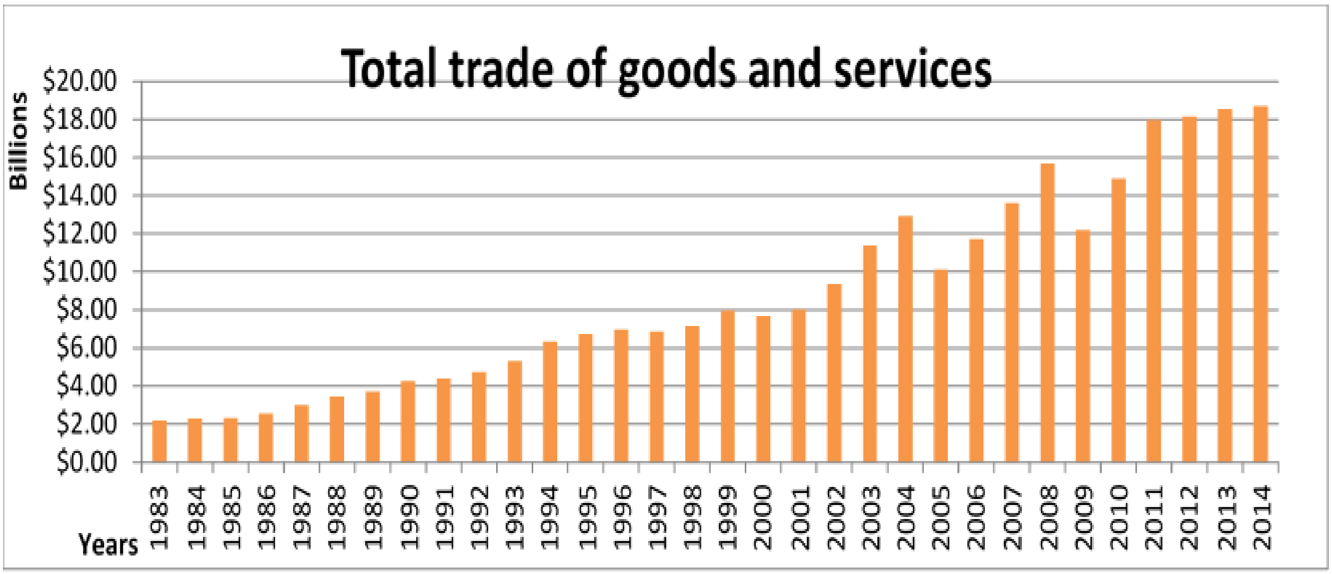


Figure 1.2.1. World Goods and Services (BPM5): Exports of goods and services, annual. In US Dollars at current prices and current exchange rates in millions. Data source http://unctadstat.unctad.org/

The liberalization of national financial and capital markets, coupled with the rapid improvements in information technology and the globalization of national economies, has catalyzed financial innovation and spurred the growth of cross-border capital movements. The globalization of financial intermediation is partly a response to the demand for mechanisms to intermediate cross-border flows and partly a response to declining barriers to trade in financial services and liberalized rules governing the entry of foreign financial institutions into domestic capital markets (IMF, 2002). The growth in cross-border capital movements also resulted in larger net capital flows, rising from $500 billion in 1990 to nearly $1.2 trillion in 2000 and $1.4 trillion in 2014 (see Figure 1.2.2).

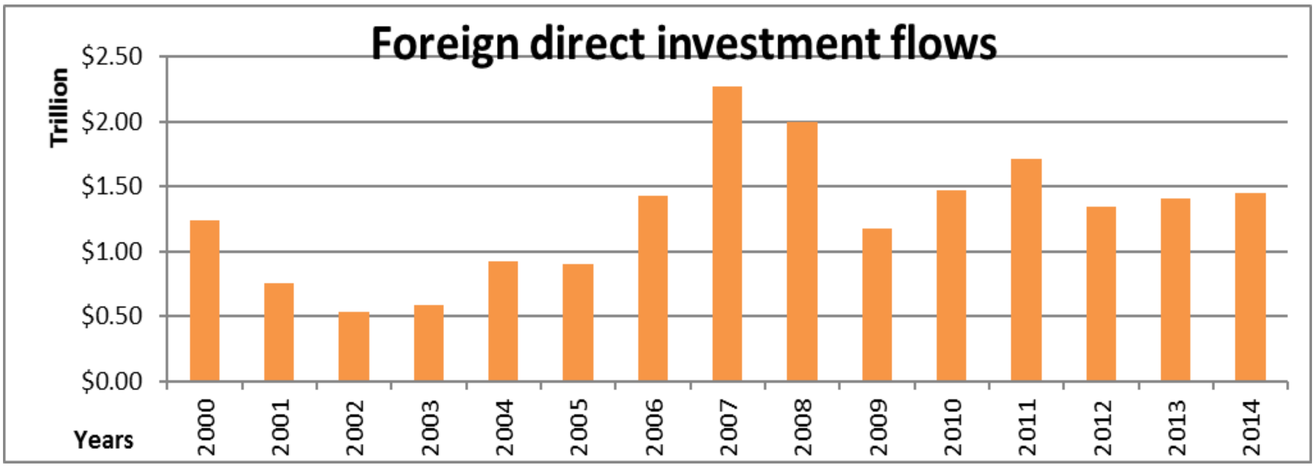


Figure 1.2.2. Inward foreign direct investment flows, annual. In US Dollars at current prices and current exchange rates in millions. Data source http://unctadstat.unctad.org/

Competition among the providers of intermediary services has increased because of technological advances and financial liberalization. The regulatory authorities in many countries have altered rules governing financial intermediation to allow a broader range of institutions to provide financial services, and new classes of nonbank financial institutions, including institutional investors, have emerged. Investment banks, securities firms, asset managers, mutual funds, insurance companies, specialty and trade finance companies, hedge funds, and even telecommunications, software, and food companies are starting to provide services similar to those traditionally provided by banks. (IMF, 2002).

Source: UNCTAD, Investment Policy Monitor database.

According to IMF, 2002 most investment policy measures remain geared towards promotion and liberalization, but the share of regulatory or restrictive measures increased. In 2013, according to UNCTAD's count, 59 countries and economies adopted 87 policy measures affecting foreign investment. Of these measures, 61 related to liberalization, promotion and facilitation of investment, while 23 introduced new restrictions or regulations on investment (Table 1.2.3).

Table 1.2.3. Changes in national investment policies

Changes in national investment policies , 2000 - 2013 (Number of mesures)														
Item	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Number of countries that introduced changes	46	52	44	60	80	78	71	50	41	47	55	49	54	59
Number of regulatory changes	**81**	**97**	**94**	**126**	**164**	**144**	**126**	**79**	**68**	**88**	**121**	**80**	**86**	**87**
Liberalization/promotion	75	85	79	113	142	118	104	58	51	61	80	59	61	61
Restriction/regulation	5	2	12	12	20	25	22	19	15	23	37	20	20	23
Nuetral/indeterminate	1	10	3	-	2	1	-	2	2	4	4	1	5	3

The share of new regulations and restrictions increased slightly, from 23 percent in 2012 to 25 percent in 2013 (Table 1.2.4).

Almost half of the policy measures applied across the board. Most of the industry-specific measures addressed the services sector (Table 1.2.4).

Table 1.2. 4. Changes in national investment policies by industry

Changes in national investment policies, by industry, 2013 (Per cent and number of measures)				
Sector/industry	Liberalization/promotion %	Restriction/regulation %	Neutral/indeterminate %	Total number of mesures
Total	**72**	**25**	**3**	**93**
Cross-industry	80	17	2	41
Agribusiness	80	20	-	5
Extractive industries	60	30	10	10
Manufacturing	75	25	-	4
Services	64	33	3	33

Source: UNCTAD, Investment Policy Monitor database.

1.3. Capital markets

Globalization forces have, changed the structure capital markets.

Banking system is changing. The process of redistribution and disintermediation is taking place. Financial intermediation is now focusing on securities rather than on deposits and loans. Banks have increasingly moved financial risks off their balance sheets to the securities markets - for example, the restructuring assets into securities to be sold and entering into interest rate swaps and other derivative transactions. Corporations and governments will also come to rely more on national and international capital markets to finance their activities. Individual investors are willing to accept credit risks and other financial risks, thanks to information technology improvements, which help to monitor, analyze and manage these risks.

Increase in cross-border financial activities. Investors, including institutional investors, are trying to increase returns and minimize risk on investment by diversifying their portfolios internationally. National financial markets are becoming increasingly integrated into one financial system. Sovereign borrowers, international companies, intermediaries can reach international markets thru financial centers located across the globe to finance their activities,

Nonbanking financial institutions compete with the banks for household savings and corporate finance in capital markets, driving the price of financial instruments down. Increasing numbers for household are bypassing the banks so they can keep their savings in higher return instruments these nonbanking financial institutions can diversify risk better, reduce the tax burden, and take advantage of economies of scale. Nonbanking financial institutions have increased dramatically in size, as well as sophistication.

Banks have expanded beyond their traditional acceptance of the deposit and lending, as countries have reducing regulatory barriers so commercial banks could enter the investment banking, asset management and insurance. That depth of capital markets has created another new source of business for banks – underwriting of bonds and stock issues. This new source will serve as a financing tool as banks increasingly turning to capital markets to raise funds for their investment activities and rely on over-the-counter (OTC) derivatives markets.

Banks were forced to look for additional sources of income, including new ways of funding as increasing competition have reduced profits of banks traditional business to very low levels.

1.4. Benefits versus risks

Change in the capital markets offered unprecedented benefits. But it has also changed the dynamics of the market in a way that is not yet fully understood.

One of the major advantages of the growing diversity of funding is the reduction of the "credit crunch". Borrowers can issue stocks or bonds on the domestic stock markets, or look for other sources of funding in international capital markets. Securitization is more efficient in reflecting the financial risk in asset pricing and allocation. The downside is that the markets are becoming more volatile, and this volatility may pose a threat to financial stability.

Borrowers and investors may get a better deal for their funding with more options to choose from. Corporations may finance investments cheaper and investors can diversify internationally and adapt the portfolio risk to their preferences. It encourages the investment and savings, which facilitate the real economic activity and growth and improve economic welfare. However, property prices may overshoot the basics of booms and busts, causing excessive volatility and distort the allocation of capital. For example, real estate prices in Asia soared and then plunged before the crisis in 1997-98, leaving much of the banks with bad loans and collateral which lost most of its value. A financial risk is becoming actively traded among institutional investors, it becomes harder to identify potential gaps and assess the magnitude of risk. Transparency in economy and financial markets, combined with a better understanding of why asset crises in market occurs, can help to better manage the risk of these markets.

Banks and companies can reduce their borrowing costs since they have a wider access to the pool of capital. However, as we have seen during the Mexican crisis of 1994-95 and 1997-98, the Asian and Russian crises risks can be high - including a sharp reversal of capital flows, international dissemination and spread (IMF, 2002).

1.5. Globalization indexes

Concept of globalization is wide and little defined in its boundaries and encompasses a range of disciplines and different perspectives. Some disciplines including anthropology or sociology focus on cultural changes of growing interconnectedness, such as the expansion of brands like Nike and McDonalds, and the increasing ease of travel. Other disciplines such as economics track the exchange of finances, goods and services through expanding global markets. Still other disciplines such as political science examine the role of international political institutions like the United Nations and the increasing power of transnational corporations. Indeed, consensus has not even been reached for the precise definition of globalization. Large of number variables represent the globalization. In general, statistical measuring is complex process subject to a variety of issues ranging from theoretical conceptualization to the selection of appropriate data and in this case, due to the wideness of the phenomenon, it is particularly difficult to find a statistical measure.

The Maastricht Globalization Index, or MGI, developed by Martens and Zywietz (2006), and Martens and Raza (2009) refers to a cross-section of 117 countries (See figure 1.5.1.).

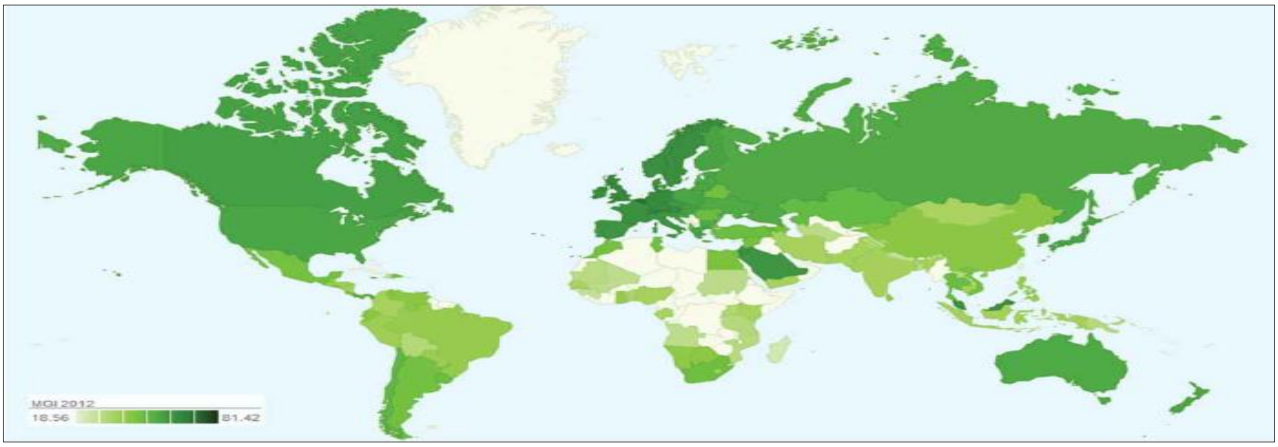


Figure 1.5.1. MGI – 2012. Source: Figge, L. & Martens, P. (2014).

This index measures the economic, social-cultural, technological, ecological and political dimensions of globalization and allows comparison of the degree and change in globalization for a large number of countries. (A. Dreher, 2009) see Table 1.5.1.

Table 1.5.1. Maastricht Globalization Index (MGI) variables.

Category	Variable name	Variable definition
Economic Domain	Trade; FDI; Capital.	Imports + exports of goods and services as a share of GDP; Gross foreign direct stocks as a share of GDP; Gross private capital flows as a share of GDP.
Social & Cultural Domain	Migrations; Tourism.	Those who changes their country of usual residence per 100 inhabitants; International arrivals + departures per 100 inhabitants.
Technological Domain	Phone; Internet.	Incoming + outgoing international telephone traffic in minutes per capita; Internet users as a share of population.
Ecological Domain	Eco footprint	Ecological deficit in global ha.
Political Domain	Embassies; Organizations; Military.	Absolute number of in-country embassies and high commissions. Absolute number of memberships in internal organizations. Trade in conventional arms as a share of military spending.

MGI revised in 2012 including a new calculation methodology and data. Results show that globalization still continues but has slowed down, due to the recent economic crisis.

Konjunkturforschungsstelle (KOF) Swiss **Economic Institute Index of Globalization.** The KOF Index of Globalization (See Figure 1.5.2.) measures the three main dimensions of globalization:

economic, social and political. Addition to three indices measuring these dimensions, the KOF calculates an overall index of globalization and sub-indices referring to:

- Actual economic flows;
- Economic restrictions;
- Data on information flows;
- Data on personal contact and;
- Data on cultural proximity.

Data are available on a yearly basis for 207 countries over the period 1970 - 2013. (A. Dreher, 2009)

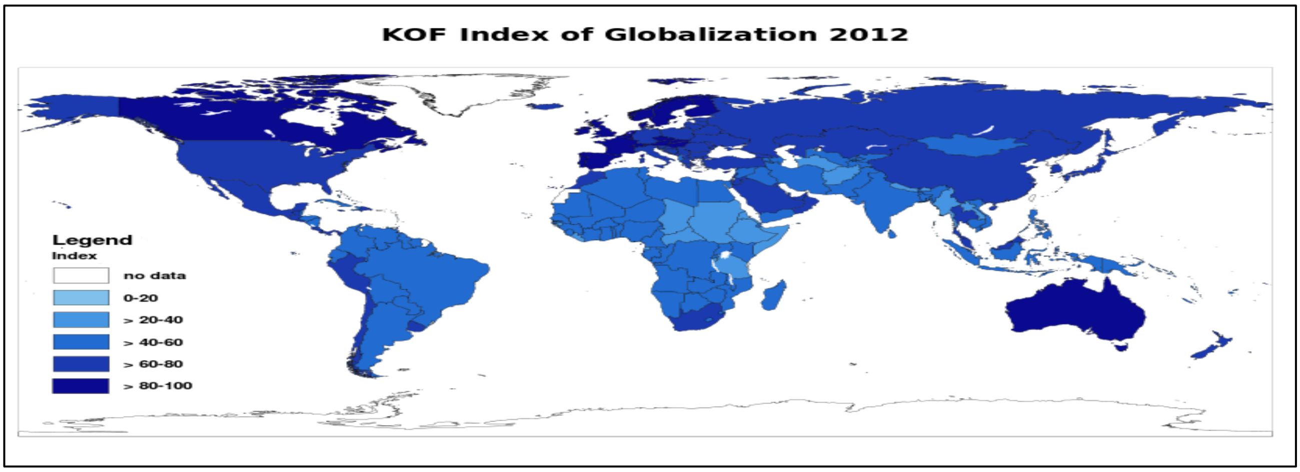


Figure 1.5.2. KOF index of globalization 2012. Source: http://globalization.kof.ethz.ch/maps/

1.6. Advanced economies and developing economies

IMF in World Economic Outlook divides the world into two major groups: advanced economies and emerging market developing economies. As used in WEO, the terms "country" and "economy" do not always refer to a territorial entity that is a state as understood by international law and practice. Some territorial entities included here are not states, although their statistical data are maintained on a separate and independent basis. This classification is not based on strict criteria, economic or otherwise, and it has evolved over time. The objective is to facilitate analysis by providing a reasonably meaningful method of organizing data. Figure 1.6.1. provides an overview of the country classification, showing the number of countries in each group by region and summarizing some key indicators of their relative size (GDP valued by purchasing power parity, total exports of goods and services, and population).

	Number of Economies	GDP Advanced Economies	GDP World	Exports of Goods and Services Advanced Economies	Exports of Goods and Services World	Population Advanced Economies	Population World
Advanced Economies	**37**	**100.0**	**42.9**	**100.0**	**62.2**	**100.0**	**14.7**
United States		37.2	15.9	16.0	10.0	30.5	4.5
Euro Area	19	28.4	12.2	41.2	25.7	32.2	4.7
Germany		8.0	3.4	12.1	7.5	7.8	1.1
France		5.6	2.4	5.9	3.7	6.1	0.9
Italy		4.6	2.0	4.3	2.7	5.8	0.9
Spain		3.4	1.4	3.1	1.9	4.4	0.7
Japan		10.2	4.4	5.9	3.7	12.2	1.8
United Kingdom		5.5	2.4	5.7	3.6	6.2	0.9
Canada		3.4	1.5	3.9	2.4	3.4	0.5
Other Advanced Economies	14	15.2	6.5	27.3	17.0	15.6	2.3
Memorandum							
Major Advanced Economies	7	74.6	32.0	53.8	33.5	72.0	10.6

Figure 1.6.1. Classification by World Economic Outlook Groups and Their Shares in Aggregate GDP, Exports of Goods and Services, and Population, 2014. Source: IMF, 2015.

The 37 advanced economies are listed in Figure 1.6.2. The seven largest in terms of GDP based on market exchange rates—the United States, Japan, Germany, France, Italy, United Kingdom, and Canada—constitute the subgroup of major advanced economies often referred to as the Group of Seven (G7).

Euro Area		
Austria	Greece	Netherlands
Belgium	Ireland	Portugal
Cyprus	Italy	Slovak Republic
Estonia	Latvia	Slovenia
Finland	Lithuania	Spain
France	Luxembourg	
Germany	Malta	
Major Advanced Economies		
Canada	Italy	United States
France	Japan	
Germany	United Kingdom	
Other Advanced Economies		
Australia	Israel	Singapore
Czech Republic	Korea	Sweden
Denmark	New Zealand	Switzerland
Hong Kong SAR[1]	Norway	Taiwan Province of China
Iceland	San Marino	

Figure 1.6.2. Advanced Economies by Subgroup. Source: IMF, 2015.

Emerging Market and Developing Economies. The group of emerging market and developing economies (152) includes all those that are not classified as advanced economies (IMF, 2015).

Following these classification countries for this research was selected. To represent European markets 4 countries form subgroup “Major Advanced Economy” were selected (France, Germany, United Kingdom, Italy). To represent Asia region, 3 countries from subgroup “Other Advanced Economies” were selected (Hong Kong, Singapore, Taiwan). Japan was excluded from this research due to extensive research on stock co-movement between Japan market and international markets. (Park and Fatemi, 1993; Janakiramanan and Lamba, 1998; Lin, Engle and Ito, 1994; Buerhan Saiti, 2014).

2. REASEARCH METHODOLOGY

Analysis of correlation, co-movement between stock markets is crucial as for investors and portfolio managers, allowing them to develop effective diversification and asset allocation strategies. This is one of fundamental issues in the Portfolio management. This research is focused on causal link and both short and long-term relationship investigation between European and Asian stock market indices for the period of 2000-2015. The following research mainly cover the estimation of short-term relationship between European and Asian stock market indices using dynamic conditional correlation (DCC-GARCH) model (Engle, 2002 and 2009), conducting impulse response analysis (Koop et al., 1996, Pesaran & Shin, 1998). The long-term interdependence between financial variables evaluated using Johansen co-integration test (Johansen (1988)) and vector error correction model (VECM) (Engle and Granger (1987).

2.1. Literature review

Extensive literature is available on co movement in equity markets. Scientists have provided empirical and theoretical research. Early research suggests benefits of risk reduction with international diversification (Levy, H. and Sarnat, M, 1970; Grubel, 1968). It was suggested by Harvey (1995) that emerging markets have low exposure to world factors, little integration and high average returns. Also early literature suggests (King and Wadhwani, 1990) that correlations are time-varying, providing evidence of increased correlations in international stock markets at a time of crises. Same conclusions were reached by Cappiello et al. (2006), who investigated regional groups correlations in the time of financial turmoil. More recent studies (S. Mollah, G. Zafirov, M, Quoreshi (2014) also suggest existence of contagion in financial markets during most recent financial crises.

Studies suggests that correlations between Central Europe and the euro area is strong. Correlation increased over time, especially after the EU entry (Gjika, D., Horváth R, 2012). Please see Table 2.1.1. for the list of recent studies reviewed regarding the contagion and co-movement of international stock markets during the crises and other periods of time.

Table 2.1.1. Literature and research reviews

Author	Methods	Objectives	Conclusions
S. Mollah, G. Zafirov, M, Quoreshi (2014).	DCC-GARCH and vector error correction (VEC).	Address contagion phenomena around financial market for the period 2006 – 2010, using U.S. dollar-denominated MSCI daily indices.	The empirical results demonstrate the existence of contagion in the financial markets during the global crisis. The results also indicate that benefits from portfolio diversification decayed significantly among countries during the crisis. S. Mollah, G. Zafirov, M, Quoreshi (2014).

Author	Methods	Objectives	Conclusions
Min, H.G., Hwang, Y. S. (2011).	DCC-GARCH and DCCX-MGARCH	Daily stock returns of four OECD countries with that of the US for the period 2006-2010.	Found a process of increasing correlations (contagion) in the first phase of the US financial crisis and an additional increase of correlations (herding) during the second phase of the US financial crisis for the UK, Australia and Switzerland. However, the impact of the US financial crisis on Japan was limited to the increase in correlation volatilities in the first phase Min, H.G., Hwang, Y. S. (2011).
Fedorova E. (2011)	GARCH - BEKK	Weekly total return from December 1998 to December 2009 and covers Poland, Hungary and the Czech Republic.	Results clearly indicate the existence of direct linkages between different stock market sectors with respect to returns and volatilities. Author found that the transmission of equity shocks between markets has increased after the EU accession in 2004. Fedorova E. (2011).
Guidi, F., Ugur, M. (2011).	MGARCH and Exponential Weighted Moving Average (EWMA) methodology.	Weekly price index values for the SEE and developed stock markets from 8th November 2000 to 19th May 2010.	Using a variety of co-integration methodologies, author shows that SEE stock markets have no long-run relationship with their mature counterparts. Guidi, F., Ugur, M. (2011).
Chang, H. (2012).	EGARCH	To compare the volatility in stock market returns prior and post global financial crisis. Daily returns TAIEX, S&P 500 and EURO STOXX 50	Taiwan stock market is mainly influenced by the price information of the preceding day. EURO STOXX 50 and S&P 500 have greater influences before or after the crisis on the negative information of the market prices. Chang, H. (2012).
Sengonul A., Degirmen, S. (2012).	GARCH (1,1)	Daily return on stock market indices. Turkish and newly joined 11 EU stock markets (since 1 May 2004).	Test results potentially present that Hungary and Slovakia, Turkey performs better after the crisis, in terms of weak form of market efficiency, then most of the newly joined EU countries. Sengonul A., Degirmen, S. (2012).
Gjika, D.,	ADCC-	Stock market co-movements	Correlations among stock markets in Central

Author	Methods	Objectives	Conclusions
Horváth R. (2012).	ARCH	in Central Europe. Using daily data from 2001 to 2011.	Europe and between Central Europe and the euro area are strong. They increased over time, especially after the EU entry and remained largely at these levels during financial crisis. Gjika, D., Horváth R. (2012).
Boubaker, A., Jaghoubbi, S. (2012).	GARCH models and Copula Approach.	Daily returns of seventeen European stock market indices, during the period 2007-2011.	Results show that there is strong evidence of market dependence in the euro area. Boubaker, A., Jaghoubbi, S. (2012)
Uddin, G.S, Arouri, M., Tiwari, A.K. (2014).	DCC-GARCH model and Wavelet Approach.	Co-movement between Germany and major International Stock Markets for period of 1992 to 2013.	Findings suggest that the increase in stock co-movement of Germany with the developed markets in recent years contains both a permanent and a transitory component. Uddin, G.S, Arouri, M., Tiwari, A.K. (2014).
M. Naseri and M. Masih (2014).	DCC-GARCH model and Wavelet Approach.	Analyzing U.S, Japan, China, India financial integration with Malaysian stock market.	Findings suggest strong financial integration exists between the Chinese and Malaysian Islamic stock markets. Furthermore, the study suggests that in the long run, investors in Malaysia could gain by diversifying their portfolios in Japan and in the short run the US market is a better option to consider. M. Naseri and M. Masih (2014).
W. Ahmad, S. Sehgal (2012).	DCC-GARCH	Investigating the contagion effects of GIPSI, USA, UK and Japan markets on BRIICKS stock markets. Data used is daily stock-price indices from 1996 – 2012.	Applying multivariate DCC-GARCH model, the results indicate significant variation in conditional correlations during Eurozone crisis period (November 17, 2009- January 31, 2012). W. Ahmad, S. Sehgal (2012).
Mohamed El Hedi Arouri, Mondher Bellalah, Duc Khuong Nguyen (2008).	DCC-GARCH	Conditional correlations between selected Latin American emerging markets and between them and the World stock market. Monthly stock indices return over the period from 1985 – 2005.	Degree of cross-market co-movements changed over time and has significantly increased since 1994 and onwards. It is demonstrated that the cross-market co-movements are subjected to various regime shifts due essentially to major stock market events.
Cho, J. H. and Parhizgari, A.	DCC-GARCH	The East Asian countries and their stock indices. Daily	Our findings indicate the presence of contagion in the equity markets across all the

Author	Methods	Objectives	Conclusions
M. (2008).		returns on stock indices for period 1996 – 2005.	fourteen pairs of source-target countries that are considered. Cho, J. H. and Parhizgari, A. M. (2008).
WANG, P. and MOORE, T. (2008).	DCC-GARCH	Aim to examine a group of Central Eastern European emerging markets integration with developed markets, represented Eurozone market, during the sample period from 1994 to 2006 with daily data.	Higher level of the stock market correlation during the period after the Asian and Russian crises and also during the post-entry period to the EU. Empirical analysis reveals that the increase in the co-movement cannot be explained by the macroeconomic convergence process, nor by monetary convergence. WANG, P. and MOORE, T. (2008).

Source: prepared by the author.

Most of the studies provide evidence of increased correlations in international stock markets at a time of crises. However, it is unclear as to whether correlations amongst equity markets have trended upwards over time. For example, Guidi, F., Ugur, M. (2011), Uddin, G.S, Arouri, M., Tiwari, A.K. (2014), Ragunathan and Mitchell (1997) argue that there has been little increase in correlations across international stock markets.

2.2. Data and Descriptive statistics

Table 2.2.1. Description of data used in research

The Data: Coverage, Periodicity, and Timeliness	
Coverage characteristics	Empirical research focuses on the daily data for 7 Indices of the Europe and Asia stock exchanges: Germany – DAX index, UK – FTSE 100 index, France – CAC 40 index, Hong Kong – HSI Index, Singapore – STI index, Taiwan – TAIEX Index. The choice of sample countries is based on both geography and cooperation levels. The empirical research was performed using daily the first difference of the natural logarithms of the stock market indices. Daily data on the stock market indices were obtained from eoddata.com for a 15-year period, i.e. from 2000-01-03 to 2015-12-31 (a total number of observations is 3748 for each index).
Periodicity	Daily.
Timeliness	Historic data.
Access by the public	
Advance release	Not applicable. (Data is available to public via various sources.
Simultaneous release to all interested parties	Not applicable. (Data gathered by author will be available together with Master thesis).

Integrity	
Dissemination of terms and conditions.	Author disseminates this data as a service to the public.
Provision of information about revision.	Data will not be revised.
Metadata update	
Metadata last certified	Date of the latest certification provided by the domain manager is 07/10/2016
Metadata last posted	07-11-16
Metadata last update	07-11-16

Source: prepared by the author.

Table 2.2.2. Descriptive statistics on Log returns from selected indices.

	STI	TAIEX	HSI	FTSEMIB	FTSE101	DAX	CAC41
Mean	3.5E-05	-1.5E-05	6.61E-05	-0.00017	-1.1E-05	0.00013	-5.1E-05
Standard Error	0.0002	0.000242	0.000256	0.000258	0.000204	0.000258	0.000251
Median	0.00011	0.000298	0.000121	0.00034	0.000307	0.000789	0.000217
Standard Deviation	0.012225	0.014835	0.015664	0.015808	0.012484	0.015834	0.015394
Sample Variance	0.000149	0.00022	0.000245	0.00025	0.000156	0.000251	0.000237
Kurtosis	7.787024	3.799938	7.445658	3.584405	5.490216	4.240154	4.268782
Skewness	-0.40838	-0.3149	-0.02197	-0.08273	-0.10161	0.09559	0.098164
Range	0.188112	0.16991	0.269888	0.19283	0.175627	0.194894	0.190885
Minimum	-0.1046	-0.09936	-0.13582	-0.08599	-0.08178	-0.07433	-0.09472
Maximum	0.083512	0.07055	0.134068	0.106839	0.093842	0.120559	0.096169
Sum	0.131423	-0.05596	0.248183	-0.63245	-0.04088	0.489165	-0.19286
Count	3748	3748	3748	3748	3748	3748	3748

Source: prepared by author.

Table 2.2.2. provides descriptive statistics on Log returns from selected indices. There are 3748 observations in our data sample. The data appear to be skewed to the left, which explains why the median is greater than the mean.

2.3. Spearman correlation

There are a lot of common econometric techniques for measuring interdependence between stock market indices. The application of these techniques mainly depends on data structure and it dynamics. Since we are dealing with continuous time series data the monotonic relationship has been measured.

In order to measure the strength of correlation between logarithmic returns of the European and Asian stock exchange indices, the non-parametric Spearman's correlation coefficient was employed:

$$\rho = 1 - \frac{6 \cdot \sum_{i=1}^{n} \left(R(\Delta \ln x_i) - R(\Delta \ln y_i)\right)^2}{n(n^2-1)}; \qquad (1)$$

where

$R(\Delta \ln x_i), R(\Delta \ln y_i)$ - the ranks of a pair of logarithmic returns of the European and Asian stock exchange indices. Each containing n observations.

If there are no repeated data values, a perfect Spearman correlation of +1 or −1 occurs when each of the variables is a perfect monotone function of the other. There are three types of correlation to be taken into account. Monotonically increasing - as the x variable increases the y variable never decreases; Monotonically decreasing - as the x variable increases the y variable never increases; Not monotonic - as the x variable increases the y variable sometimes decreases and sometimes increases.

2.4. Measuring short-run relationship

The short-run relationship among the European and Asian stock markets was explored by (a) measuring the dynamic relationship between the European and Asian stock market indices, and applying (b) generalized impulse response analysis.

2.4.1. DCC-GARCH model

The main motivation using DCC-GARCH model for measuring correlation between different assets was the flexibility of univariate GARCH but not the complexity of conventional multivariate GARCH.

DCC-GARCH models, which parameterize the conditional correlations directly, are estimated in two steps:

1. a series of univariate GARCH estimates;
2. the correlation estimate.

These methods are less computationally expensive over multivariate GARCH models in that the number of parameters to be estimated in the correlation process is independent of the number of series to be correlated.

The DCC-GARCH model employed in this research was introduced by Engle (2002) is a generalization of the Bollerslev (1990) constant conditional correlation (CCC) estimator. The estimation of a GARCH (1,1) model is an intermediate step in order to derive inputs for the DCC-GARCH model that was used to model correlation between European and Asian stock market indices.

Assume that stock market returns from the k series are multivariate normally distributed with zero mean and conditional variance-covariance matrix H_t, our multivariate DCC-GARCH model can be presented as follows:

$$\begin{cases} r_t = \mu_t + \varepsilon_t, \ \varepsilon_t | I_{t-1} \text{ N} \rightarrow (0, H_t) \\ H_t = D_t R_t D_t \end{cases}; \qquad (2)$$

Where, r_t is the $(k * 1)$ vector of the returns on stock market indices; ε_t is a $(k * 1)$ vector of zero mean return innovations conditional on the information available at time t-1; $\mu_{i,t} = \delta_{i0} + \delta_{i|r\, i,t-1}$ for market i; D_t is a $(k * k)$ diagonal matrix with elements on its main diagonal being the conditional standard deviations of the returns on each market in the sample and R_t is the $(k * k)$ conditional correlation matrix and D_t and R_t are defined as follows:

$$D_t = diag(\sqrt{h_{1t}}, \sqrt{h_{2t}}, \dots, \sqrt{h_{7t}}); \qquad (3)$$

The conditional variance follows a univariate GARCH process:

$$\mathrm{R_t} = \left(\sqrt{\mathrm{DiagQ_t}}\right) \mathrm{Q_t}\left(\sqrt{\mathrm{DiagQ_t}}\right); \qquad (4)$$

where

$\mathrm{Q_t} = (1 - \alpha - \beta)\bar{\mathrm{Q}} + \alpha \mathrm{u_{t-1}} \mathrm{u}' + \beta \mathrm{Q_{t-1}}$ refers to $(k * k)$ symmetric positive definite matrix with $u_{it} = \varepsilon_{it} | \sqrt{h_{\mathrm{iit}}}$, $\bar{Q}$ $(k * k)$ is unconditional variance matrix of u_t, and α and β are non-negative scalar parameters satisfying α+β < 1.

The conditional correlation coefficient ρ_{ij} between two markets i and j is then expressed by the following equation:

$$\rho_{ij} = \frac{(1-\alpha-\beta)\bar{q}_{ij} + \alpha u_{i,t-1} u_{j,t-1} + \beta q_{ij,t-1}}{\sqrt{((1-\alpha-\beta)\bar{q}_{ii} + \alpha u^2{}_{i,t-1} + \beta q_{ii,t-1})\,((1-\alpha-\beta)\bar{q}_{jj} + \alpha u^2{}_{j,t-1} + \beta q_{jj,t-1})}}; \qquad (5)$$

In this formulation, q_{ij} refers to the element located in the $i\,th$ row and j th column of the symmetric positive definite matrix Q_t. As mention before, the estimation of the DCC-GARCH can be estimated using a two-stage procedure. In the first stage, univariate GARCH (1,1) model is estimated for each time series. During the second stage, the transformed residuals from the first stage (i.e., the estimated residuals are standardized by their conditional standard deviations) are used to infer the conditional correlation estimators. The log-likelihood of the observations on ε_t is given by

$$L = -0.5 \ \sum_{t=1}^{T} (n \log(2\pi) + \log|D_t R_t D_t| + \varepsilon_t' \, D_t^{-1} R_t^{-1} D_t^{-1} \, \varepsilon_t); \qquad (6)$$

since

$$u_t = \varepsilon_t , \sqrt{h_t} = D_t^{-1}\varepsilon_t; \qquad (7)$$

the log-likelihood function can be rewritten as follows:

$$L = -0.5 \sum_{t=1}^{T} (n \log(2\pi) + 2 \log|D_t| + \log|R_t| + u_t' R_t^{-1} u_t); \qquad (8)$$

The model described above is the first dynamic conditional model introduced by Engle (2002). Despite the model takes into consideration such important issues as time-variance of correlation between assets, particularly the effect of past return shocks on volatility and correlation, and the numerous studies support DCC-GARCH as an accurate method both for short - and for long term - periods (Peters, 2008), the model obviously has some limitations and drawbacks. The main limitation is an inability to capture the notion of asymmetric effects in conditional correlations of assets, ignoring the sign of past effects of negative shocks. Indeed, it has been proved that negative returns during the turbulent and downward periods could lead to increase in correlations Cappiello et al. (2006).

2.4.2. Generalized impulse response analysis

In addition to method mentioned above the short-run interdependence among the European and Asian stock markets was investigated by applying the generalized impulse response analysis (Koop et al., 1996, Pesaran & Shin, 1996). Impulse response functions show the reaction of one variable to the shocks on other variables in a VAR system. The main advantage of the generalized approach is that this approach is invariant to the ordering of the variables in the VAR system compared to the traditional impulse response analysis that provides different empirical results depending on the variable ordering. The model equation is as follow:

$$Y_t = A_1 Y_{t-1} + \cdots + A_p Y_{t-p} + U_t = \phi(B) U_t = \sum_{i=0}^{\infty} \phi_i U_{t-i} ; \qquad (9)$$

$$\phi_t = A_1 \phi_{t-1} + A_1 \phi_{t-1} + \cdots + A_p \phi_{t-p}; \qquad (10)$$

where

Y_t – 7-dimensional vector of the European and Asian stock exchange indices;

ϕ_i – the coefficients measuring the impulse response, e.g. $\phi_{jk,i}$ represents the response of stock market index j to a positive shock of one standard deviation in stock market index k occurred i-th period ago.

2.5. Measuring long-run relationship

The long-run relationship among the European and Asian stock markets was explored by (a) testing for co-integration among the European and Asian stock market indices, applying (b) vector error correction model (VECM).

2.5.1. Co-integration testing

Co-integration test is performed to estimate the long-run relationship between European and Asian stock market indices. In particular Johansen procedure is employed to determine whether two-time series are interrelated in a long-term. The Johansen co-integration test that proposed by Johansen (1988) was applied to determine how many common co-integrating vectors there were across the European and Asian stock indices.

In practice, testing for co-integration is similar to testing the linear regression residuals ε_t for stationarity.

$$x_{1,t} = \alpha + \beta_2 x_{2,k} + \beta_3 x_{3,k} + \cdots + \beta_k x_{k,t} + \varepsilon_t \ ; \qquad (11)$$

where

$x_{1,t}$, $x_{2,t}$,…, $x_{k,t}$ – stock market indices;

α – constant term;

$\beta_2, \beta_3, \ldots, \beta_k$ – regression model parameter estimates;

ε_t – regression model error term.

In order to establish a co-integration relationship, we have to run OLS regression first and then test the model residuals for stationarity. However, there are one thing we should bear in mind. The test results are sensitive for the selection of dependent variable included in the model i.e. the residuals vary based on which time series is designated as the dependent variable, and the tests may give different results. To overcome this situation, we use Johansen co-integration test. The one is invariant to the ordering of variables. That means there is no difference which variable should be included into regression model equation first.

In general, co-integration assumes the presence of common non-stationary (i.e. I (1)) processes underlying the input time series variables. Each model equation represents the presence of linear combination between dependent and independent variable:

$$x_{1,t} = \alpha_1 + \beta_1 z_{1,t} + \beta_2 z_{2,t} + \cdots + \beta_p z_{p,t} + \varepsilon_{1,t} \ ; \qquad (12)$$

$$x_{2,t} = \alpha_2 + \phi_1 z_{1,t} + \phi_2 z_{2,t} + \cdots + \phi_p z_{p,t} + \varepsilon_{2,t} \ ; \qquad (13)$$

$$\cdots$$

$$x_{m,t} = \alpha_m + \sigma_1 z_{1,t} + \sigma_2 z_{2,t} + \cdots + \sigma_p z_{p,t} + \varepsilon_{m,t} \ ; \qquad (14)$$

The number of independent linear combinations (k) is related to the assumed number of common non-stationary underlying processes (p) as follows:

$$p = m - k; \qquad (15)$$

Along with co-integration testing there are 3 possible outcomes:

1. $k = 0$; $p = m$. No cointegration.
2. $0 < k < m$; $0 < p < m$. Cointegration.
3. $k = m$; $p = 0$. Cointegration is not relevant here as all time series are stationary (i.e. I (0) processes).

The Johansen test has two forms: the trace test and the maximum eigenvalue test. In this research we apply trace test since it is more informative than maximum eigenvalue test.

The trace test examines the number of linear combinations (i.e.) to be equal to a given value (K_o), and the alternative hypothesis for K to be greater than K_o:

$$H_0: K = K_o$$
$$H_a: K > K_o$$

To test for the existence of co-integration using the trace test, we set $K_o = 0$ (no cointegration), and examine whether the null hypothesis can be rejected. If this the case, then we conclude there is at least one co-integration relationship and conclude the presence of co-integration between the variables.

2.5.2. Vector error correction model (VECM)

Engle and Granger (1987) have shown that when the series x_t and y_t are cointegrated a standard Granger-causality test is misspecified, because it does not allow for the distinction between the short-run and the long run-effect. At this point a vector error correction model (VECM) should be used instead. It is a linear transformation of the ARDL models and provides a link between the short-run and the long-run effect (Banerjee et al. 1993, 1998).

Allowing for a constant and assuming that there is r co-integrating relations, we can define the VECM as:

$$\Delta y_t = \alpha\beta` y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + v + \varepsilon_t; \qquad (16)$$

where

y_t is a vector of variables;

v is a vector of parameters;

Γ are matrices of parameters;

ε_t is a vector of disturbances (ε_t has mean 0, has covariance matrix Σ, and is i.i.d. normal over time).

The coefficients α and β of the error correction terms give the adjustment rates at which short-run dynamics converge to the long-run equilibrium relationship. If α and β are negative and significant a relationship between x_t and y_t exist in the long run (T. Gries, M. Redlin, 2009). The standard error-correction procedure is a two-step method:

1. In a first step the error correction term is obtained by saving residuals of separate estimation of the long-run equilibrium of x_t and y_t.
2. In a second step the VECM with the included error correction term can be estimated.

2.6. Computation

All computations (Spearman correlation, DCC-GARCH, generalized impulse response analysis, Johansen co-integration test, Vector error correction model (VECM)) will be performed using "***R***". "***R***" is a free software environment for statistical computing and graphics. Exact script and add-on packages used for this research are available on the CD with the rest of the Data. CD is included in the end of master thesis. Decision to place the script and data to CD was based on the number of data series and script lines that would amount to very high numbers of pages. (3748 lines for data and 264 lines of code).

3. ASSESSMENT OF CO-MOVEMENT

3.1. Data visualization

The first and by far the most crucial step in data analysis is to visualize the data and find any patterns that would help to choose the strategy of data modeling and its manipulation. First of we plotted European and Asian nominal indices to check whether there are any trends in indices dynamics that should be taken into account (See below: Figure 3.1.1.). The line plots have been used to visualize 7 index historical close prices over time. Each line plot represents different index dynamics. Before we plotted the data we identified non-working days (i.e. days when the stock markets are closed) and removed those observations case wise. As shown from Figure 3.1.1. the FTSE MIB (IT) and HSI (Hong Kong) indices are the biggest by their nominal values comparing with other European and Asian indices. Also, the fluctuation of the FTSE MIB (IT) are significantly higher in comparison with HSI, STI etc. especially after „information technology bubble "(2000) and during global financial crisis (2008–2012). In addition, all indices that we cover in this research have been negatively impacted by the following crisis. As a result, a sharp decline in nominal prices is observed during this period.

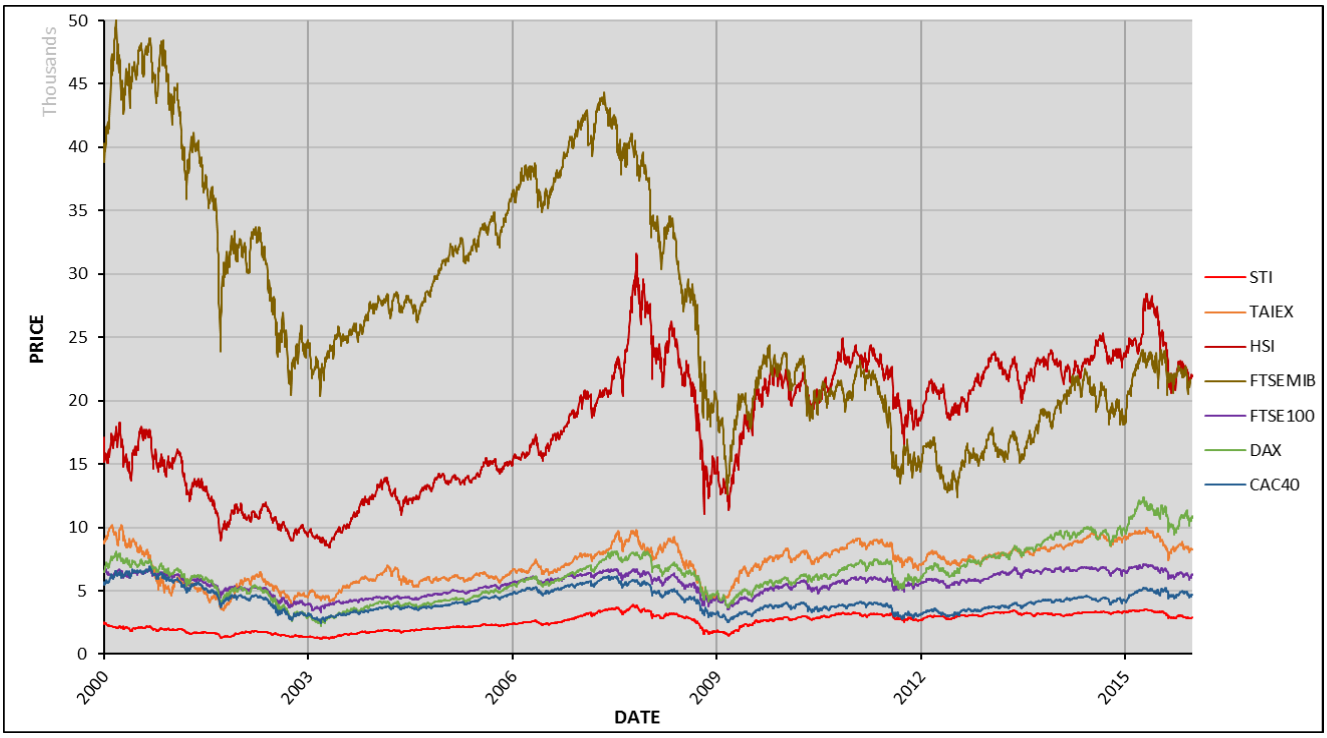


Figure 3.1.1. Visualization of indices daily close price for the period of 15 years. Source: prepared by the author.

The graphical time series analysis revealed there are patterns of growth and decline that forms trends and non-stationarity. Following these findings, we transform our data using log return function. Such transformation let us measure daily percentage growth/decline for each time series. The historical log returns of European and Asian stock market expected values are near zero which shows some evidence of weak stationarity (See Figure 3.1.2.). Though, there are significant fluctuations from the mean so we fail to observe constant variance over time which violates the assumption of time series stationarity.

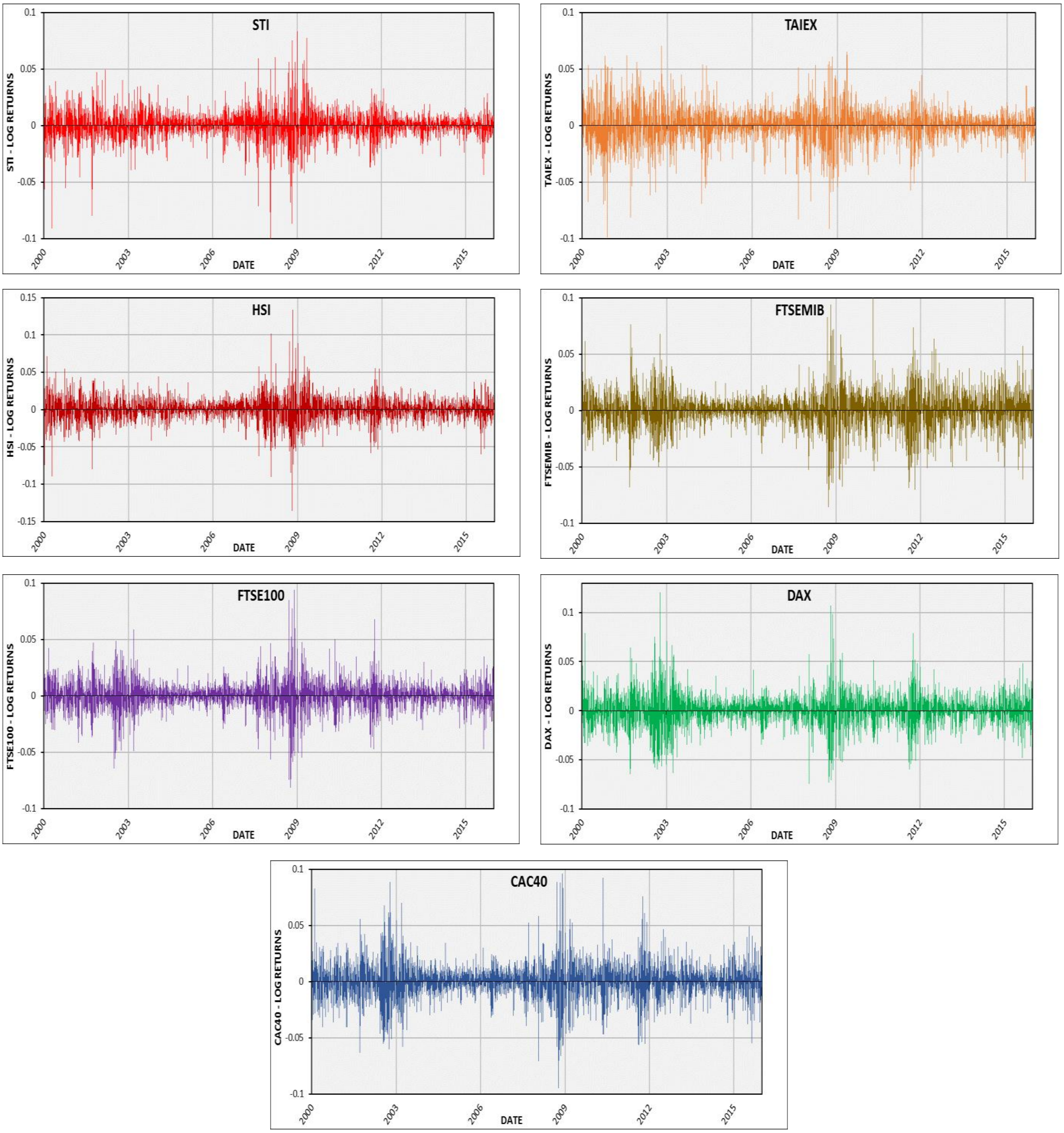


Figure 3.1.2. Visualization of Log Returns for individual Indices. Source: prepared by the author.

Very clear pattern is observed during the global financial crisis which started around 2007. During this period the highest variance in log returns is observed in Honk Kong (HSI) index. Highest positive change in daily logarithmic return is 0.134 and negative -0.135. Interestingly these maxes occur on consecutive days. -0.135 occurred on 2008-10-27 when 0.134 log return was reached on 2008-10-28. On October 27, 2008 the index fell to 11,015.84 points, daily change of - 12.70%. On this day HIS index has fallen nearly two-thirds from its all-time peak. (HSI - Press release). All indices experienced high variance during the 2007 global financial crisis. During recent year (2015) most of the indices experienced more stable log returns, staying in the limits of 0.05.

3.2. Spearman correlation results

In this section we evaluate the correlation, calculated using Spearman's method, between European and Asian indices. The correlation plot has been used to visualize the correlation strength between each indices pair. Blue color indicates higher positive correlation and the red one indicates higher negative correlation. To simplify the interpretation of the results we only interested in upper triangular correlation matrix as lower triangular matrix is a mirror matrix with duplicate coefficients. The results suggest all correlations in a matrix are positive and statistically significant as non-significant and diagonal correlations marked with blank (white) squares i.e. there are no such except of diagonal matrix. (See figure 3.2.1.)

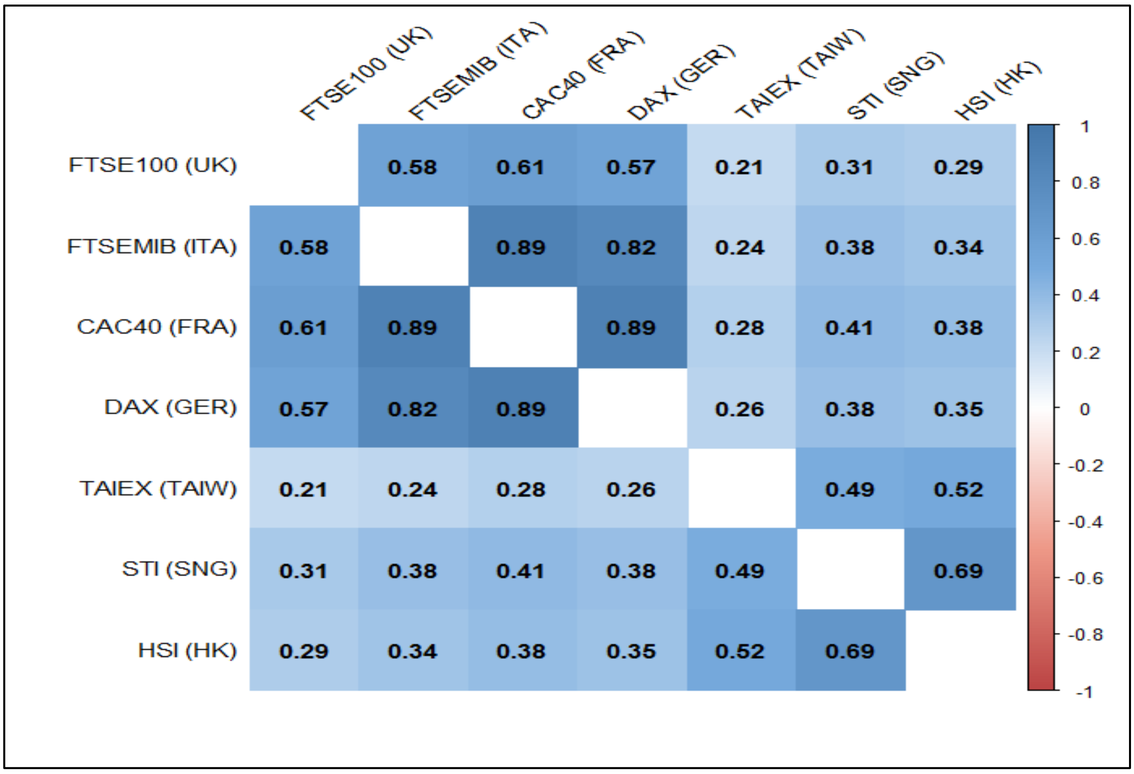


Figure 3.2.1. Spearman's correlation coefficients. Source: prepared by the author.

Comparing the relationship between different indices in a same region we may conclude there are strong regional dependence between European indices and moderate regional dependence between Asia indices. In particular, the highest correlation is observed between European-to-European and Asian-to-Asian indices. In the European case, the pairwise correlation between indices ranges from 0.89 (CAC40 vs. DAX and FTSEMIB) to 0.57 (DAX vs. FTSE100). In the Asian case, there is slightly weaker relationship between indices. The pairwise correlation ranges from 0.49 (STI vs. TAIEX) to 0.69 (HSI vs. STI). Comparing indices correlations between European and Asian regions apart we should notice the presence of moderate-to-weak relationship between indices. The highest correlation in cross regional indices is observed between French CAC40 and Singapore STI index (0.41). These empirical results suggest that the European and Asian stock markets are more integrated at the regional level as the interdependence between different region indices are mostly weak.

3.3. DCC-GARCH results

In addition to Spearman correlation results, DCC-GARCH model provides detailed metric on how European and Asian indices are interrelated at each given period of time so the short-run DCC GARCH have been applied.

The empirical results suggest that dynamic conditional correlation among the logarithmic returns of 7 European and Asian stock market indices vary over time, see Appendix 1 for full visual representation of the DCC-GARCH results. In particular, the highest dynamic correlation is observed in the dynamics of regional European stock indices, (See Figure 3.3.1.) DAX (GER) and FTSEMIB (ITA), CAC40 (FRA) and DAX (GER), CAC40 (FRA) and FTSEMIB (ITA). France (CAC40) and Germany (DAX) stands out as a pair with lowest historical fluctuation in correlation ranging from +0.63 to + 0.97.

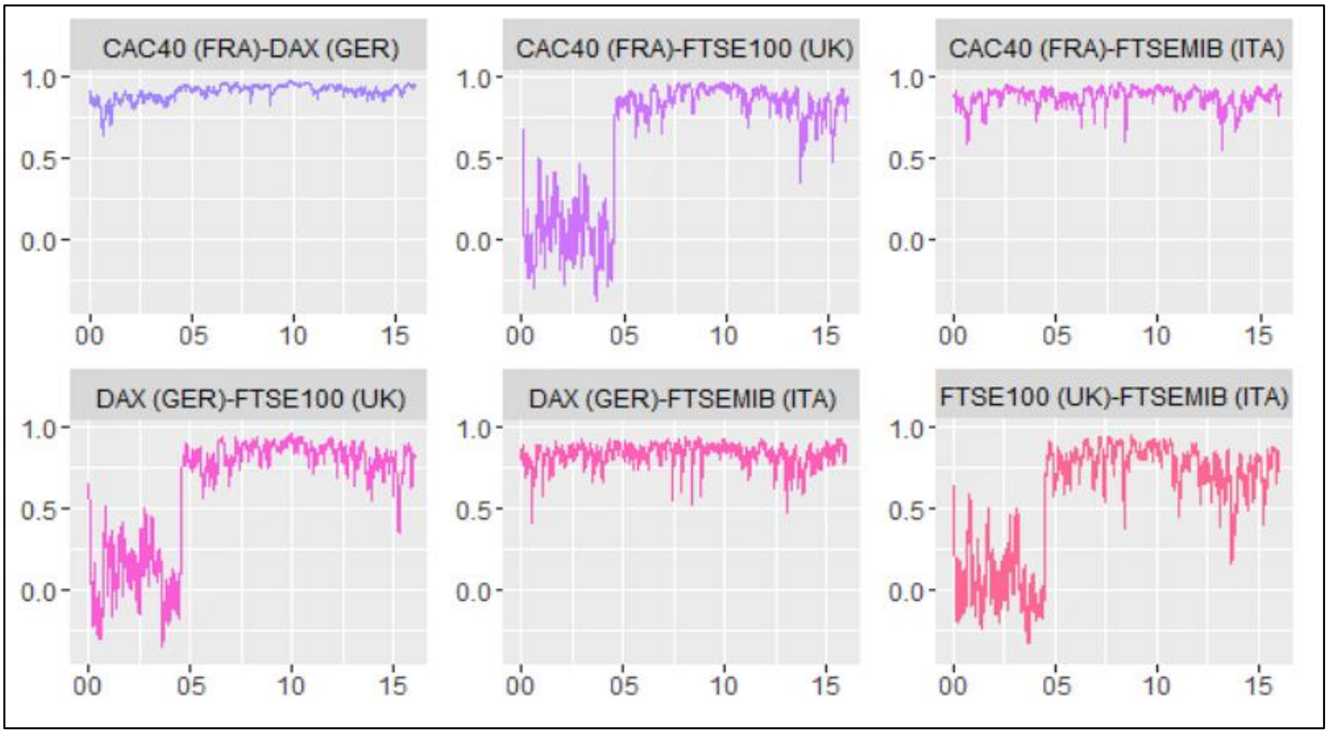


Figure 3.3.1. Dynamic correlation for European stock indices. For period of 2000 – 2015. Date is represented on horizontal axis while DCC – GARCH is represented on Vertical axis. Source: prepared by the author

Highest dynamic correlation fluctuations are observed in the dynamics of DAX (GER) and FTSE100 (UK), FTSE100 (UK) and FTSEMIB (ITA), CAC40 (FRA) and FTSE 100 (UK). In addition, up until 2005 the dynamic conditional correlation between logarithmic returns of these pairs ranged between -0.3 and +0.5 which indicates the high variance of the correlation. Although, after 2005, the dynamic conditional correlation between pairs mentioned above increased significantly and positive correlation ranged between +0.3 and +0.8. Comparing correlations between selected European indices we may conclude that there is stable relationship and co – movement in short term as dynamic conditional correlation ranges between +0.5 and +0.9 after the 2005.

Dynamic conditional correlation between three Asia indices reveals that analyzed indices share positive moderate dynamic conditional correlation (See Figure 3.3.2.) Highest correlation and most stable variance of the correlation is observed between Singapore (STI) and Hong Kong (HSI) indices. With this pair, correlation varies from +0.3 to +0.8 over period of 15 years. Taiwan (TAIEX) and Hong Kong (HSI) pair experience higher variance of the correlation over the same period, reaching low as +0.1 and high as +0.8 points. Taiwan (TAIEX) and Singapore (STI) pair show moderate positive correlation from +0.1 to +0.75 over the period of 15 years. It shows higher variance then Singapore (STI) and Hong Kong (HSI) pair as well. Interesting observation can be made at the time of late 2014 and early 2015, when Singapore (STI) and Hong Kong (HSI), Taiwan (TAIEX) and Hong Kong (HSI) pairs experience a drop of correlation about 0.2 points. Taiwan (TAIEX) and Singapore (STI) correlation during this period dropped about 0.4 point.

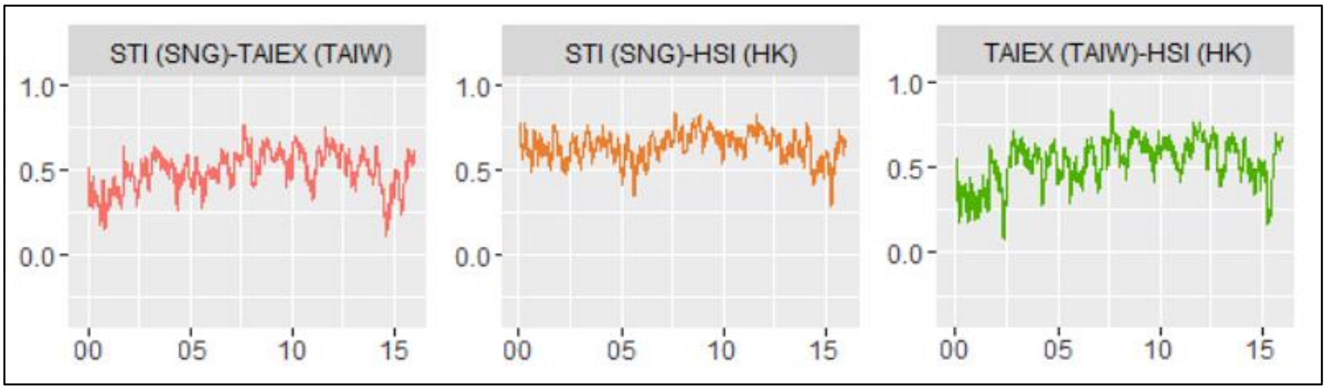


Figure 3.3.2. Dynamic correlation for Asia stock indices. For period of 2000 – 2015. Date is represented on horizontal axis while DCC – GARCH is represented on Vertical axis. Source: prepared by the author.

The dynamic conditional correlation between logarithmic returns of European – Asian market indices pairs ranged between -0.08 and +0.62 during the period under analysis which indicates there are low-to-moderate, mostly positive correlation (See Figure 3.3.3.). Interesting enough this high variance occurs in one particular pair, Singapore (STI) and UK (FTSE100). After further observation it is clear that UK (FTSE100) index has higher variance with all Asia regional indices, selected for this analysis. UK (FTSE100) with Hong Kong (HSI) from +0.007 to +0.49. UK (FTSE100) with Singapore (STI) from -0.08 to +0.62. UK (FTSE100) with Taiwan (TAIEX) from -0.02 to +0.45.

Other European indices selected for this research do not variate in correlation as much as UK (FTSE100) index. Singapore (STI) index variance with France (CAC40) and Germany (DAX) is about 0.38 point for the period.

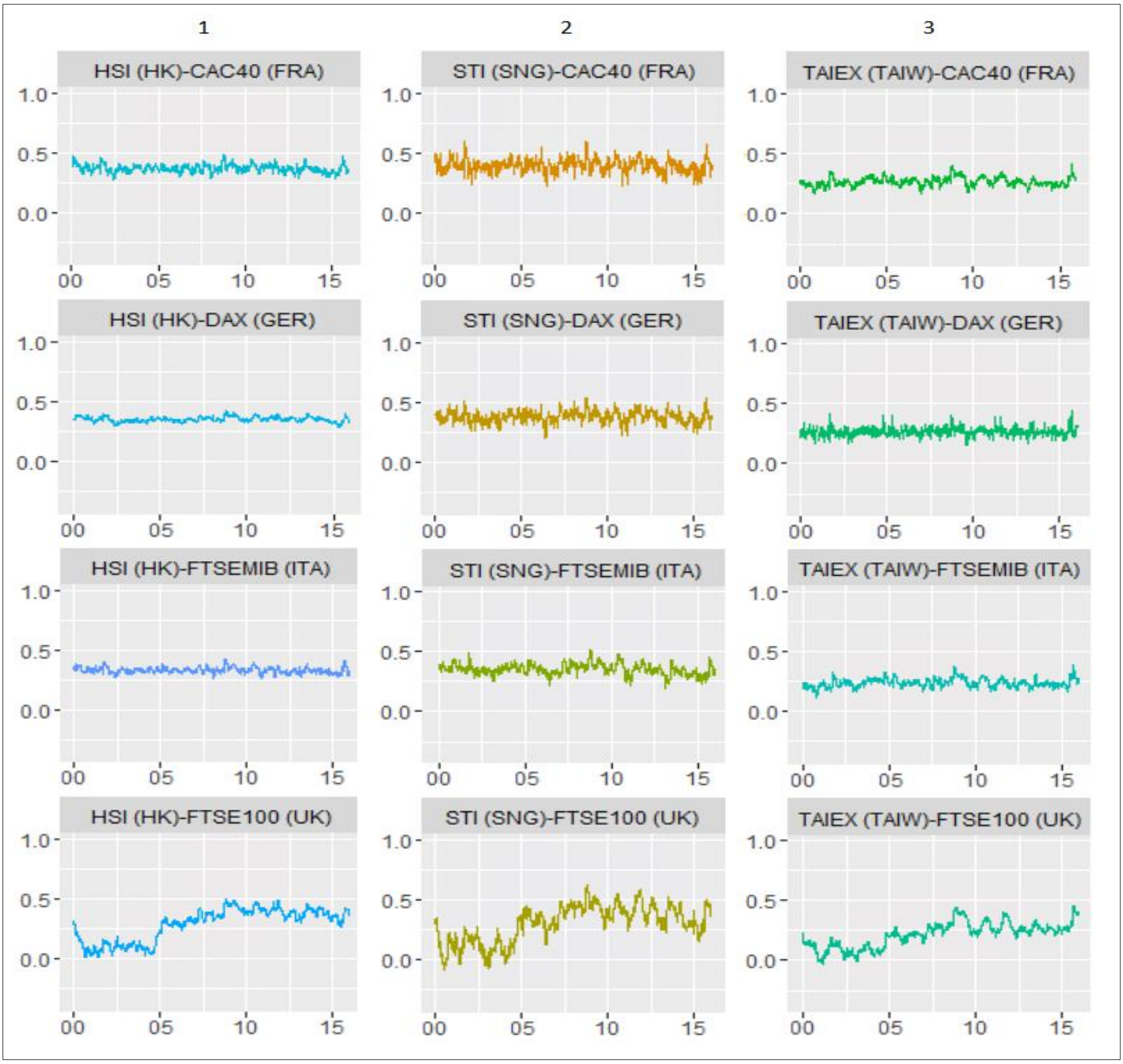


Figure 3.3.3. Dynamic correlation for Asia – Europe stock indices. For period of 2000 – 2015. Date is represented on horizontal axis while DCC – GARCH is represented on Vertical axis. Source: prepared by the author.

Dynamic conditional correlation between European – Asian indices reveals that there is no significant relationship between European and Asian markets. (See Figure 3.3.3.)

Comparing Asian – to – Asian and European – to – European correlations we should notice that Asian market indices are less related with each other. For instance, the dynamic correlation between STI – TAIEX and STI – HSI ranging between +0.3 and +0.7 during the period under analysis (Figure 3.3.1.). To help identify these differences simple average of dynamic conditional correlation has been calculated for selected period from 2000 to 2015 (See Figure 3.3.4.). From these result we can state that, on average, selected Asia region indices experience moderate positive dynamic conditional correlation, while selected European indices experience moderate (all pairs which includes UK – FTSE100) to high (all pairs that exclude UK – FTSE100) positive dynamic conditional correlation. While on average cross regional dynamic conditional correlation stays in a low range for all the pairs, reaching the highest average point of +0.4 in Singapore (STI) and France (CAC40) pair.

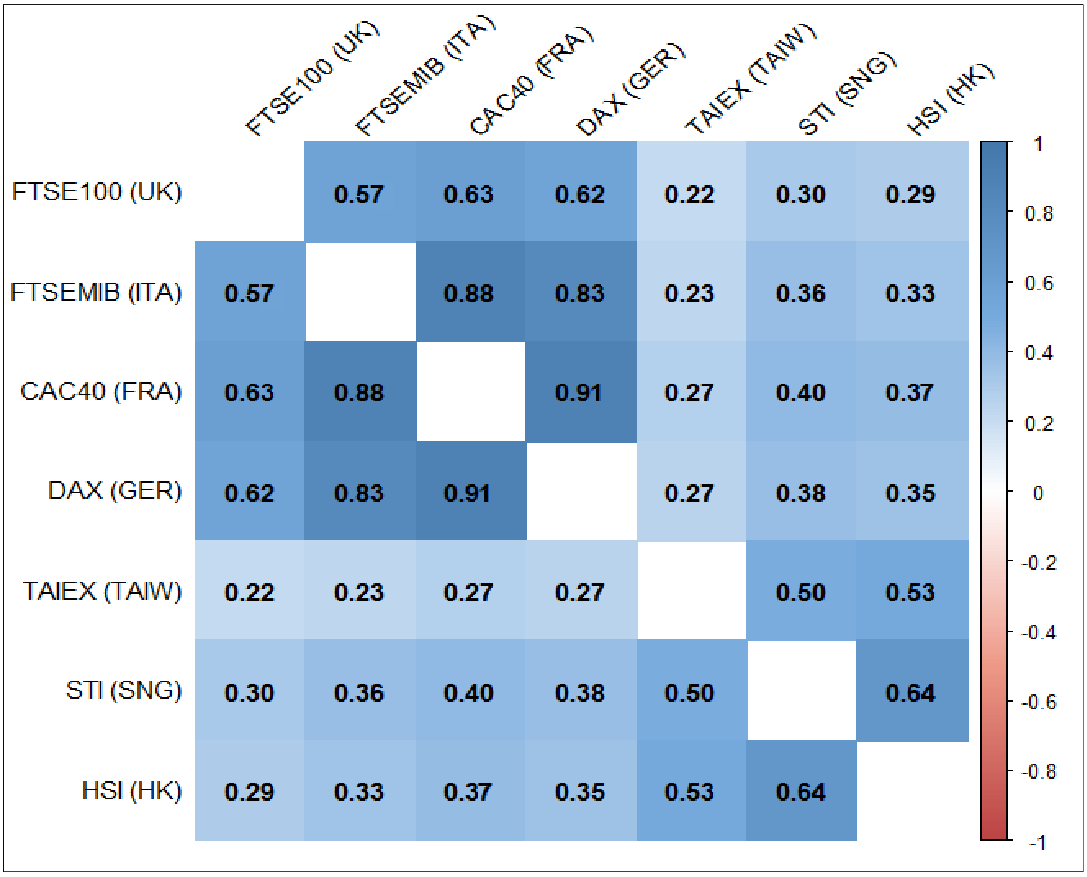


Figure 3.3.4. Simple average of DCC-GARCH results for period of 2000 – 2015. Source: prepared by author.

These results support our previous findings (see figure 3.2.1. Spearman correlation) of weak association between different region assets. Also, we may conclude there is stronger association between European region assets than Asian region assets.

3.4. Generalized impulse responds analysis

The impulse response analysis was applied in order to analyze the short-run interdependence of the European and Asian stock indices. The generalized impulse response functions representing the reaction of one index to a shock in another are obtained for all possible index pairs (x to y; y to x; x to x and y to y).

As shown in Figure 3.4.1 the shocks to STI from other stock indices lasting only for 1 day. STI shock to itself peaking in the first day with a response value of around 1.2 %. STI respond to shocks from European indices are moderate reaching 0.5% on the first day. Shocks from European indices have highest impacted on STI from all three Asian indices. Shocks from Singapore (STI) to European indices are low with exception on Italy (FTSEMIB) index reaching peak of 0.35% on the fifth day (see Figure 3.4.2.)

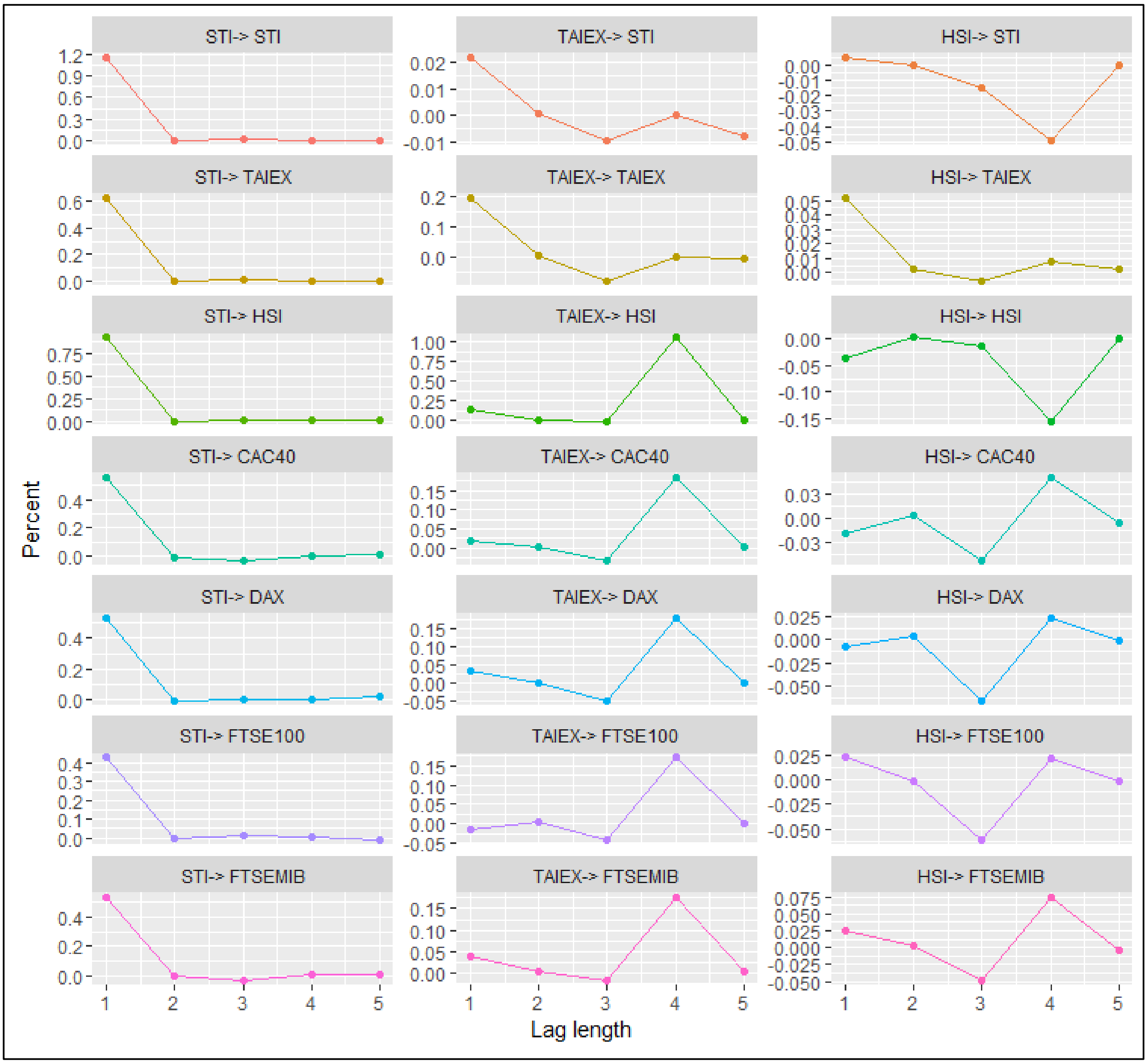


Figure 3.4.1. Generalized impulse respond analysis of Asia indices effect on Asian and European indices. Lag length represents days. Source: prepared by author.

Taiwan (TAIEX) index reaction to shocks on Hong Kong (HSI) index is highest and peaking at 1 % on the fourth day. Almost no shock was noticed in opposite direction from Taiwan (TAIEX) to Honk Kong index, with results showing 0.05 % shock on the first day. Taiwan (TAIEX) reaction to shocks from European indices is almost identical, occurs on the fourth day with 0.15%. Taiwan 's TAIEX index reaction to shocks from Singapore 's STI are not significant as peaking in the first day with a response value of around 0.02 % and in the next couple of days dying to 0 %. Shocks to

Germany (DAX) index from Taiwan reaches 1.25% on the second day, less significant reactions to shocks from Taiwan are observed with Italy, 0.3% on the fifth day. (see Figure 3.4.2.)

Comparing HSI reaction to shocks from other indices we should mention that HSI reaction have very much the same pattern to all European indices as accumulated response to CAC40 (0.05 %), DAX (0.025 %), FTSE100 (0.025 %) and FTSEMIB (0.0705 %) and peaking on 3rd and 4th days. (See figure 3.4.1.). European indices respond to shock from Honk Kong does not show any patterns and varies from negative response on France (CAC40) index -0.04% peaking on third day, UK (FTSE100) index respond is -0.125% on the second day and positive respond of Germany (DAX) and Italy (FTSEMIB) ranging from 0.3% to 0.4% on second and fifth days.

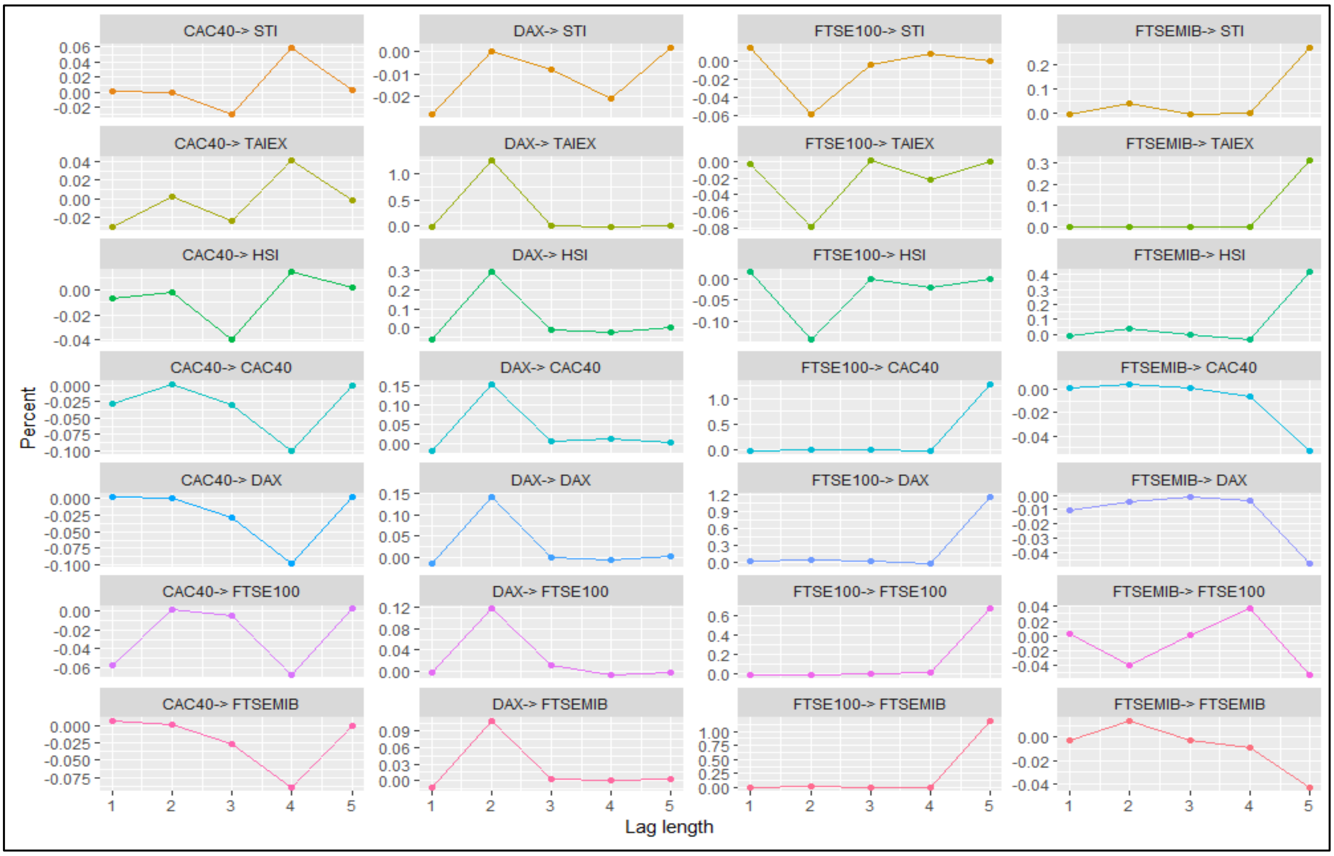


Figure 3.4.2. Generalized impulse respond analysis of European indices effect on Asian and European indices. Lag length represents days. Source: prepared by author.

The response of France (CAC40) to shocks on DAX, FTSE100 and FTSEMIB are similar. Peaks on the third day with -0.1% DAX, -0.06% FTSE100, -0.075% FTSEMIB.

The response of DAX to shocks from all indices peaking after the 2nd day (with exception of DAX from STI) meaning there are short-lasting effects of external shocks on DAX stock index lasting only for two days.

The shocks of STI, TAIEX and HSI to FTSE100 varies from 0 to -0.125% and peaks on the second day. Though, the response of FTSE100 to shocks from other European indices is more than significant comparing with the effect from Asian indices. Accumulated response to CAC40 (1.3 %), DAX (1.2 %), FTSE100 (0.7 %) and FTSEMIB (1.25 %) peaking on the 5th day.

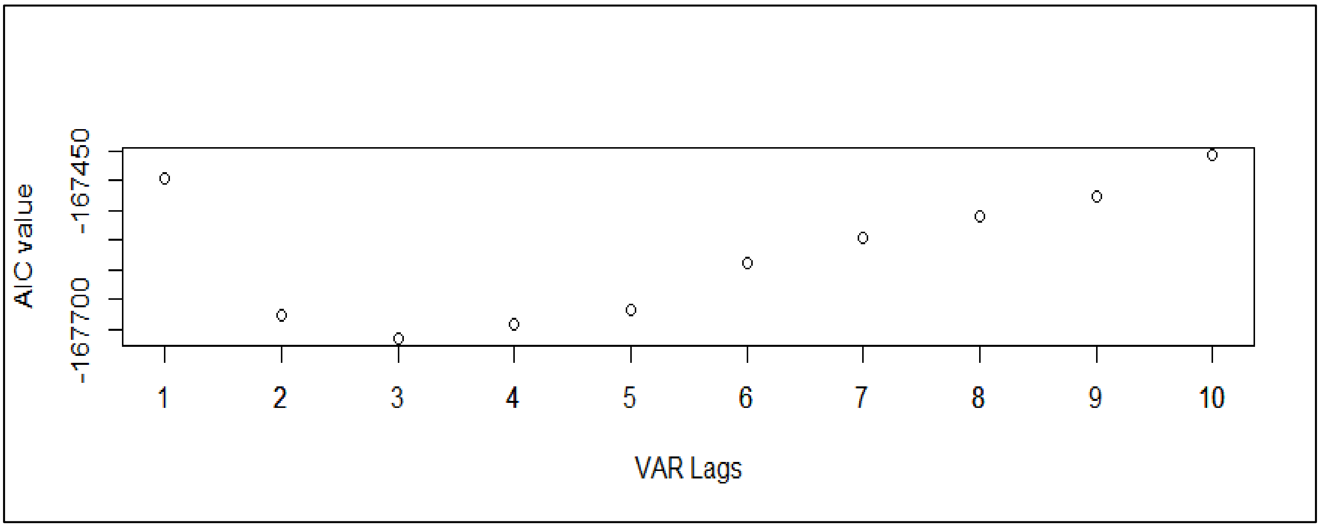
In general shock responds in cross regional pairs is low. On average reaching about 0.1 % with few exceptions with Singapore (STI) index respond to European indices. STI respond to shocks from European indices with 0.4 % on the first day and it will decline to 0% on the second day. Second exception in cross regional pairs is Italy (FTSEMIB) index. Respond to the shocks from Asia indices in Italy occurs only on the fourth day with 0.3% to 0.4% respond. Third exception is Germany (DAX) index, which respond to shock in Taiwan and Honk Kong indices on the second day with 1% and 0.3%.

Regional responses usually are much higher in Europa it varies from -0.1% (France to Germany) to 1.2%(UK to Germany).) and reaches 1% in Asia markets (Taiwan to shocks in Honk Kong.)

3.5. Co-integration test

To test for co-integration or fit VECM, we must first specify how many lags to include into the model. In this case we estimate VAR model with different lag length (1 to 10 days) and calculate Akaike information criterion (AIC) statistics. The results suggest the optimal lag is 3 days (AIC = -167715.1) as we are interested in lowest possible AIC value (See Figure 3.5.1.). Keeping in mind the information about optimal lag length, the long-run relationship among the European and Asian stock markets was explored by testing for co-integration among the European and Asian stock market indices. The results of the Johansen co-integration trace test are reported in Table 3.5.1.

Figure 3.5.1. Selecting the optimal Lag length. Source: prepared by author.



The co-integration test results let us reject the null hypothesis up until r = 6 with a 0.01 level (H0: r <=6, trc = 858,3 > 11.65), meaning there are at most 7 co-integrating vectors and we could say that there are at most 7 co-integrating relations between the European and Asian stock indices (Table 3.5.1.). As a result, we verified that 7 indices have a common stochastic drift. Since we established presence of 7 co-integrating equations based on the trace statistic the next step is to estimate a VECM with 7 co-integrating equations.

Table 3.5.1. The results of the Johansen cointegration trace test.

Null hypothesis	Trace test statistics (trc)	Critical values		
		10pct	5pct	1pct
r <= 6	858.3***	6.5	8.18	11.65
r <= 5	1952.5***	15.66	17.95	23.52
r <= 4	3164.4***	28.71	31.52	37.22
r <= 3	4392***	45.23	48.28	55.43
r <= 2	5750***	66.49	70.6	78.87
r <= 1	7203.6***	85.18	90.39	104.2
r = 0	9051.5***	118.99	124.25	136.06

***denotes rejection of the hypothesis at the 0.01 level. Source:preperade by author.

In general, the results suggest that there is the long-run relationship among the European and Asian stock markets so the next step is to estimate the parameters of such relationships.

3.6. Vector error correction model (VECM)

A natural progression from a co-integration analysis is the VECM modeling, especially when the level series are non-stationary. In the previous section we test for the rank of the co-integration using the methodology by Johansen (1988). Having determined that there are a 7 co-integrating equations, we now want to estimate the parameters of a 7-dimensional VECM for European and Asian indices.

The overall significance of the VECM model parameter estimates are acceptable. The statistically significant parameters colored green, the asterisk (***) denotes the 0.01 level of significance. The estimate of the coefficients D_STI (STI.l3) and D_STI (CAC40.l3) is -1.06 and -0.175. Thus when the average STI return rate is too high, it quickly falls back toward the itself and CAC 40 level. Furthermore, the estimate of the coefficients D_STI (DAX.l3) and D_STI (FTSE100.l3) is 0.343 and 0.308 meaning when the average DAX and FTSE100 return rate increases the average return rate in STI quickly adjusts toward the DAX and FTSE100 level at the same time that the DAX and FTSE100 prices are adjusting.

We also should notice that when the average STI, TAIEX, HSI, CAC40, DAX FTSE100 and FTSEMIB return rate is too high, it quickly falls back toward itself i.e. the index itself eventually returns to its equilibrium.

Speaking of Asian indices, TAIEX equation have two positive parameter estimated meaning that when the average DAX (0.322) and FTSE100 (0.158) return rate increases the average return rate in TAIEX quickly adjusts toward the DAX and FTSE100 level at the same time that the DAX and FTSE100 prices are adjusting. The following holds for all equations which indicates, there are strong long-term relationship between all European and Asian indices and Germany's DAX and UK's FTSE100. There is one more significant long-term relationship between HSI and STI as the estimate of the coefficient D_HIS (STI.l3) is 0.127. When the average STI return rate increases the average return rate in HSI quickly adjusts toward the STI level at the same time that the STI prices are adjusting.

The analysis revealed there is negative parameter estimated in DAX equation. Thus when the average DAX return rate is too high, it quickly falls back toward itself. The Italian's FTSEMIB and French's CAC40 have significance long-term relationship (-0.546) as when the average FTSEMIB return rate is too high, it quickly falls back toward the itself and CAC 40 level (Table 3.6.1).

Table 3.6.1. The vector error correction model results. Source: prepared by Author.

	D STI	D TAIEX	D HSI	D CAC40	D DAX	D FTSE100	D FTSEMIB
STI.dl1	-1.003***	0.114***	0.16***	-0.048	-0.021	-0.018	-0.043
TAIEX.dl1	-0.054***	-1.085***	-0.105***	-0.007	0.013	-0.001	0.002
HSI.dl1	-0.101***	-0.049***	-1.227***	0.015	-0.01	0.03	0.044
CAC40.dl1	-0.112***	-0.05	-0.117***	-1.558***	-0.383***	-0.108***	-0.41***
DAX.dl1	0.168***	0.193***	0.224***	0.237***	-0.925***	0.07***	0.172***
FTSE100.dl1	0.249***	0.18***	0.319***	0.6***	0.6***	-1.027***	0.489***
FTSEMIB.dl1	0.04	0.026	0.076***	-0.015	-0.04	0.023	-1.041***
STI.dl2	-1.029***	0.137***	0.152***	-0.005	0.025	0.067	0.021
TAIEX.dl2	-0.056***	-1.108***	-0.11***	0.013	0.027	-0.017	0.031
HSI.dl2	-0.078***	-0.032	-1.266***	-0.077***	-0.107***	-0.011	-0.03
CAC40.dl2	-0.114***	0.029	-0.119	-1.652***	-0.344***	-0.104	-0.5***
DAX.dl2	0.261***	0.272***	0.349***	0.203***	-0.993***	0.058	0.183***
FTSE100.dl2	0.316***	0.166***	0.409***	0.836***	0.79***	-1.07***	0.661***
FTSEMIB.dl2	-0.012	-0.039	0	-0.036	-0.098***	0.01	-1.071***
STI.l3	-1.06***	0.091	0.127***	-0.036	0.012	0.037	0.031
TAIEX.l3	-0.022	-1.095***	-0.104***	0.003	0.047	-0.004	0.019
HSI.l3	-0.062	-0.017	-1.266***	-0.06	-0.111***	-0.005	-0.018
CAC40.l3	-0.175***	0.021	-0.115	-1.729***	-0.382***	-0.123	-0.546***
DAX.l3	0.343***	0.322***	0.397***	0.194***	-1.012***	0.035	0.171***
FTSE100.l3	0.308***	0.158***	0.444***	0.93***	0.87***	-1.134***	0.72***
FTSEMIB.l3	0.002	-0.049	-0.023	-0.004	-0.06	0.081	-1.043***
constant	-1.79E-07	-7.60E-05	2.97E-05	-0.00011	0.000106	-1.70E-05	-0.00022

***parameter estimate statistically significant at the 0.01 level

To sum up, we may conclude there are moderate long-term relationship between all European and Asian indices except of interactions between Italy (FTSEMIB) and Asian indices. The results proved that average STI, TAIEX, HSI, CAC40, FTSEMIB return rate adjusts to the average return rate in DAX and FTSE100. Although, there is opposite relationship between DAX and FTSE100 to itself. Since there are negative coefficients in DAX-DAX and FTSE100-FTSE100 (-1.02 and -1.13, respectively) the high increase in DAX and FTSE100 quickly falls back toward itself.

CONCLUSIONS AND RECOMENDATIONS

1. Financial globalization process is not final yet. Process will continue which will lead to increasing interdependence between economic areas. Financial globalization changes the operation conditions of financial institutions by opening new development opportunities for them. Opens access to borrowing, lending and investing world-wide. Main factors that drive globalization are: advances in technology (information, computer); liberalization of economies, financial and capital markets; competition between financial intermediary service providers. Globalization also has its drawbacks. It generates new types of risk, which constitute challenges to central banks and supervisors of financial markets. Globalization of financial markets and the related rapid growth of turnover in credit derivatives, force a focus on understanding, what types of risk are generated in particular market segments. The risks involved can be considerable—including sharp reversals of capital flows, international spillovers, and contagion. Such risks should be continuously analyzed by central banks and supervisory authorities.
2. Spearman correlation coefficient shows us that there is strong regional dependence between European indices and moderate regional dependence between Asia indices. Comparing indices correlations between European and Asian regions we should notice the presence of moderate-to-weak relationship between indices. The highest correlation in cross regional indices is observed between French CAC40 and Singapore STI index (0.41).
3. Comparing dynamic conditional correlations between selected European indices we may conclude that there is stable relationship and co – movement in short term as dynamic conditional correlation ranges between +0.5 and +0.9 after the 2005. Highest DCC fluctuations are observed with pairs that include UK indices. Around 2004 July we see a start of rapid change in DCC in pairs with UK. Change took place in one month and went from low as 0.2 to 0.8. This sudden shift in DCC could be related to changes in economic and political policies on trade and migration that took place with expansion of the European Union on 1 of May, 2004. Dynamic conditional correlation between three Asia indices reveals positive moderate dynamic conditional (average 0.5 – 0.64). The dynamic conditional correlation between logarithmic returns of European – Asian market indices pairs ranged between -0.08 and +0.62 during the period under analysis which indicates there are low-to-moderate, mostly positive correlation. Interesting enough the high variance in DCC between European – Asian indices occurs in pairs that include UK indices.
4. Generalized impulse respond analysis revealed that shock responds in cross regional pairs is low. On average reaching about 0.1 % with few exceptions with Singapore (STI) index respond to European indices. Second exception in cross regional pairs is Italy (FTSEMIB) index. Respond to the shocks from Asia indices in Italy occurs only on the fourth day with 0.3% to 0.4% respond. Third exception is Germany (DAX) index, which respond to shock in Taiwan and Honk Kong indices on the second day with 1% and 0.3%. Regional responses usually are much higher: in

Europe from -0.1% (France to Germany) to 1.2%(UK to Germany).) and 1% in Asia markets (Taiwan to shocks in Honk Kong.).

5. As a result of co-integration test, we verify that 7 indices have a common stochastic drift, suggesting that there is the long-run relationship among the European and Asian stock markets. These empirical results suggest that the European and Asian stock markets are more integrated at the regional level as the interdependence between different regional indices are low to moderate. This helps answering first research problem. Diversification in cross regional indices still has advantages since cross regional co-movement is relatively low to moderate. Shocks form European indices are weakest on Taiwan (TAIEX) and Honk Kong (HSI). And shocks from Asian indices are weakest on UK (FTSE100) and France (CAC40). Vector error correction model shows moderate long-term relationship between all European and Asian indices, except Italy. Strongest long-term relationship from Asia is with DAX, FTSE100.
6. National stock markets face a higher risk of regional shocks since cross-regional shocks are weak, with few exceptions with Singapore, Germany and Italy facing higher shocks from cross-regional indices.
7. Recommended pairs for portfolio diversification are Taiwan (TAIEX) and France (CAC40), pair shows smallest DCC correlation and low respond to shocks and low relationship in a long run. Second pair would be: Honk Kong (HSI) and France (CAC40). Pair shows low DCC correlation and low respond to shocks and low relationship in a long run. Third pair: Taiwan (TAIEX) and UK (FTSE100). Pair shows low DCC correlation and low respond to shocks and moderate relationship in a long run, tracking UK (FTSE10) index. Recommend to avoid diversifying your portfolio with Asian indices if you include Germany (DAX) index. Germany shows low to moderate DCC correlation, shock responds has high variance, and log-term relationship is significant and tends to follow Germany (DAX) index average rate return.

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ANNOTATION

In the master thesis co-movement of European (Germany – DAX, France – CAC40, UK – FTSE100, Italy – FTSEMIB) and Asian (Singapore – STI, Honk Kong – HSI, Taiwan – TAIEX) stock markets is assessed, for the period of 2000 – 2015. Assessment was necessary to answer the problem analyzed in the research: how international portfolio is affected if markets move together and how shocks from abroad affect national stock markets. Logarithmic daily returns for selected indices are analyzed and tested with econometric models: dynamic conditional correlation generalized autoregressive conditional heteroskedasticity model (DCC - GARCH), generalized impulse response analysis, co-integration testing, vector error correction model (VECM).

In the first part of the thesis financial globalization is analyzed, main factors that influenced financial globalization and benefits and risks are presented. In the second part the econometric models used in the research are presented and explained. In the third part results of the research are presented and explained with visual representation of data. Master thesis ends with conclusions and recommendations for portfolio structure if analyzed indices are part of the portfolio.

Key words: portfolio diversification, co-movement, financial globalization, DCC – GARCH, generalized impulse response analysis, Johansen co-integration testing, VECM.

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ANOTACIJA

Magistro baigiamajame darbe yra analizuojama koreliacija ir bendras judėjimas tarp Europos (Vokietija-DAX, Prancūzija-CAC40, JK-FTSE100, Italija-FTSEMIB) ir Azijos (Singapūras – VMI, Honk Kong-HSI, Taivanas-TAIEX) akcijų rinkų, 2000-2015 m. laikotarpiu. Įvertinimas buvo būtinas norint atsakyti, moksliniame tyrime analizuojamas problemas: kaip rinkų koreliacija ir bendras judėjimas paveiks tarptautinį portfelį ir kaip nacionalinės vertybinių popierių rinkos reaguos į šoko rizika iš tarptautinių rinkų. Logaritminė dienos grąža, pasirinktiems indeksams, analizuojama ir testuojama ekonometriniais modeliais: dinaminis sąlyginės koreliacijos apibendrintas autoregresijos sąlyginio heteroskedastiškumo modelis (DCC - GARCH), apibendrintas atsakas į impulsą funkcija, Johansen kointegravimo testas, vektorinių paklaidų korekcijos modelis (VECM).

Pirmojoje darbo dalyje analizuojama finansinė globalizacija, pateikiami pagrindiniai veiksniai kurie nulėmė finansinės globalizacijos raidą. Įvardijamos finansinės globalizacijos naudos ir rizikos. Antroje dalyje pateikiami ir paaiškinami ekonometriniai modeliai naudojami moksliniame tyrime. Trečioje dalyje aptariami mokslinio tyrimo rezultatai. Rezultatai atvaizduojami grafiškai. Magistro darbas užbaigiamas išvadomis ir rekomendacijomis sudarinėjant investicinius portfelius su analizuojamais indeksais.

Raktiniai žodžiai: investicinio portfelio diversifikacija, koreliacija , finansinės globalizacijos, DCC-GARCH, apibendrintas atsakas į impulsą funkcija, Johansen kointegravimo testavimas, vektorinių paklaidų korekcijos modelis (VECM).

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SUMMARY

This financial markets master thesis is important and relevant to many international investors, fund managers, policy makers. Liberalization of capital and financial innovation in recent decades spurred rapid international growth of business and financial markets. Financial globalization changes the operation conditions of financial institutions by opening new development opportunities for them. Access to international diversification has offered unprecedented benefits. Of course, all these benefits would be limited in the long run if international stock markets were interdependent and co-moved together. The basic research problem was raised – how international portfolio is affected if markets move together and how shocks from abroad affect national stock markets? The object is daily equity returns in European and Asian Stock markets. The main aim of this study is to assess the co-movement between particular Asian and European equity markets. The main tasks of the study are: to analyze background and outcome of financial globalization, to describe and evaluate statistical data and using econometric models empirically assess co-movement and interdependence of European and Asian stock markets.

The methodology of master thesis: systemic and comparative analysis of the scientific literature. Empirical investigation was performed using Spearman's correlation coefficient, dynamic conditional correlation generalized autoregressive conditional heteroskedasticity model (DCC - GARCH), generalized impulse response analysis, co-integration testing, vector error correction model (VECM). Empirical results suggest that there is strong regional dependence between European indices and moderate regional dependence between Asia indices. Comparing indices correlations between European and Asian regions we should notice the presence of moderate-to-weak relationship between indices. Generalized impulse respond analysis revealed that shock responds in cross regional pairs is low with few exceptions with Singapore, Italy and Germany. Johansen co-integration testing suggest low to moderate long-term relationship among the European and Asian stock markets. These empirical results suggest that the European and Asian stock markets are more integrated at the regional level. At the end of the master thesis recommendations and answer to the research problem is provided, which states that diversification in international stock markets still have advantages since cross regional co-movement is relatively low to moderate and national stock markets face higher risk of regional shock rather than cross regional.

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SANTRAUKA

Finansų rinkų magistro baigiamasis darbas yra aktualus tarptautiniams investuotojams, fondų valdytojams, monetarinės politikos formuotojams. Kapitalo liberalizavimas ir finansinės inovacijos pastarąjį dešimtmetį paskatino tarptautinio verslo ir finansų rinkų augimą.

Finansinė globalizacija pakeitė finansinių institucijų veikimo sąlygas, atsivėrė naujų plėtros galimybių. Prieiga prie tarptautinių rinkų atvėrė didžiules galimybes diversifikuoti tarptautinėje rinkoje. Žinoma, šios galimybės būtų apribotos jei ilguoju laikotarpiu tarptautinės vertybinių popierių rinkos tarpusavyje būtų koreliuojančios ir judėtu kartu. Iškelta tyrimo problema – kaip rinkų koreliacija ir bendras judėjimas paveiks tarptautinį portfelį ir kaip nacionalinės vertybinių popierių rinkos reaguos į šoko rizika iš tarptautinių rinkų. Tyrimo objektas – dieninė nuosavybės vertybinių popierių grąža, Europos ir Azijos vertybinių popierių rinkose. Pagrindinis šio tyrimo tikslas yra įvertinti koreliacija ir bendras judėjimo tendencijas tarp Azijos ir Europos vertybinių popierių rinkų. Tyrimo pagrindiniai uždaviniai yra: išanalizuoti finansinę globalizaciją nulėmusius veiksnius, apibūdinti ir įvertinti statistinius duomenis ir ekonometrinius modelius. Ištirti koreliaciją ir bendro judėjimo tendencijas, Europos ir Azijos akcijų rinkas. Tyrimo metodika: sisteminė ir lyginamoji mokslinės literatūros analizė.

Empirinis tyrimas buvo atliktas naudojant Spearmano koreliacijos koeficientą, dinaminės sąlyginės koreliacijos apibendrintas autoregresijos sąlyginio heteroskedastiškumo modelis (DCC - GARCH), apibendrinto atsako į impulsą funkcija, Johansen kointegravimo testas, vektorinių paklaidų korekcijos modelis (VECM).

Empiriniai rezultatai rodo, kad egzistuoja stipri regioninė priklausomybė tarp Europos indeksus ir vidutinė regioninė priklausomybė tarp Azijos indeksų. Lyginant indeksų koreliacijas tarp Europos ir Azijos regionų mes randame silpną bei vidutinį ryšįs tarp indeksų. Apibendrinto atsako į impulsą funkcijos analizė parodė, kad šokai tarp skirtingų regiono porų yra silpni, su retomis išimtimis dėl Singapūro, Italijos ir Vokietijos. Šie empiriniai rezultatai parodo, kad Europos ir Azijos akcijų rinkos labiau integruotos regioniniame lygmenyje. Darbo pabaigoje atsakome į tyrimo problemas, kur teigiama, kad diversifikavimas tarptautinėse vertybinių popierių rinkose vis dar turi privalomų, nes skirtingų regionų koreliacija ir bendro judėjimo tendencijos yra palyginti mažo arba vidutinio stiprumo, o nacionalinių akcijų rinkas stipriau veikia regionų rinkų šokai, nei skirtingų regiono akcijų rinkų šokai.

ANNEXES

ANNEX 1.

Visual representation of all DCC-GARCH results