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STOCK AND BOND MARKET INTEGRATION: EVIDENCE FROM RUSSIAN FINANCIAL MARKETS

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ABSTRACT

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Minimizing the risks of an investment portfolio but not in the favour of expected returns is one of the key interests of an investor. Typically, portfolio diversification is achieved using two main strategies: investing in different classes of assets thought to have little or negative correlations or investing in similar classes of assets in multiple markets through international diversification.

This study investigates integration of the Russian financial markets in the time period of January 1, 2003 to December 28, 2007 using daily data. The aim is to test the intra-country and cross-country integration of the Russian stock and bond markets between seven countries. Our test methodology for the short-run dynamics testing is the vector autoregressive model (VAR) and for the long-run cointegration testing we use the Johansen cointegration test which is an extension to VAR.

The empirical results of this study show that the Russian stock and bond markets are not integrated in the long-run either at intra-country or cross-country level which means that the markets are relatively segmented. The short-run dynamics are also relatively low. This implies a presence of potential gains from diversification.

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Yksi sijoittajan tärkeimmistä ja vaikeimmista tavoitteista on riskien minimointi tinkimättä kuitenkaan tuotto-odotuksista. Yleisesti portfolion hajautus voidaan jakaa kahteen ryhmään: sijoitetaan erilaisiin arvopapereihin, joiden yhteisvaihtelut ovat hyvin vähäisiä tai vaihtoehtoisesti sijoitetaan samanlaisiin arvopapereihin mutta eri maihin käyttäen kansainvälistä hajautusta.

Tämän tutkimuksen tarkoituksena on selvittää kuinka Venäjän osake- ja joukkolainamarkkinat ovat integroituneet maan sisäisesti ja kansainvälisesti seitsemän eri maan kesken sekä pitkällä että lyhyellä aikavälillä. Testausmenetelmänä lyhyen aikavälin dynamiikkojen selvittämiseen käytetään vektoriautoregressiivistä mallia ja pitkän aikavälin yhteisintegraation testauksessa käytetään Johansenin yhteisintegraatiotestiä, joka on laajennus vektoriautoregressiiviselle mallille. Aineisto koostuu päivittäisistä havainnoista aikaväliltä 1.1.2003–28.12.2007.

Testitulosten mukaan Venäjän osake- ja joukkolainamarkkinat eivät ole maan sisäisesti eivätkä myöskään kansainvälisesti integroituneet pitkällä aikavälillä. Myös myös lyhyen aikavälin yhteisvaihtelut ovat heikkoja. Tämä tarkoittaa sitä, että mahdolliset hajautushyödyt ovat ilmeiset.

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1 INTRODUCTION

1.1 Background

One of the most important decisions for investor is asset allocation. Important thing in asset allocation is to know how different financial markets are integrated. If for example stock and bond markets are not highly integrated, it is possible to lower the portfolio risk by diversification.

Studies on the integration of stock and bond markets are concentrated on the major developed markets like the US markets (e.g., Scruggs & Glabadanidis (2003); Downing & al. (2007)) and the European markets (e.g., Christiansen (2007); Kim & al. (2006)).[1] There are also some studies considering the emerging markets (e.g., Rockinger & Urga (2001)).

Developed markets are anyhow becoming less effective in cross-country diversification. According to the studies of Christiansen (2007) and Kim & al. (2006) countries in the European Monetary Union have been highly integrated after introducing Euro, but also the US markets are highly integrated with European markets. However, according to Rockinger & Urga (2001) and Anatoliev (2005) emerging markets have been an interesting option for investors, not just because they can offer outstanding return possibilities, but also because they can be used in diversification more effectively. This is due to their lower degree integration with more developed counterparts. Probably, one of the most interesting emerging markets is Russia.

There is a vast literature on financial market integration in general, but the earlier literature considering the Russian financial markets is still rather quiet, especially on bond markets. According to the author's knowledge

[1] Best to our knowledge, there are also at least two studies considering integration of the Finnish financial markets, see Nummelin & Vaihekoski (2002) and Antell (2004).

there is only one study (see Hayo & Kutao 2002) which covers integration of the Russian bond markets at some level, and no studies on intra-country integration of the Russian financial markets. In other words, all previous studies have covered only Russian stock markets and their integration (e.g., Pesonen (1999); Anatoliev (2005); Lucey & Voronkova (2005); Goriaev & Zabotkin (2006); Saleem & Vaihekoski (2008)). Small amount of studies on the Russian financial markets is probably explained by the fact that the Russian financial markets are still quite young and enormous crises occurred during 1997-1998. This has limited the possibility to use longer data series.

However, Russia's infancy and latest crises are already in the near history, and it is possible to get data for a reasonable timeline and investigate the intra-country and cross-country integration of the Russian stock and bond markets. This paper builds on earlier the studies of Lucey & Voronkova (2005) and Hsiao & al. (2006) on the Russian stock market integration by adapting their long-run relationships testing with the Johansen cointegration test and short-run dynamics testing with the vector autoregressive model (VAR).

The contribution of this study is twofold. First, best to our knowledge there are no earlier studies on the intra-country integration of the Russian stock and bond markets. Second, there are no earlier studies considering cross-country bond market integration covering also the Russian bond market.

1.2 Objectives and research methodology

The purpose of paper is to investigate integration of the Russian stock and bond markets in the time period of January 1, 2003 to December 28, 2007. We will also give a comprehensive review considering earlier integration studies and the Russian financial markets.

The research questions of this study are as follows. First, are the Russian stock and bond markets integrated at intra-country level in the long-run and the short-run? We will investigate cross-asset integration between Russian stocks, corporate bonds and government bonds. Second, are the Russian stock and bond markets integrated at cross-country level with seven country pairs in the long-run and the short-run? We will investigate intra-asset integration integrations between stocks and corporate bonds.

In the short-run dynamics testing we will use the VAR model and in the long-run cointegration testing we will use the Johansen cointegration test which is an extension to the VAR. In order to employ the Johansen cointegration test it needs to be investigated whether or not time series contains a unit root. For the unit root testing we will employ Augmented Dickey-Fuller test (ADF).

1.3 Limitations

There are few limitations in this study. First, in the empirical part of this study we will concentrate only on linear regression methods, which mean that we will not use any sophisticated models (e.g., GARGH, Karman-filter, time-varying models) in our volatility modelling. Instead we tend to use the simplest "rate of change" method. This decision made because previous studies have shown that strong assumptions in non-linear methods may work poorly for this kind of countries and models, although interpretations considering this are controversial (see e.g., Hayo & Kutao (2002); Anatoliev (2005)). Second, we will concentrate to study integration only with aggregate stock and bond indices. That means we will not use any individual assets in our study. This is has been a typical approach also in the previous studies. Third, we will not empirically test any other causes or determinants for stock and bond market movements or how they might affect to the level of the integration. However, this is interesting and important aspect considering further studies. Fourth, like it is commonly know, the Russian markets were in highly unpredictable and risky stage before the year 2003. Because of these extreme events we have decided to limit our timeline to five years.

1.4 Structure

The remainder of this master's thesis is organized as follows. Chapter 2 presents theoretical framework with a literature review of the previous studies and empirical results regarding the subject matter of this study. Chapter 3 provides the main characteristics of the Russian financial markets. The data collection method and data characteristics are described in Chapter 4 and the research methodology in Chapter 5. Chapter 6 presents the empirical results of the data set of this study. Finally, Chapter 7 is for conclusions.

2 THEORETICAL FRAMEWORK AND PREVIOUS STUDIES

2.1 Integration of financial markets

Minimizing the risks of an investment portfolio but not in the favour of the returns is one of the key interests for an investor. Typically, portfolio diversification is achieved using two main strategies: investing in different classes of assets thought to have little or negative correlations or investing in similar classes of assets in multiple markets through international diversification (Cappiello & al., 2003). This means that the integration of financial markets is one of the key importances for investors and policy makers. It is therefore not surprising that cross-country co-movements between stocks and between bonds have been analyzed thoroughly in the earlier literature. Stock-bond correlations are first analyzed by Campbell & Ammer (1993) and there is a vast literature on financial market integration in general (see e.g., Baele & al. (2004)), stock market integration (see e.g., Bekaert & Harvey (1995); Bekaert & al. (2002)); Bracker & al. (1999)) and stock market co- movements, bond market integration and co-movement (see e.g., Barr & Priestley (2004)) and potential negative effects of this evidenced by the contagion literature (see e.g., Bekaert & al. (2005)).

One may ask what integration of financial markets concretely means. According to Antell (2005) markets are integrated if asset prices are driven by common underlying factors and a shock to one asset might have implications on the movements of other asset classes, or implications back on the fundamentals. Hence prices will not be driven only by own shocks, but also by movements in other assets. For example, a negative shock to equity prices tends to decrease bond returns. The risk reduction possibilities due to shifting investments from one asset category or country to another, is highly due to the return and volatility linkages between the markets. Opposite for integrated markets are segmented markets where movements in assets are driven only by own shocks, and not by movements in other assets. Bekaert & Harvey (1995) defined that integration of asset markets is divided in three stages. Asset markets are either perfectly integrated, perfectly segmented, or partially integrated but the extent of integration is constant over time.

The literature on financial linkages has evolved along two separate strands in recent years. One of these strands has been focusing on the domestic transmission of asset price shocks and its determinants. Another direction of the literature has been to analyze international linkages. Some studies have also put together investigation of the both intra-country and cross-country integration as we will in our study.

The points of views in the earlier studies are also twofold. The first one can been seen as the investor's point of view based approach which is mostly inspired by the possibility to lower portfolio risk via diversification, i.e., diversification possibilities exist if markets are not highly integrated. This is also our approach and it is also the most common approach in the earlier literature. The second one is inspired by the benefits of high level integration. This approach is from the point of view of policy makers to create highly integrated economic areas like the European Monetary Union. De Santis & Gérard (2006) states two widely accepted economic benefits of integration: first the better sharing of risks; and second, the increase of the potential economic growth.

An interesting and important thing is how to investigate financial markets integration. First, it needs to be decided which assets are included to the study, i.e., the ones which are interested or the ones which are relevant considering a certain study. Second, what kind of approach and methodology is suitable to a certain study? The levels of asset market integrations have been investigated with different correlation and regression models. Models and approaches used in the previous literature are various but two main categories exist; linear and non-linear models, i.e., techniques with or without volatility modelling. An echo from the earlier literature is that there is no simple way to decide the most comprehensive model to use. The data, objectives and relevancy of the volatility modelling can be seen as critical determinants when deciding appropriate model. Hence, a quick review to the most used models is a worthwhile. It might also help reader to understand better our review of earlier literature.

Some studies are based on classical linear regression techniques (CLR), and these techniques have been also widely used with international and capital asset prising models (ICAPM, CAPM) and also with arbitrage prising theory (APT) models. CLR models are still used in some extend with integration studies but ICAPM, CAPM and APT models have not been very popular in the latest literature regarding integration studies. Advantage of a simple linear regression is that it is very easy to implement and understand. Minus sides are that simple linear model may not capture all the relevant features of the data and the results are not as informative as is the case with the latest models developed exactly for integration testing.

Non-linear modelling is also widely used in integration studies. A non-linear regression can be considered as a linear one but when in linear models volatility is non-modelled in non-linear volatility is modelled. Typical non-linear models are GARCH models and GARCH models with time-varying covariance, and they have been also used with CAPM etc. frameworks. Non-linear models are widely used but their usage in some cases is controversial. Non-linear models make strong assumptions considering the data which has been used and according to Brooks (2002) only some relationships in finance are unambiguously considered to be non-linear, which are for example relationships between underlying assets and their derivatives. This means that all data is not suitable for non-linear models but on the other hand, some data cannot be explained with linear regression. Another disadvantage is also that for integration testing a basic non-linear model is not as informative as the models developed exactly for integration testing. However, volatility modelling used with the latest models is very informative considering also integration studies.

Some studies have used so-called “regime switching” models and they can be either linear or non-linear. These models are used to study impacts of large-scale events, such as wars, financial panics, and changes in government policy or introducing the Euro. These kind of impacts makes financial series change over time in terms of its mean value, its volatility, or what extent its current value is related to its previous value. For a certain data and objects of the study these models can be very useful and they have been quite popular.

In the latest studies the most widely used models has been probably VAR, and tests which are based on VARs like; the Johansen cointegration test and the Granger causality test. VAR can be considered as a hybrid between univariate models and simultaneous equations models. VAR techniques can be for example used to test long-run cointegration and dynamic lead-lag interactions between assets. VAR techniques can be used with or without volatility modelling. The advantage of these tests is that for integration study purposes their results are very informative and useful.

We will not test the quality or adequacy of different models, hence will use techniques based only on one model. In our empirical study we are interested in only about the recent integration of the Russian Financial markets. This means that our timeline is relatively short and we know that markets been quite steadily growing without any major crises, i.e., no time-varying or regime switching models are needed. As an addition, according to Anatoliev (2005) GARCH etc. volatility modelling is not highly recommended when studying Russian financial markets. We will also reject CAPM or APT frameworks, because they have not been especially popular in the latest literature. On these bases, we will choose the VAR model and the Johansen cointegration test without volatility modelling to our empirical test methodology. These tests have also been very popular in the latest literature.

2.2 Determinants of integration and segmentation

The global financial markets integration has increased significantly since the late 1980s. A key factor underlying this process has been an increased globalization of investments where investors seek higher returns and the opportunity to diversify risks. A higher level of financial market integration has also been a target in some cases like for example in the European Monetary Union. At the same time, in the process of policies towards opening markets, many countries, especially developing countries, encourage capital openness by dismantling restrictions and controls on capital inflows and outflows, deregulating domestic financial markets, liberalizing restrictions on foreign direct investment and improving their economic environments and prospects through the introduction of market-oriented reforms (Agenor, 2003).

Investor should also be aware that correlations are dynamic and varies over time, changing the amount of portfolio diversification within given asset allocation (Cappiello & al., 2003). In particular, a number of studies document that correlation between assets increases during bear markets and decreases when markets rally (see e.g., Erb & al. (1994); De Santis & Gérard (1997); Ang & Begaert (1999); Das & Uppal (2004); Longing & Solnik (2001)).

Closely related literature to integration studies focuses on explaining the price discovery process. In our empirical part we have limited out testing the causes of integration or segmentation. However, it is an interesting and relevant part of integration studies; why there are segmented and integrated markets?

In modern finance the fair price of any asset is calculated as the conditional expectation of its future payoffs multiplied with a stochastic discount factor, or pricing kernel. Thus, in a discrete time environment, prices can be computed as

$$P_t^* = E_t\left(W_{t+1}^* M_{t+1}^*\right), \tag{1}$$

where W_{t+1}^* represents the cash flows generated by the asset in time $t+1$ and M_{t+1}^* is the stochastic pricing kernel (d'Adonna & Kind, 2006).

According to Rigobon & Sack (2003) movements in the price of one asset are likely to be importantly affected by the contemporaneous movements of other assets. This behaviour arises in part of because asset prices are driven by underlying factors such as, macroeconomical developments, monetary policy expectations, or risk preferences that likely affect one another.

We will now go trough the most relevant determinants causing integration and segmentation. We have categorized these determinants as: liberalization, volatility and risk preferences, macroeconomical factors, the US markets, the European Monetary Union and regions. Results of the earlier studies considering these determinants are partly controversial probably due to differences in sample period, data frequency, indices and methodologies.

Liberalization

According to the study of Jithendranathan & Kravchenko (2002) the world financial markets integration is a gradual process that begins when foreign investors are allowed to invest in a countries domestic market and the domestic investors are allowed to invest in foreign equities. The other necessary conditions for full integration of equity markets are the elimination of barriers to cross boarder investments.

Evans & Hnatkovska (2005) presented in their integration study a model to examine how to the integration in world financial markets affect the behaviour of international capital flows and financial returns. Their model predicts that international capital flows are large (in absolute value) and very volatile during the early stages of financial integration when international asset trading is concentrated on bonds. As integration progresses and households gain access to world equity markets, the size and volatility of international bond flows fall dramatically but continue to exceed the size and volatility of international equity flows. This is the natural outcome of greater risk sharing facilitated by increased integration.

Volatility and risk preferences

d'Adonna & Kind (2006) found in their G7 country study that higher variability of the dividend yield boosts the variability of stock returns and reduces the correlation of stocks and bonds. Cappiello & al. (2003) states that correlation between assets increases during bear markets and decreases when markets rally. Also, according to Antell (2005); if the expected volatility in one market increases, there is a shift of funds towards the other markets. These findings also echo results in study of Arshapanelli & al. (2003) for the US stock and bond markets. They found that stocks are rewarded for their specific component of risk while bonds are rewarded for the common component of risk they share with stocks.

Macroeconomical factors

d'Adonna & Kind (2006) studied international stock-bond correlations in G7 countries to macroeconomic fundamentals in the US markets with monthly data. Their model implies that the volatility of the real interest rate increases the correlation between stocks and bonds. This result is intuitive, given that the real interest rate discounts both future dividends and cash flows deriving from fixed-income securities. Inflation shocks tend to reduce the correlation between stocks and bonds, which reflects the fact that in their model stocks provide complete insurance with respect to future inflation.

Soenen & Johnson (2002) investigated how different factors affect to the level of economic integration between twelve Asian equity markets and Japan. They found evidence for these Asian markets to become more integrated over time, especially since 1994. Higher import shares as well as a greater differential in inflation rates, real interest rates and gross domestic product growth rates have negative effects on stock market co-movements between country pairs. Conversely, increased export share by Asian economies to Japan and greater foreign direct investment from Japan to other Asian economies contribute to greater co-movement.

The US markets

Baele (2003) found in their study on European financial markets that EU shocks explain about 15 percent of local variance, compared to 20 percent for US shocks. While the US continues to be the dominating influence in European equity markets, the importance of the regional European market is rising considerably. The study of Baur (2007) on eight developed countries also echo these findings; the US stock and bond markets are affecting both foreign stock and bond markets and the influence of the US stock and bond markets has increased for all countries. The influence of the stock market is anyhow considerably stronger. The study of Glezakos & al. (2007) on the US markets and European markets of also confirms the dominance of the US financial market on all other markets of the sample. However, the study of Phengphis & Apilado (2004) on EMU and non-EMU countries gives opposite results. Their results indicate that the US stock market does not exert influences on long-run performances of other included stock markets.

The European Monetary Union

According to the earlier studies about effects of the European Monetary Union (EMU) has been very successful in its financial markets integration process. Cappiello & al. (2003) studied effects of the EMU to the global equity and bond markets. They found that introduction of Euro in January 1999 made a structural break in correlation, although not in volatility. Euro created almost perfectly correlated bond markets within Euro area. However, also correlation in the equity markets both within and outside the EMU have increased after introduction of Euro. De Santis & Gérard (2006) studied how the establishment of the EMU has affected to the integration between the 30 biggest world economies in both equity and bond markets. Their results are that the EMU has strengthened integration within the EMU area. In the study of Cappiello & al. (2006) results suggest an overall increase in the integration of both equity and bond Euro area markets since the introduction of the single currency. However, while the integration is very advanced for all Euro area government bond markets, as for equity markets it seems to lag behind, and progress limited to large Euro area economies. Baele & al. (2004) found in their study also that the Euro area corporate bond market seems reasonably well integrated. Same results are found in the study of Ehrman & al. (2007) on France, Germany, Italy, and Spain that the EMU does seem to have led to essentially a single, unified Euro area bond market.

Regions

According to earlier literature regions are usually highly integrated but also exceptions can be found. As we mentioned earlier, Europe is good example of a highly integrated region, especially within the Euro area. According to the studies of Chi & al. (2006) and Vo (2006) also Asian equity markets are highly integrated together and less integrated with other countries and regions. Also according to Erb & al. (1998) Asian equity markets are highly integrated and crises are contagious. According to the same study, Latin American markets are not highly integrated and crises are not especially contagious. Results considering Latin America get support from the study of Hunter (2005). They investigated the level of integration of the stock markets of Argentina, Chile, and Mexico. Results indicate that there is no distinct trend toward higher levels of integration. In fact, the markets of Argentina and Mexico have become increasingly segmented over the post-liberalization period. However, the latter results are contrary to the results of Chen & al. (2002). Their results say that Latin American stock markets are cointegrated.

2.3 Empirical results from previous studies

In this section we have gathered the relevant studies somehow similar with our study. Studies considering the Russian financial markets are reviewed separately in Chapter 3. The literature on financial linkages has evolved along two separate strands in recent years. One of these strands has been focusing on the domestic transmission of asset price shocks and its determinants. Another direction of the literature has been to analyze international linkages. We will first review studies considering integration at intra-country level and then at cross-country level. Most of the previous studies are about cross-country linkages and only few exist about intra-country linkages. We have made this review using only the most relevant and literature considering our study.

In the earlier literature, besides commonly familiar terms like correlation and integration, reader may face more unfamiliar terms such as cointegration, spillover, contagion, convergence or flight-to-quality. Hence because these terms are widely used in integration literature, a small review to the terminology is worth taking. Ahlgren & Antell (2002) defines cointegration a long-term equilibrium phenomenon when it is possible that the movements of cointegrating variables deviate in the short-run but not in the long-run. Cashing & al. (1995) defines contagion as a shock transfer when a shock in one asset market has transmitted to another asset markets. A related aspect is spillover which Christiansen (2007) defines as the level which volatility of one asset market is affected from volatility of another asset market. Baele & al. (2004) defines convergence simply as a synonym for integration. Hartmann & al. (2004) defines flight-to-quality as a phenomenon when crash in stock markets causes boom in corporate bond markets.

Intra-country integration

Table 1 summarizes the results and attributes of the studies which have examined the integration at intra-country level. The Studies in Table 1 are presented in a chronological order. Each paper is discussed separately and important findings and implications are pointed out.

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Table 1. Reviews of intra-country integration studies.

Author(s)	Market(s)	Period	Methodology	Results
Antell (2004)	Finland	1991-2003	GMM and VAR-EGARGH	Volatility link between stocks and bonds is relatively weak
Johnson & Young (2004)	Switzerland	1973-2002	GARCH	Negative trend in the correlations between stocks and bonds
Li & Zou (2006)	China	2003-2005	DCC	Stock-bond market integration low level but stock-stock market integration quite high
Kim & al. (2006)	Europe, Japan and the USA	1994-2003	EGARCH and Granger causality test	Integration has trended downwards to zero and even negative mean levels in most European countries and in Japan and the USA.
Baur (2007)	8 developed countries	1994-2006	GARCH and Granger causality test	Markets are not integrated

Antell (2004) studied integration of Finnish stock, bond, and money markets with the generalized method of movements (GMM) and VAR-EGARCH models during 1991-2003. The stock-bond market pairing, and the stock-money market pairing yielded a volatility link lower than the return correlation. The volatility link between the stock market, measured with the HEX General index, and the money market is surprisingly clearly negative. In this case periods with high stock market volatility are countered by periods of lower volatility in the bond and money markets.

However, the link between the bond market and the money market is clearly positive. The corresponding correlations using the HEX Portfolio Yield Index as stock market measure yielded positive values, and against the money market roughly the same as the return correlation.

Johnson & Young (2004) examined bond and stock market volatility in Switzerland during 1973-2002 with GARCH. They found that the lack of a trend in the ratio of bond stock standard deviations and a negative trend in the correlations between stocks and bonds indicate that the effectiveness of bonds as diversification vehicles in Switzerland has not declined, but rather increased over time. This finding has implications for portfolio asset allocation decisions for global investors. The results of their study indicate that it is dangerous to assume that trends in market volatility are similar across the developed securities markets.

Li & Zou (2006) studied financial market correlations in Chinese markets from during 2003-2005 using dynamic conditional correlation model (DCC). Results indicate that the stock-bond market integration is still at a low level, although the stock-stock market integration has reached a quite high level. In addition, the relatively smaller volatility in T-bond returns provides potential gains in reducing portfolio risk by flight-to-quality. They found also evidence that the stock-bond correlations tend to increase only when their returns have both been hit by bad news, but the stock-stock correlations tend to increase only when their returns have both been hit by good news.

Kim & al. (2006) studied time-varying conditional correlations between stock and bond market returns in European countries, Japan and the US during 1994-2003, using EGARCH and Granger causality. Their founding were that intra-stock and bond market integration with the EMU has strengthened in the sample period, inter-stock-bond market integration at country level has trended downwards to zero and even negative mean levels in most European countries, Japan and the US.

Baur (2007) investigated integration of stock and bond markets and the influence of the US markets in eight developed countries during 1994-2006 with GARCH and Granger causality test. Their results can be summarized as follows: (i) there is no causality from bond to stock markets or from stock to bond markets on average but in several sub-periods, (ii) the US stock and bond markets are affecting both foreign stock and bond markets and (iii) the influence of the US stock and bond markets has increased for all countries (the influence of the stock market is considerably stronger) and dominates other influences e.g., the effects of a country's own stock or bond markets. Their findings imply cross-country linkages with the US govern and dominate stock-bond co-movements. In addition, if there is Granger causality from stock to bond markets or from bond markets to stock markets there is also a feedback effect in many cases. In other words, in times in which stock markets cause bond markets, bond markets cause stock markets and vice versa. Moreover, in times of stock-bond or bond-stock market causality there is often an additional effect of the US stock or bond market on the foreign country's bond or stock market.

Cross-country integration

Table 2 summarizes the results and attributes of the studies which have examined integration at cross-country level. We have reviewed papers which include the both stock and bond market integration and also papers which includes only stock or bond market integration. The Studies in Table 2 are presented in a chronological order. Each paper is discussed separately and important findings and implications are pointed out.

Table 2. Reviews of cross-country integration studies. Symbol * (**) after markets indicates that paper includes only stock (bond) market integration testing.

Author(s)	Market(s)	Period	Methodology	Results
Cashin & al. (1995)	7 developed countries and 6 emerging countries*	1989-1995	Johansen cointegration test	Integrations have strengthened
Ahlgren & Antell (2002)	6 developed countries*	1980-1990	Johansen cointegration test	Markets are not integrated
Chen & al. (2002)	6 Latin American countries*	1995-2000	Johansen cointegration test	Markets are integrated
Baele (2003)	13 European countries and the USA*	1980-2001	Regime switching model	Integrations have altered
Hartman & al (2004)	G-5 countries	1987-1999	Non-parametric asymptotic tail dependence measure	Stock markets are more integrated than bond markets
Moschitz (2004)	The USA and emerging market index	1994-2003	Regime switching model	Markets are not integrated
Hunter & Simon (2005)	The US, the UK, Germany and Japan**	1992-2002	Bivariate GARCH	Markets are weakly integrated
Kim & al. (2005)	European Union countries	1998-2003	Dynamic cointegration	Markets are integrated
Giot & Petitjean (2005)	6 developed countries	1973-2004	Regime switching model	Some of the markets are integrated
Morana & Beltratti (2006)	The USA, the UK, Japan and Germany*	1973-2004	Principal component analysis	Markets are integrated
Vo (2006)	The USA, Australia and 12 Asian countries**	1990-2005	Johansen cointegration and Granger causality tests	The USA and Australia are not integrated with Asia
Andersen & al. (2006)	The USA, the UK and Germany	1998-2002	GARCH	Markets are integrated
Christensen (2007)	The USA and 9 European countries	1988-2003	GARCH	Markets are integrated
Glezakos & al. (2007)	Greece and 10 developed countries*	2000-2006	Johansen cointegration and Granger causality test	Greece is integrated with the USA and Germany

Cashin & al. (1995) investigated the level of integration at the long run at the short-run level of seven industrial (the US, Japan, the UK, France, Spain, Australia and Germany) and six emerging country equity markets

(Brazil, Mexico, Korea, Malaysia, Thailand and Jordan), and changes in this integration during 1989-1995 with the Johansen cointegration test. Paper's findings suggest that both intra-regional and inter-regional integration have strengthened during their sample period. They found that the long-run integration of emerging equity markets increased in the early 1990s and the long-run integration of industrial countries have been high all the time during their sample period. The short-term findings were that cross-country contagion effects of country specific shocks dissipate in matter of weeks while contagion effects of global shocks take several months to unwind themselves. This means that diversification benefits exist, but investors have to monitor more closely developments in emerging markets.

Ahlgren & Antell (2002) examined the evidence for cointegration between the stock markets of Finland, France, Germany, Sweden, the UK and the USA from during 1980-1997. In their study they applied the Johansen cointegration test and the both monthly and quarterly data were used. In monthly data one cointegrating vector was found using the trace test statistic and no cointegrating vectors using the max test statistic. Most of the evidence for cointegration is due to the use of asymptotic rather than small-sample critical values. Their study's results indicate that international stock prices are not cointegrated.

Chen & al. (2002) investigated the dynamic interdependence between stock markets of Argentina, Brazil, Chile, Colombia, Mexico and Venezuela during 1995-2000. They used the Johansen cointegration test and found one cointegrating vector which appears to explain the dependencies in prices. Their results suggest that the potential for diversifying risk by investing in different Latin American markets is limited.

Baele (2003) investigated whether the efforts for more economic, monetary, and financial integration in Europe have fundamentally altered the intensity of shock spillovers from the US to 13 European stock markets during 1980-2001 with regime switching model. Their results were surprising because the increase in EU shock spillover intensity is mainly situated in the second part of the 1980s and the first part of the 1990s, and not during the period directly before and after the introduction of the single currency. In fact, in many countries, the sensitivity to EU shocks dropped considerably after 1999. Over the full sample, EU shocks explain about 15 percent of local variance, compared to 20 percent for US shocks. The importance of the regional European market is anyhow rising considerably.

Hartmann & al. (2004) investigated asset return linkages during periods of stress with non-parametric asymptotic tail dependence measure. Their estimates for the G-5 countries during 1987-1999 suggest that simultaneous crashes between stock markets are much more likely than between bond markets. However, for the assessment of financial system stability the widely disregarded cross-asset perspective is particularly important. For example, their data showed that stock-bond contagion is about as frequent as flight-to-quality from stocks into bonds. Extreme cross-border linkages are surprisingly similar to national linkages, illustrating a potential downside to international financial integration.

Moschitz (2004) studied correlations of US stocks, emerging market bonds and US low-grade corporate bonds during 1994-2003 with regime switching model. Results were far from being perfectly correlated. Study states that investing in different assets provides diversification benefits. The size of potential diversification benefits is determined by the correlations among asset returns. Unconditional correlation coefficients are not very high. However, correlations may increase dramatically in times of financial distress. It is exactly during crisis periods when diversification is most valuable. If correlations increase precisely in these moments, diversification benefits are limited. It has been found that, in general, correlations are low (high) when volatilities are high (low). In times of financial crisis diversification benefits do not decrease, rather increase. All, univariate and bivariate regime switching models, as well as multivariate time-varying correlations models confirm these conclusions. Looking carefully at the daily behaviour of volatilities and correlations during financial periods shows that markets do not move together very closely. Idiosyncratic shocks seem to be the main driving forces in each market. One exception is the run-up to the Asian crisis with relatively high correlations across all markets. However, most of these correlations turned negative immediately after the crisis occurred.

Hunter & Simon (2005) used a bivariate GARCH framework in their study to examine the lead-lag relations and the conditional correlations between 10-year US government bond returns and their counterparts from the UK, Germany, and Japan during 1992-2002. They found that while mean and volatility spillovers exist between the major international bond markets, they are much weaker than those between equity markets. The results also indicate that the correlations between the US and other major bond market returns are time varying and are driven by changing macroeconomic and market conditions. However, in contrast to the finding that the benefits of international diversification in equity markets evaporate during high-stress periods, they found that the benefits of diversification across major government bond markets do not decrease during periods of extremely high bond market volatility or following extremely negative US and foreign bond returns.

Kim & al. (2005) examined in their paper the integration of European government bond markets during 1998-2003 using daily returns to assess the time-varying level of financial integration with dynamic cointegration model. They found evidence of strong contemporaneous and dynamic linkages between the Euro zone bonds. However, there is much weaker evidence outside of the Euro zone for the three new EU markets of the Czech Republic, Hungary and Poland, and the UK. In general, the degree of integration for these markets is weak and stable, with little evidence of further deepening despite the increased political integration associated with further enlargement of the EU.

Giot & Petitjean (2005) made a cointegration analysis with regime switching model for stock and bond markets of France, Germany, Japan, Netherlands, the UK and the US during 1973-2004. They found a valid and meaningful long-term cointegrating relationship between stock index prices, earnings (or dividends) and bond yields for the US, the UK, the Netherlands and Germany. The coefficients on the long-run relationship always showed the expected signs when they are significantly different from zero. Overall, the results suggest that the bond-equity yield ratio does contain more information than the simple equity yield on a monthly basis.

Morana & Beltratti (2006) investigated in their paper stock market returns using principal component analysis (PCA) for the US, the UK, Germany and Japan during 1973-2004 with monthly data to assess the linkages holding across moments and markets. In the light of the theoretical framework proposed in the paper, the results point to a progressive integration of the four stock markets, leading to increasing co-movements in prices, returns, volatility and correlation. Evidence of a positive and non spurious linkage between volatility and correlation, and a trend increase in correlation coefficients over time, is also found. All the above mentioned linkages seem to be particularly strong for the US, the UK and Germany.

Vo (2006) investigated international financial integration by examining the interdependence of government bond yields in 12 Asian government bond markets during 1990-2005 with the Johansen cointegration and Granger causality tests. Their analysis did not indicate a very high degree of international integration between Australian and US bond yields with selected Asian bond markets. Their results give a strong implication for international investors and fund managers in relation to international diversification. The low level of correlations and cointegrations indicate that considerable diversification benefits can be obtained by Australian or US investors contemplating investing in these Asian markets.

Andersen & al. (2006) investigated integration in the US, German and British stock, bond and foreign exchange markets during 1998-2002 with GARCH models. Their generalized estimation approach used high-frequency data and documented highly significant contemporaneous cross-market and cross-country linkages, even after controlling for macroeconomic announcement effects. These findings generally point toward important direct spillover effects among foreign and the US equity markets, revealed by use of synchronous high-frequency futures data that made possible to observe the interaction of actively traded financial assets around announcement times.

Christensen (2007) investigated the integration of bond and stock markets in the US and 9 European countries during 1988-2003 with GARCH model. They found significant volatility spillover into the individual bond and equity markets from the global and regional bond and equity markets. Results indicated that bond (stock) market volatility is mainly influenced by bond (stock) market effects. Local, regional, and global effects have all been found to be of importance for European bond and stock volatility. They accounted for the structural break caused by the introduction of the Euro. European financial markets have become much more integrated after the introduction of the Euro, this is particularly the case for the European bond markets, and even more so for the EMU countries' bond markets.

Glezakos & al. (2007) investigated the short and long-run relationships between major world financial markets during 2000-2006 with particular attention to the Greek stock exchange. Their research methodology employed VAR model Johansen cointegration test. Their results confirm the dominance of the US financial market on all other markets of the sample. The influence of Germany is especially noticeable on the Athens stock exchange.

Along with the studies shown in Table 2 and discussed in the previous, there are few studies worth mentioning before this theoretical section is concluded.

DeFusco & al. (1996) studied long-run integration relationships between the US and 13 emerging capital markets in three geographical regions of the world. None of the three regions examined possesses cointegrated markets. The lack of cointegration indicates that the correlation between returns from each market is independent of the investment horizon. Return correlations using weekly data correspond to the long-run investment horizon correlation. Correlations among the returns from these countries are low on average and occasionally negative. The apparent independence of markets within these three emerging regions suggests that diversification across these countries is effective.

Soenen & Johnson (2002) investigated Asian equity markets. They studied how twelve equity markets in Asia are integrated with Japan's equity market. They found that the equity markets of Australia, China, Hong Kong, Malaysia, New Zealand and Singapore are highly integrated with the stock market in Japan. There is also evidence for these Asian markets to become more integrated over time, especially since 1994.

Phengphis & Apilado (2004) made a comparative analysis of cointegration between stock market price indices of the major EMU and the non-EMU countries. They used conventional Johansen methodology with several diagnostic techniques to ensure the robustness of test results. Their major findings to investors and policymakers are that economic interdependence appears to be the important contributing factor and that the US stock market does not exert influences on long-run performances of other included stock markets. Furthermore, while the UK is not an EMU member, it may be viewed as a quasi EMU participant due to its stock market being cointegrated with and yet one of the common stochastic trends (besides those of Germany, Italy, and the Netherlands) within the EMU stock markets under investigation.

Hunter (2005) investigated the level of integration of the stock markets of Argentina, Chile and Mexico into the world capital market in the post-liberalization period. They found that these markets experience time-varying integration and are, on average, still not highly internationally integrated. Furthermore, there is no distinct trend toward higher levels of integration. In fact, the markets of Argentina and Mexico have become increasingly segmented over the post-liberalization period. Results indicate that financial and economic openness, stock market liquidity and volatility, and the state of the currency market significantly affect the level of segmentation.

Chi & al. (2006) examined the degree of financial integration that exists in East Asian equity markets using the International Capital Asset Pricing Model methodology. They employed three market portfolios to test for integration: the weighted average equity index of all sample countries, the Japanese market index and the US market index. Their study shows that the level of financial efficiency and the integration of sample countries is high and has improved significantly during 1991-2005, and these East Asian countries are more financially integrated within the region and with the Asian leading market (Japan) than with the world leading market (the USA).

3 RUSSIAN FINANCIAL MARKETS

3.1 Structure of the Russian financial markets

The key factor of the Russian equity market is an over-concentrated ownership. According to the study of Mirkin & Lebedeva (2006) the evidence of capital concentration is high premium for vote (difference between prices of ordinary and preferred shares), reaching 45-50% and that the majority of companies have 2-4 stakeholders who control 70-80% of the equity capital and are not interested in its dilution. The government as a shareholder is also dominating in a number of industries. Therefore the company model based on capitalization growth appears to be attractive in Russia only when the major owners of the company aspire to raise foreign funds or expect to sell stakes to transfer a part of control with 10-15% of its shares to return the initial investments (Mirkin & Lebedeva, 2006).

According to Anatoliev (2005) there is a universal perception in the Russian financial market that market prices of traded equities do not reflect their underlying fundamental values. Even blue chip stocks rarely pay dividends, and when they do, they constitute a tiny fraction of the market price. This kind of lack of transparency indicates problems in Russia's politics, and risks that are included in the prices (Korhonen, 2004). Also the book values of companies, inherited from Soviet era bookkeeping, underestimate the fundamental value of companies (Anatoliev, 2005). Hence, we see that the price fluctuations may reflect more the dynamics of overall economic and political factors than changes in fundamental values of the company. However, recent boom in oil prices and Russia's strong progress in development of its economy and has dramatically raised equity prises.

Russian debt markets have become very interesting for the investors. This is by the fact that in the equity markets, the largest domestic issuers which have listings inside Russia and in the West are characterized by very low free float and makes companies very depended on debt financing. Only 5-6% of listed companies' equities are traded on the largest Russian stock exchange, namely the Moscow Interbank Currency Stock Exchange (MICEX) (Mirkin & Lebedeva, 2006).

According to the study of Mirkin & Lebedeva (2006) the Russian corporate bond market has proved itself as highly profitable and without any meaningful defaults. Foreign investors taking the opportunity presented by unrestricted entry into the market and subsequent easy repatriation of revenues receive all advantages of trading inside the world of Russian high-yielding corporate bonds, offering the capability to create multi-instrumental, liquid and diversified bond portfolios. Financial engineering offers very different classes of Russian bonds establishing many ways and opportunities to take into account special interests and tastes of investors (Mirkin & Lebedeva, 2007). The Russian stock and bond markets have been quite easily accessed for the both local and international investors. The stock markets in Russia surely have offered high incomes but also high volatility.

There are a number of stock exchanges in Russia. In terms of value, most of the trading takes place through leading trade floor MICEX or through Russian Trading System (RTS). In RTS trading is concentrated mostly on stocks and trading is denominated in US dollars. RTS is dominated by international investors; while Russian traders are concentrated in MICEX which also offers liquid bond, currency and derivatives trading floors (Grigoriev & Valitova 2002).[2]

[2] One should know that the true nature of ownerships is impossible to know because complex offshore ownership structures are very popular. Therefore foreign investments from Cyprus, Bahamas and Luxemburg are often actually made with Russian origin capital.

As it can been seen in Table 3, MICEX is the highly dominating by turnover.

Table 3. The turnover of the Russian stock floors in 2004-2007, bln USD.

	2004	2005	2006	Jan-Aug 2007
MICEX	151.2	225.6	754.9	1018.2
RTS	26.1	38	61.2	11.4

(Source: MICEX (2007))

There are also a number of regional stock exchanges; but their share is negligible compared to MICEX and RTS (Lucey & Voronkova, 2005). The Federal Commission on the Securities Market (FCSM) and Central Bank of Russia regulates all trading floors in Russia (Jithendranathan & Kravchenko, 2002).

MICEX

MICEX is the leading Russian trading facility for currencies, stocks, bonds and derivatives. MICEX started as currency exchange in 1992 and followed later with government bond trading in 1993, stock trading in 1997, government and municipal bond trading in 1999. At the moment corporate and municipal bond markets are the fastest growing bond markets in Russia. Banks and institutions in Russia are using mostly only MICEX in their transactions and MICEX organizes the primary placement and the secondary circulation of federal bonds (OBRs).

Blue chip issuers of stocks include Gazprom, RAO UES, LUKoil, Rostelekom, Sberbank and Mosenergo. Stock market capitalization has grown from 80 bln USD to 890 bln USD during 2002-2006. In August 2007 capitalization was already 970 bln USD. The most capitalized companies are Gazprom, 244.4 bln USD, Sberbank 84.0 bln USD and Rosneft 78.6 bln USD (MICEX, 2007).

The market value of federal bonds has grown from 6 bln USD to 29.9 bln USD during 2002-2006. In august 2007 their value was already 39.9 bln USD. The market value of corporate bonds has grown from 1 bln USD to 16 bln USD during 2002-2006. In august 2007 their value was already 26 bln USD. The biggest issuers in terms of the nominal values of bond issues are VTB 1.36 bln USD, RZhD 1.29 bln USD and Gazprom 1.17 bln USD. The market value of municipal bonds has grown from 0.2 bln USD to 6.5 bln USD during 2002-2006. In august 2007 their value was dropped to 5.8 bln USD. The biggest issuers in terms of the nominal values of bond issues are Moscow city 6.59 bln USD, Moscow region 1.82 bln USD and Samara region 0.45 bln USD (MICEX, 2007).

In Table 4 is presented the numbers of bond and equity issuers in the MICEX Stock Exchange. As it can be seen, the amount of issuers has rapidly increased during the last two years time.

Table 4. Issuers in the MICEX Stock Exchange.

	January 1. 2005	January 1. 2006	January 1. 2007	August 31. 2007
Total number of issuers	241	358	530	637
Issuers of equities	81	161	193	197
Issuers of bonds	179	245	364	482

(Source: MICEX (2007))

RTS

RTS was established in the middle of 1995. It is the first electronic trading facility in Russia and uses trading technologies provided by NASDAQ. This classic (quote driven) market remains the main venue for trading by foreign and domestic investors. An order-driven stock market, established in 2002 in cooperation with St. Petersburg Stock Exchange, aims to develop the rouble stock market segment of RTS. Companies from the energy, oil and telecommunication industries account for more than 60% of RTS capitalisation. RTS has also developed bond, OTC and derivative arms (FORTS) (Lucey & Voronkova, 2005).

RTS is the leader in the number of different securities traded in Russia with more than 1800 different securities is traded. FORTS is the leading derivatives market in Russia and on of the top-20 derivatives market of the world. Daily average trading volume on FORTS reaches 1 billion USD. Taking into account reported OTC trades; the overall volume of RTS markets reaches 2.5 billion USD a day (Euromoney, 2008).

3.2 Main events in the Russian financial markets

Although we are investigating only the years after the crisis, we will now go briefly through the main events from the crisis times to this day. This will give to the reader more perspective how Russia has changed dramatically during the last 10 years and which determinants have caused extreme volatility in the markets.

The crisis of 1997-1998 in the Russian financial markets is usually divided into three periods: October 1997-January 1998, March-May 1998 and July-August 1998. During the period to October 1997, the RTS Index displayed an impressive 94% growth. However, positive tendencies in the stock market were taking place against the background of poor fundamentals in the Russian economy. Budget crisis, banking system vulnerability and high value of short-term government liabilities relative to the central bank reserves, aggravated by instability of the international financial markets, in particular, by events in South Asian markets in 1997. Under these circumstances, foreign investors who had commenced close monitoring of economic fundamentals began to sell government and corporate bonds. Increased demand for foreign currency triggered a sharp decline in Central Bank's reserves. These events were reflected in the falling stock market: by January 1998, RTS Index had plummeted by 50%. In March-May 1998 there followed a further 20% decline in stock market prices. The government crisis, a worsening balance of payments deficit, and issuance of new debt induced foreign investors to continue selling Russian securities (Lucey & Voronkova, 2005).

Despite financial aid provided by IMF and IBRD in July, a further decline in prices of Russian securities took place. The crisis of the Russian banking system provided an additional reason. Russian banks, facing increased claims from foreign lenders, were induced to sell securities to maintain their currency reserves. As a result, a new wave of price declines took place. On 17 August 1998, the Russian Central Bank allowed the rouble to depreciate. On August 17, 1988 Russian abandoned the defence of the Russian rouble and placed a 90-day moratorium on commercial external debt payments. The value of the Russian rouble plunged from USD/RUR 6.235 at the end of July 1998 to USD/RUR 16.064 by the end of September 1998. The direct cause of the crisis was the failure of Russian government in addressing the fiscal imbalance of the economy and falling oil prices, which was the main source of foreign exchange for Russia (Cooper, 1999). During August-September 1998, the RTS Index fell by almost 70% (Lucey & Voronkova, 2005).

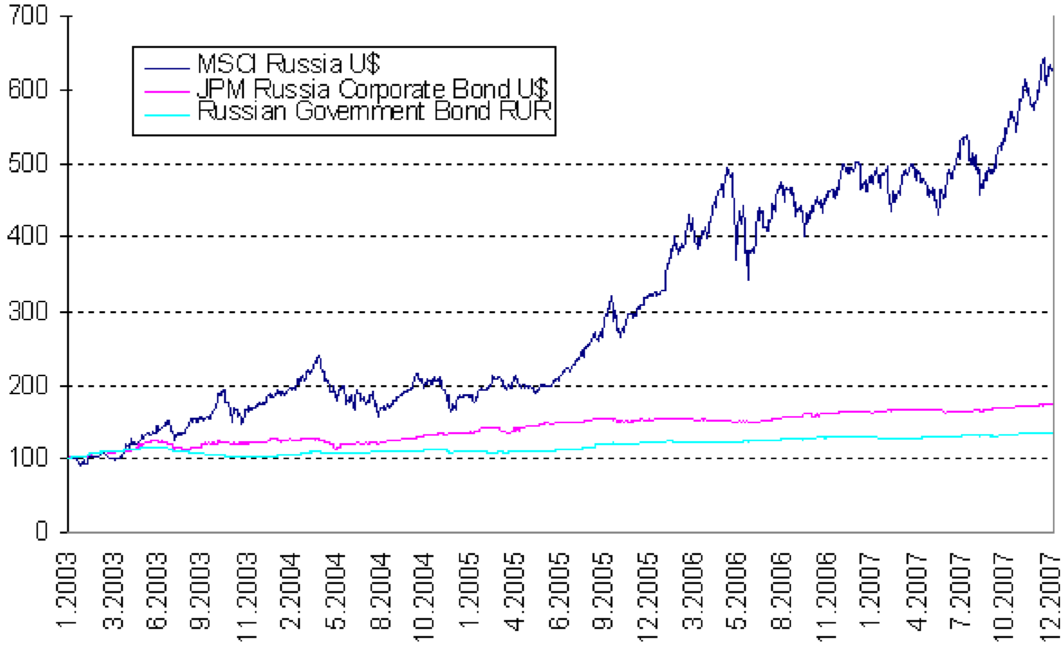
By 1999 international interest in the Russian stock market was at low level which reflected in record-low levels of trading activity. Trading volumes had fallen by 84% since 1997. Low turnover created pre-conditions for speculative growth of the market that amounted to 194% and made RTS the fastest growing market in the world. In the next year, despite the fastest growth of the Russian economy since the start of reforms, the performance of the stock market was disappointing: RTS declined by 20%. This reflected primarily a decline in prices of Russian blue chips, mostly oil companies depending heavily on the dynamics of the oil prices (Lucey & Voronkova, 2005).

However, the improving macroeconomic and political situation helped to revive the interest of investors and boost turnover, which more than doubled in 2000. President Yeltsin resigned and Vladimir Putin was elected in 2000. During 2001-2003 the Russian market grew, in contrast to the slowdown in the US and EU economies and financial and political instability in Latin American emerging markets. When Putin and Bush had a summit in Texas in the end of 2001 and in 2002 RTS grew by a third (Goriaev & Zabotkin, 2006). In October 2003, Moody's raised Russian sovereign rating to investment grade (FINAM, 2007; MICEX, 2007).

In 2003 the political risks of investing in the Russian market became important again, against the background of the conflict between Yukos and the government, which led to imprisonment of the head of the company, Khodorkovsky and Lebedev. The market reacted with a 25% decline during October 2003. However, the overall results for the year were positive due to a remarkable increase in prices of selected blue chips (Lucey & Voronkova, 2005). President Putin was re-elected in 2004 but the Yukos saga along with similar cases of disproportionate back-dated tax charges against other companies (e.g., Vimpelcom and Sibneft) triggered several double-digit corrections in the market. The most serious of them in April-July 2004 dragged the RTS down by 33%. However, even after the last correction in December 2004, the RTS index was still 6% above its level when the whole affair began (Goriaev & Zabotkin, 2006). After these Yukos related events in January 2005 S&P raised Russian sovereign rating to investment grade. In January 2005 liberalization of Gazprom equities were done in January-June 2006 indices grew 40%, but afterwards there were capital outflow from the emerging markets and index dropped almost 30%. In august 2006, IPO of Rosneft was successful and index rose again 200 points. In March 2007 index were at the level of 2000 points when the biggest fall of Chinese stock market in 10 years dropped index for a while but it quickly reached the level at it was before (FINAM, 2007; MICEX, 2007).

This is the short history of the Russian financial market during the last ten years. However, we are mostly interested in the timeline during our empirical study. The favourable growth of the stock and bond markets during the timeline of our empirical study is presented in Figure 1 where are the performances of presumably the most comprehensive composite financial market indices considering the Russian markets. In Figure 1 is presented the MSCI Russia stock market index, the JPM Russia Corporate Bond index and the Russian Government Bond index during 2003-2007.

Figure 1. MSCI Russia U$, JPM Corporate Bond Russia U$ and Russian Government Bond RUR indices from January 2003 to December 2007. The indices have been scaled to start from 100.



We can see that all indices have raised from the year 2003 levels and the MSCI Russia index has been the fastest growing and even booming since the 2005. This shows how great earnings in the stock markets have available. The JPM Russia Corporate Bond index shows that the corporate bond markets have been in the upward position but the growth has been really modest. Russian Government Bond index have been also in the upswing but even less than the JPM Russia Corporate Bond index.

3.3 Earlier literature on the Russian financial markets

Studies about co-movements of the Russian financial markets are not plentiful and they usually analyse Russia along with other Central and Eastern European (CEE) markets. The conclusions of these studies do not necessarily conform to each other, due to differences in sample period, data frequency, stock market indices, and adjustment procedures applied to the indices used. Besides of study of Hayo & Kutan (2004) all literature is concentrated only on the stock markets, which limits our review also.

One of the first studies is study of Linne (1998). Their study sought to investigate whether newly established Eastern European markets (Russia, Poland, Hungary, the Czech Republic and Slovak Republic) display any long-term relationships within the group or with mature markets (Germany, UK, France, Italy, Switzerland, the US and Japan). Examining local stock market indices expressed in US dollars, at weekly frequency, over the period from 1991 to 1997, the results suggest that Russian stock market indices displayed no linkages with any of the analysed markets.

Jochum & al. (1998) pointed out the importance of political and economic events in Russia for other Eastern European economies (Hungary, Poland and the Czech Republic). Using principle component analysis and Hansen-Johansen (1993) tests of cointegration vector constancy, they find considerable differences between short-term and long-term linkages between the markets. They find a significant increase in the values of daily correlations during crisis periods between market returns and the absence of cointegration vectors for all of the markets.

Study of Pesonen (1999) examined how the Russian stock markets were affected by Thailand, Indonesia, South Korea, Malaysia, Philippines, Hong Kong, Japan, the UK and the USA during 1997-1998. Their results suggest that Asian crisis didn’t affect much for stock prises in Russia. On the other hand, Russian stock prises were found to follow in particular, the US and Japanese stock prices.

Fedorov & Sarkissian (2000) examined the issue of integration at the industry level, finding unsurprisingly that integration with the world market proxy is the greater, the larger and more internationally orientated (via trade) is the typical industry firm.

Gelos & Sahay (2000) explored financial spillovers, due to external crises, to CEE foreign exchange and stock markets. They found increasing financial market integration since 1993, measured by the change in (unadjusted) stock return correlations. The increase is especially significant around the Russian crisis, as was found by Jochum & al. (1998). Also Gelos & Sahay (2000) found strong evidence of shock transmission from Russian to Central European markets, and document evidence that negative shocks in Russia have stronger effects on other emerging markets than positive ones. A similar study by Baele & Goldfain (2000) notes that EU equity shocks have had increased influence on CEE since 1998, but that the Russian market remains isolated from EU influences.

Rockinger & Urga (2001) investigated integration of the four CEE countries and Russia over the period from 1994 to 1997 using an extended Bekaert & Harvey (1997) model for conditional volatility with time varying parameters. The study uses daily data for the most important local stock market indices expressed in US dollars. The results suggest that the Russian stock market differs from the other three markets with regard to sources of shock spillovers. Before the year 1995 would have allowed German or US investors to hedge against local risks. The negative correlation between Russia and the United States and Germany has decreased after that. This means that they became more important sources of shock spillovers for Russia. For the other countries while UK have always played an important role. Germany played important role until spring 1995 but not after that. The US markets instead have played very small role all the time.

Jithendranathan & Kravchenko (2002) analysed the effect of the 1998 financial crisis on the monthly returns of the Russian equity markets. They found that the crisis had statistically positive effect on the overall Russian equity returns. The crisis had altered the investor confidence in the Russian equity markets in such a way that the equity premiums have gone up after the crisis. On the other hand their results indicate that the integration between the Russian equity market and the world equity market has increased during the post-crisis period. One of the main characteristics of the Russian equity market was the low trading volume. Only a handful of stocks were traded daily, which made the market less informational efficient. Due to this the effect of the 1998 crisis is hard to measure at the individual firm level.

Hayo & Kutan (2004) analysed the impact of US stock returns on the Russian stock and bond markets (along with other factors such as oil prices and political news), within a GARCH framework. For the 1995-2001 period, they echo the results of Rockinger & Urga (2001), suggesting US stock returns tend to Granger-cause Russian stock returns. This expected growing importance of global integration is also likely to diminish opportunities for US investors to reduce portfolio risk through diversification. Therefore, other transition economies, such as those in the central and eastern Europe, may provide a better alternative for diversification. However, European financial markets are also correlated with US markets and the growing international interdependency makes it more and more difficult to successfully diversify risk.

Anatoliev (2005) studied global integration of Russian stock markets and they did not find any clear positive trend in the degree of integration of the Russian stock market with other stock markets, both regional and sectoral. However, spillovers from other stock markets into the Russian markets have increased in recent years, while spillovers in the opposite direction have diminished. There is evidence that the integration with developed European markets is higher than that with the US and Asian markets. The co-movements of Russian and world sectoral stock markets exhibit a varying pattern. They are high much of the time, but not necessarily greater for energy markets, despite the domination of the Russian market by oil and gas extraction companies.

Lucey & Voronkova (2005) examined the relationship between Russian, developed markets, and other Central and Eastern European equity markets over the 1995-2004 period. During this period the Russian crisis of 1997-1998 had major impacts on equity markets worldwide. Using traditional Johansen multivariate cointegration approaches, they found no equilibrium relationships when the overall sample is considered. However, having applied the test to the sub-periods preceding and following the Russian crisis of August 1998 and using the recursive version of the test as well, they found evidence that the effect of the Russian crisis is more complex. Further examination, using alternative techniques that account for variability and excess volatility in financial data, indicated that the Russian market shows significantly more evidence of integration with developed markets, albeit the extent of interdependencies differs for the US and European markets. The USA remains the dominant market from which shocks impact the Russian market. All novel methods showed an increase in the number of cointegrating relationships after the crisis period. In particular, the Gregory-Hansen test indicated that the change occurred around the Russian crisis and not in an earlier period associated with the Asian financial turmoil.

Hsiao & al. (2006) examined how Russian financial affected to the long-run relationship and short-run dynamic linkages among the US, Germany and the four Eastern European stock markets. They investigated long-run relationships with the Johansen cointegration test and short-run dynamics with VAR. In general, the empirical results reveal that both the long-run cointegration relationships and the short-run dynamic linkages among these markets and the US were strengthened after the crisis.

Saleem & Vaihekoski (2008) studied international asset pricing models and pricing of global and local sources of risk in the Russian stock market using weekly data from 1999 to 2006. They extended the multivariate GARCH-M framework of De Santis & Gérard (1998), by allowing conditional local influence as well. Saleem & Vaihekoski (2008) found global risk to be time-varying. They also found that currency risk is priced and highly time varying in the Russian market. Moreover, their results suggest that the Russian market is partially segmented and local risk is also priced in the market.

Results of these studies tell us that the possibilities for efficient diversification between Russia and the USA have been have changed since the crises. Results indicate that diversification benefits were better before the crisis in the Russian markets. Diversification benefits between Russia and Europe have also lowered relatively. According to these results this seems to be the situation at least in the stock markets. However, the results do not say that the markets integrated highly but co-movements have increased in the recent years. However, there is relevant reason to expect that the level of integration is not constant because for example results in the study of Hsiao & al. (2006) clearly suggest that the degree and nature of stock market integration tends to change over time.

An interesting question is that how markets become globally integrated? According to the study of Jithendranathan & Kravchenko (2002) integration of global financial markets is a gradual process that begins when foreign investors are allowed to invest in a countries domestic market and the domestic investors are allowed to invest in foreign markets. The other necessary conditions for full integration of equity markets are the elimination of barriers to cross boarder investments. The following are some of the barriers for equity markets for being non-integrated, i.e., segmented:

1. Restrictions on convertibility of the country's currency.
2. Restrictions on foreign ownership of domestic assets.
3. Restrictions on domestic investors investing in foreign assets.
4. Taxation and other legal barriers.

In the case of Russia, even from the earlier days of evolution of equity markets, foreign investors were a dominant presence. For this reason it can be assumed that Russian equity markets should be more integrated with the world markets, compared to other emerging markets at that level of development.

Further liberalization and deepening of Russian markets will likely result in increased financial market co-movements between Russian and global markets, indicating more spillover effects in the future. Russian policymakers may need to consider designing appropriate regulatory measures to maintain the stability of the domestic market in order to reduce the level of risk in financial markets (Hayo & Kutan, 2004).

4 DATA

4.1 Time series

We will investigate the intra-country and cross-country integration of the Russian financial markets as follows. The intra-country integration investigation is done by using the MSCI Russia index, the JP Morgan Russia Corporate Bond Index (JPM Russia CBI) and the Russian Government Bond index (by Capitallogica). The cross-country integration investigation is done by using the MSCI indices and JPM Corporate Bond indices of Russia, the USA, the UK, Germany, Czech Republic, Poland, China and Japan.

We have chosen these countries because of the following reasons. The USA by general concession is the strongest financial market worldwide. The UK and Germany are the strongest European markets. Czech Republic and Poland are interesting emerging European markets which may be linked with Russia. China is often an alternative for the Russian markets and one of the most interesting emerging markets worldwide. Japan is one of the strongest financial market worldwide and the leader in the Asia region. According to these reasons they can be considered to be relevant countries to the Russian markets. As an addition by using these countries our results are more comparable with earlier integration studies.

Our data run from January 1, 2003 to December 28, 2007 giving a total of 1304 daily observations for each time series. The data is retrieved from the Thompson’s DataStream and all stock and bond indices are at daily frequency measured US dollar denominated total return indices except the Russian government bond index which is Russian rouble denominated. Returns for the indices are calculated as continuously compounded returns, using log difference of prices.

Roll (1992) raises a number of important issues relevant to studies of inter-market linkages which indices. He suggests that the index behaviour is affected by two factors: the technical procedure of the index construction and composition, and the role of exchange rates. When the returns of indices are expressed in a nation's own (local) currency, part of the index's return volatility is induced by monetary phenomena such as changes in anticipated and actual inflation rates. However, according to Hamao & al. (1990) and Chen & al. (2002), their results remain essentially unchanged after conversion to a common currency.

4.2 Descriptive statistics

Tables 5 and 6 present descriptive statistics for daily stock and bond market returns respectively. The returns are computed as logarithmic differences. Since the returns are denominated in US dollars, they consist of two components; the change of the index in domestic currency and the change in the dollar exchange rate.

The biggest mean returns considering stock markets are reported for Czech Republic 43.28% and the lowest for the USA and the UK 11.78%. The biggest mean returns considering bond markets are reported to Poland 13.60% and the lowest for Japan 1.98%. The highest standard deviations considering stock markets are reported for Russia 29.97% and the lowest for the USA 12.95%. The biggest standard deviations considering bond markets are reported for Czech Republic 12.20% and the lowest for the USA 4.42%. Skewness values for all indices are between -2.65 and 0.32. All of the indices have negative values for skewness, expect the Japan bond index, which is somewhat surprising. Negative values indicate that the return distributions are skewed to the left and not to the right as usually is the case.

Table 5. Descriptive statistics for stock indices. In table are shown descriptive statistics of stock indices with logarithmic returns. Mean and standard deviation are annualized. Jarque-Bera is a test of normality and H_0 is normal distribution. The compared Chi-Square value is 5.991 with two degrees of freedom. ** indicates significance at 1% level and * at 5% level. For the all time series N = 1304.

Time series	Mean	Min.	Max.	Std. Dev.	Skew-ness	Kurto-sis	Jarque-Bera
USA	11.78%	-3.60%	3.48%	12.95%	-0.12	4.86	>100.00**
UK	11.78%	-4.62%	5.26%	15.08%	-0.25	5.20	>100.00**
Germany	26.35%	-5.00%	5.79%	18.72%	-0.17	4.93	>100.00**
Czech	43.28%	-6.44%	8.76%	21.92%	-0.28	5.74	>100.00**
Poland	30.40%	-6.41%	5.76%	24.88%	-0.13	3.88	45.77**
Russia	35.25%	-10.49%	10.81%	29.97%	-0.60	7.54	>100.00**
China	37.20%	-6.59%	8.06%	24.18%	-0.18	5.68	>100.00**
Japan	13.50%	-6.61%	4.37%	19.31%	-0.25	4.71	>100.00**

The values for kurtosis are relatively high for all indices, notably for the Russian government bond index 68.60 and Czech Republic bond index 29.30. High values can be explained to some extend with bullish markets during our sample period. High excess kurtosis is also quite common for financial data like ours.

Table 6. Descriptive statistics for bond indices. In table are shown descriptive statistics of bond indices with logarithmic returns. Mean and standard deviation are annualized. Jarque-Bera is a test of normality and H_0 is normal distribution. The compared Chi-Square value is 5.991 with two degrees of freedom. ** indicates significance at 1% level and * at 5% level. For the all time series N = 1304.

Time series	Mean	Min.	Max.	Std. Dev.	Skew-ness	Kurto-sis	Jarque-Bera
USA	4.00%	-1.24%	1.08%	4.42%	-0.16	4.70	>100.00**
UK	8.15%	-2.11%	2.13%	9.81%	-0.09	3.43	>12.14**
Germany	9.78%	-2.36%	2.46%	9.95%	-0.09	3.83	38.87**
Czech	11.88%	-6.95%	6.87%	12.20%	-0.19	29.30	>100.00**
Poland	13.60%	-3.51%	2.71%	12.13%	-0.25	4.11	81.12**
Russia	10.65%	-2.48%	2.59%	6.74%	-0.22	8.26	>100.00**
China	5.93%	-1.34%	1.14%	4.59%	-0.14	4.60	>100.00**
Japan	1.98%	-1.98%	2.79%	9.19%	0.32	4.43	>100.00**
Government	5.93%	-3.81%	3.14%	4.23%	-2.65	68.60	>100.00**

In Appendix is presented the performances of our indices. By looking at these graphs it can easily be seen that the Japan bond index is much different from the others with is up and downs, while the other indices are on a happy rise during our sample period.

Jarque-Bera (J-B) is a test statistic for testing whether the series is normally distributed. The test statistic measures the difference of the skewness and kurtosis of the series with those from the normal distribution. The statistic is computed as:

$$J - B = \frac{N-k}{6}\left(S^2 + \frac{(K-3)^2}{4}\right), \qquad (2)$$

where S is the skewness, K is the kurtosis, and k represents the number of estimated coefficients used to create the series. Under the null hypothesis of a normal distribution, the J-B statistic is distributed as Chi-Square with 2 degrees of freedom (Eviews5 user's guide, 2004).The return distributions are almost all highly non-normal and the J-B test rejects normality at the 1% and 5% levels for all indices. Only the UK bond is even close to the normality.

We have made also a correlation analysis for our time series by employing a one-tailed Pearson correlation test. Table 6 presents a pair wise correlation matrix of our indices.

Table 7. The Pearson correlation coefficients between time series. In table are shown bivariate correlations of stock and bond indices. The test one-tailed and ** represents statistical significance at 1% level and * at 5% level and N = 1304. s and b denotes stock and bond indices respectively.

Index	s USA	s UK s	s GER	s CZH	s POL	s RUS	s CHI	s JPN	b USA	b UK	b GER	b CZH	b POL	b RUS	b CHI	b JPN	b GOV
s USA	1																
s UK	0.427**	1															
s GER	0.534**	0.786**	1														
s ZCH	0.141**	0.425**	0.385**	1													
s POL	0.230**	0.492**	0.455**	0.501**	1												
s RUS	0.178**	0.359**	0.309**	0.410**	0.415**	1											
s CHI	0.089**	0.314**	0.289**	0.287**	0.366**	0.261**	1										
s JPN	0.037	0.235**	0.242**	0.276**	0.233**	0.179**	0.441**	1									
b USA	-0.213**	-0.134**	-0.175*	0.012	-0.091**	-0.062*	-0.045	0.048*	1								
b UK	-0.106**	0.267**	0.123**	0.236**	0.180**	0.013	0.037	0.155**	0.395**	1							
b GER	-0.091**	0.183**	0.170**	0.280**	0.187**	0.021	0.018	0.158**	0.377**	0.825**	1						
b ZCH	-0.029	0.184**	0.184**	0.294**	0.214**	0.051*	0.065**	0.156**	0.147**	0.476**	0.566**	1					
b POL	0.088**	0.363**	0.326**	0.369**	0.536**	0.208**	0.168**	0.185**	0.145**	0.558**	0.647**	0.500**	1				
b RUS	0.106**	0.146**	0.152*	0.201**	0.186**	0.193	0.066**	0.095**	0.435**	0.301**	0.343**	0.192**	0.301**	1			
b CHI	-0.180**	-0.102**	-0.141*	0.026	-0.069**	-0.050*	-0.026	0.052*	0.943**	0.397**	0.377**	0.159**	0.161**	0.466**	1		
b JPN	-0.093**	0.028	0.059*	0.128**	0.075**	-0.021	-0.054*	0.314**	0.232**	0.479**	0.527**	0.324**	0.341**	0.192**	0.218**	1	
b GOV	0.004	0.039	0.015	0.071**	0.072**	0.119*	0.059*	0.056*	0.027	0.066**	0.056*	0.025	0.053*	0.097**	0.028	0.065**	1

Surprisingly, the intra-country correlation coefficients are relatively low. Russian stock/Russian corporate bond correlation is only 0.193, Russian corporate bond/Government bond 0.097 and Russian stock/Government bond 0.119 all at 1% significance level. At the cross-country level the highest correlation coefficients regarding the Russian stock markets and its peers can be found for Russia/UK 0.359, Russia/Germany 0.309, Russia/Czech Republic and 0.410 Russia/Poland 0.415 all at 1% significance level. Quite surprisingly correlation for Russia/USA is only 0.178.The highest correlation coefficients regarding the Russian bond market and its peers can be found for Russia/USA 0.435, Russia/UK 0.301, Russia/Germany 0.343 and Russia/Poland 0.301 and Russia/China 0.466 all at 1% significance level. These kinds of correlations are not giving us expectations of especially high integrations between indices.

5 METHODOLOGY

5.1 Unit root testing

Time series can be stationary or non-stationary. In order to use the Johansen cointegration test it need to be investigated whether or not time series are stationary or not.

A stationary time series can be defined as a one with constant mean, constant variance and constant autocovariances for each given lag. This means that movements of stationary time series are predictable and not following random walk process. If a series includes at least one unit root it is considered to be non-stationary and following random walk process.

Since autocorrelation test is impropriate method to investigate stationary, more sophisticated test are required to be used. In order to investigate time series stationary, we will implement augmented Dickey-Fuller (ADF) test which builds on Dickey-Fuller (DF) test. In order to present ADF we will first present DF test because ADF is more easily explained in this way.[3]

5.1.1 Dickey-Fuller test

Dickey & Fuller (1979) invented unit root testing which still widely used in order to investigate stationary. If a time series contains at least one unit root, time series is from a non-stationary process. A non-stationary series with one unit root is written as $\mathrm{I}(1)$. A stationary series without unit root is written as $\mathrm{I}(0)$. A time series with one unit root need to be integrated once time to make it stationary. A non-stationary time series with d unit roots is written as $\mathrm{I}(d)$ and it need to be integrated d times to make it stationary.

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[3] Phillips & Perron (1988) introdouced a Phillps-Perron test for unit root testing. However, their methodology has not been as popular as ADF in the earlier integration studies.

The assumption of DF test is that variable y_t is from simple AR(1) process. If not, DF test will give spurious results. The basic objective of DF test is to examine the null hypothesis. The null hyphotesis means that series contains an unit root and rejecting the null hypothesis means that series is from stationary process without an unit root. Simply form of DF test can be written as

$$y_t = \phi y_{t-1} + u_t, \qquad (3)$$

where u_t is a random disturbance term which is white noise and the null hyphotesis is not rejected when $\phi = 1$ and the null hyphotesis is rejected when $\phi < 1$ (Brooks, 2002).

In order to ease the computation and interpretation, instead of equation (3), the following equation can be employed

$$\Delta y_t = \psi y_{t-1} + ut. \qquad (4)$$

The test of $\phi = 1$ is equivalent to a test of $\psi = 0$ (since $\phi - 1 = \psi$). Equation (4) is quite often preferred because it makes more complex autoregressive models such as AR(p) processes easier to calculate (Brooks, 2002).

DF tests are also known as τ-tests: $\tau, \tau_\mu, \tau_\tau$. The first one can be written as as our Equation (4). The second and third of these tests, τ_μ, τ_τ, are equivalent to the first, except that the second and third allow for a constant, and a constant and deterministic trend, respectively. The second one includes a constant α to be deterministic factor and it can be written as

$$\Delta y_t = \alpha + \psi y_{t-1} + u_t. \qquad (5)$$

The third one includes a constant α and a deterministic time trend δt and it can be written as

$$\Delta y_t = \alpha + \delta t + \psi y_{t-1} + u_t. \tag{6}$$

When the null hypothesis can not be rejected, i.e., $\psi = 0$, there is a unit root for researched time series. Thus time series is non-stationary and suitable for cointegration test. One should know that the parameter ψ is the subject of interest when used pure random walk model or models with the constant or time trend. This means that neither the values nor significances of the constant or time trend are of interest (Brooks, 2002).

5.1.2 Augmented Dickey-Fuller test

Traditional DF tests are valid only if random disturbance term u_t is white noise. In particular, u_t is assumed not to be autocorrelated, but would be so if there was autocorrelation in the dependent variable of the regression (Δy_t) which has not been modelled. In this case, the test would be oversized, meaning that the true size of the test (the proportion of times a correct null hypothesis is incorrectly rejected) would be higher than the nominal size used (e.g. 5%). The solution is to augment the test using p lags of the dependent variable. The alternative model in case is now written

$$\Delta y_t = \psi y_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta y_{t-1} + u_t. \tag{7}$$

The lags of Δy_t now "soak up" any dynamic structure present in the dependent variable, to ensure that u_t is not autocorrelated. The test is known as an ADF test and is still conducted on ψ, and the same critical values are used (Brooks, 2002).

5.2 Vector autoregressive model

Beside other purposes, VAR models can be used to study dynamic short-run lead-lag relationships between time series. VAR models were popularised in econometrics by Sims (1980). VAR can be seen as a hybrid between univariate models and simultaneous equations models but VAR models have several advantages considering these models. The biggest advantage considering these models is that with simultaneous equations models it can be problematic to define which variables are exogenous or endogenous. This is a very important point because it needs to be defined. In VAR models this is not a problem because in VAR they are all endogenous (Brooks, 2002).

A VAR equation can be written as

$$y_t = \beta_1 y_{t-1} + \beta_2 y_{t-2} + ... + \beta_k y_{t-k} + u_t , \qquad (9)$$

there are y_t endogenous variables which forms ($n \times 1$) matrixes and β_k coefficient estimates which forms ($n \times n$) matrixes and there are k lags of each variable (Brooks, 2002).

However, a VAR equation itself do not give information which of the variables in the model have statistically significant impacts on the future values of each of the variables in the system or, how long it would take for the effect of that variable to work through the system. Such information will be given by an examination of the VAR's impulse responses and variance decompositions.

5.2.1 Impulse responses

Impulse responses trace out the responsiveness of the dependent variables in the VAR to shocks to each of the variable. So, for each variable from each equation separately, a unit shock is applied to the error and the effects upon the VAR system over time are noted. Thus, if there are g variables in a system, a total of g^2 impulse responses could be generated. The way that this is achieved in practise is by expressing the VAR model as a vector moving average (VMA). Provided that the system is stable, the shock should gradually die away (Brooks, 2002).

To illustrate how impulse responses operate, consider the following bivariate VAR(1)

$$y_t = A_1 y_{t-1} + u_t, \tag{10}$$

where $A_1 \begin{bmatrix} 0.5 & 0.3 \\ 0.0 & 0.2 \end{bmatrix}$.

The VAR can also be written out using the elements of the matrices and vectors as

$$\begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} = \begin{bmatrix} 0.5 & 0.3 \\ 0.0 & 0.2 \end{bmatrix} \begin{bmatrix} y_{1t-1} \\ y_{2t-1} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix}. \tag{11}$$

Consider the effect at time $t = 0,1,\ldots,$ of a unit shock to y_{1t} at time $t = 0$

$$y_0 = \begin{bmatrix} u_{10} \\ u_{20} \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}, \tag{12}$$

$$y_1 = A_1 y_0 = \begin{bmatrix} 0.5 & 0.3 \\ 0.0 & 0.2 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 0.5 \\ 0 \end{bmatrix}, \tag{13}$$

$$y_2 = A_1 y_1 = \begin{bmatrix} 0.5 & 0.3 \\ 0.0 & 0.2 \end{bmatrix} \begin{bmatrix} 0.5 \\ 0 \end{bmatrix} = \begin{bmatrix} 0.25 \\ 0 \end{bmatrix} \tag{14}$$

and so on. It would be possible to plot the impulse response functions of y_{1t} and y_{2t} to a unit shock in y_{1t}. Notice that the effect on y_{2t} is always zero, since the variable y_{1t-1} has a zero coefficient attached to it in the equation for y_{2t} (Brooks, 2002).

Now consider the effect of a unit shock to y_{2t} at time $t = 0$

$$y_0 = \begin{bmatrix} u_{10} \\ u_{20} \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}, \tag{15}$$

$$y_1 = A_1 y_0 = \begin{bmatrix} 0.5 & 0.3 \\ 0.0 & 0.2 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 0.3 \\ 0.2 \end{bmatrix}, \tag{16}$$

$$y_2 = A_1 y_1 = \begin{bmatrix} 0.5 & 0.3 \\ 0.0 & 0.2 \end{bmatrix} \begin{bmatrix} 0.3 \\ 0.2 \end{bmatrix} = \begin{bmatrix} 0.21 \\ 0.04 \end{bmatrix} \tag{17}$$

and so on. Although it is probably fairly easy to see what the effects of shocks will be in such a simple VAR, the same principles can be applied in the context of VARs containing more equations or more lags, where it is much more difficult to see by eye what are the interactions between the equations (Brooks, 2002).

5.2.2 Variance decompositions

Variance decompositions offer a slightly different method for examining VAR system dynamics than the impulse responses. Variance decompositions give the proportion of the movement in the dependent variables that are due to their “own” shocks, versus shocks to the other variables. A shock to the variable *X* will of course directly affect that variable, but it will also be transmitted to all of the other variables in the system through the dynamic of the VAR. Variance decompositions determine how much of the step-ahead forecast error variance of a given variable is explained by the innovations to each explanatory variable.

5.3 Johansen cointegration test

The empirical studies employing methodology of cointegration has been increasingly becoming popular in the literature. Cointegration test can be used to study long-run relationships between time series. If asset prices are cointegrated, prices in different markets cannot move “too far” away from each other. In contrast, a lack of cointegration suggests that asset markets have no long-run link and prices in different markets can diverge without bound (Alhgren & Antell, 2002).

The concept of cointegration was first introduced by Granger (1981). Engle & Granger (1987) propose a procedure for testing the cointegration hypothesis. A levels-regression is performed to generate residuals which may be thought of as equilibrium pricing errors. Residuals are then subjected to tests for cointegration. Tests for cointegration proposed by Engle & Granger (1987) rely on a super convergence result and apply an ordinary least squares (OLS) estimation to obtain parameter estimates of the cointegrating vector. This potentially presents a problem for the OLS regression, which is capable of finding at most one cointegrating relationship no matter how many variables there are in the system. Also, one can not be sure if the possibly found cointegration relationship is the strongest among the other possible cointegrating relationships. The Engle-Granger method also has a problem of being a two-step method and thus the mistakes during the first step of the testing process will be inherited to the second step of the process (Chen & al., 2002; Brooks, 2002).

Johansen (1988) and Johansen & Juselius (1990) developed a method which does not have the weaknesses of Engle-Granger method and they derive maximum likelihood estimators of the cointegrating vectors for an autoregressive process with independent Gaussian errors and a likelihood ratio test for the number of cointegrating vectors. Their procedure has the advantage of taking into account the error structure of the underlying process. It can incorporate different short and long-run dynamics of a system of economic variables. It enables us to estimate and test the equilibrium relationship among non-stationary series while abstracting from short-term deviations from equilibrium. Thus, it provides relatively powerful tests when the model is correctly specified (Chen & al., 2002). We will therefore use the Johansen test in our research.

In order to use the Johansen test, the VAR equation needs to be turned into a vector error correction model (VECM) of the form

$$\Delta y_t = \Pi y_{t-k} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta_{y-2} + ... + \Gamma_{k-1} \Delta y_{t-(k-1)} + u_t, \qquad (18)$$

where $\Pi = \left(\sum_{j=1}^{k} \beta_i \right) - I_g$ and $\Gamma_i = \left(\sum_{j=1}^{i} \beta_j \right) - I_g$.

When defying the VAR-model in VECM-form, we gain information of changes in long and short term relationships of estimates Π and Γ_i in relation to changes of variable y_t. The Johansen test centres around an examination of the Π matrix and Π can be interpreted as a long-run coefficient matrix, since in equilibrium, all the Δy_{t-i} value will be zero, and setting the error terms, u_t, to their expected value of zero will leave $\Pi y_{t-i} = 0$ (Vo, 2006).

The test for cointegration is calculated by looking at the rank of Π matrix via its eigenvalues and Johansen & Juselius (1990) suggest two different methods for the testing of numbers of cointegrating vectors:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln\left(1 - \hat{\lambda}_i\right) \tag{19}$$

and

$$\lambda_{\max}(r, r+1) = -T \ln\left(1 - \hat{\lambda}_{r+1}\right), \tag{20}$$

where λ_{trace} is a joint test where the null is that the number of cointegrating vectors is less than or equal to r against an unspecified or general alternative that there are more than r. $\lambda_{\max}$ conducts separate tests on each eigenvalue, and has as its null hypothesis that the number of cointegrating vectors is r against an alternative of $r+1$. Cointegrating vectors can be thought of as representing constraints that an economic system imposes on the movement of the variables in the system in the long-run. Consequently, the more cointegrating vectors there are, the more stable the markets are (Dickey & al., 1994).

Both methods above testing the number of cointegrating vectors are based on maximal eigenvalue. The maximum eigenvalue test tends to give better results when the trace tests are either large or small (Chen & al., 2002). Osterwald-Lenum (1992) provides a more complete set of critical values for the Johansen test. For both methods we can compare the test results with simulated critical values, and if the test statistic is greater than the critical value we reject the null hypothesis.

5.4 Problems with the methodology

For all of our test methodologies we are obligated to choose the lag length. How we can be sure that the lag length which we are using is optimal? According to Brooks (2002) and Vo (2006) the frequency of the data can be used to decide the lag lenght. So, for example, if the data is monthly, use 12 lags, if the data are quarterly, use 4 lags and so on. Clearly, this not an obivous choise for higher frequency data like daily or hourly. Another option for all of our test methodologies is to employ an information criterion test to decide the optimal lag lenght. The number of lags that minimises the value of an information criterion is optimal according to the test. There are three popular information criterion tests, namely Akaike's (1974) information criterion (AIC), Schwarz's (1978) Bayesian information criterion (SBIC) and the Hannan & Quinn (1979) information criterion (HQIC). According to Brooks (2002) SBIC embodies a much stiffer penalty than AIC, while HQIC is somewhere in between. In despite of this, in the earlier studies AIC has been probably the most popular and therefore will also use AIC to choose the optimal lag length for of our test methodologies. AIC can be algebraically expressed as

$$AIC = \ln\left(\hat{\sigma}^2\right) + \frac{2k}{T}, \tag{21}$$

where $\hat{\sigma}^2$ the residual variance (also equivalent to the residual sum of squares divided by the number of degrees of freedom, $T - k$), $k = p + q + 1$ is the total number of parameters estimated and T is the sample size (Brooks, 2002).

Reliable integration testing is not that simple as our test methodology may presume. Can we make waterproof conclusions on financial market integrations using cointegration tests? The answer is yes and no. The Johansen cointegration test is one of the most popular methodologies in the most recent papers and we can assume that it is reliable. However, Cheung & Lai (1993) find that with small samples sizes the Johansen cointegration test are biased towards finding cointegration more often than what asymptotic theory suggests. This result is backed also with the study of Godbout & van Norden (1997) which results implicated considerable size distortion with this test. We are tried to eliminate this bias in our empirical testing by using daily data which gives us sufficient amount of samples.

However, for us it is interesting what the results actually tell us and what kind of conclusions we can make based on them. By the asset market integration one understands that assets in every markets are exposed to the same set of risk factors and the risk premium on each factor are the same in all markets. This is actually something what cointegration test does not tell us. With our test results we only can be reliable on the fact that price movements are or are not cointegrated, not the actual markets and their determinants itself. According to Alhgren & Antell (2002) the interesting question is whether co-movements of asset prices and cointegration really reflect the integration of asset markets itself. One would expect asset prices to be cointegrated if asset markets are integrated. Engsted & Lund (1997) showed in their study that asset prices will be cointegrated if the underlying fundamentals determining asset prices are cointegrated. However, according to the study of Kasa (1992) It is of course still possible that prices are cointegrated for some other reason not having to do with asset market integration.

Can we keep the results which VAR gives us reliable considering short-term integration and dynamics? As it is with cointegration testing, the answer is yes and no. We can consider that VAR is a proven methodology but its results considering impacts are somewhat misinforming. This is because of the fact that even if the results implicates that the variable *X* causes movements in the values of *Y*, we can not actually say that *X* is causing these movements, only that results simply implies a chronological order of the movements. Therefore, it could be validly only stated that movements in the variable *Y* appear to lag movements in the values of *X*.

The short-run dynamics testing with VAR is not unproblematic. Ordering of the variables to the VAR framework is controversial. Some studies like Mills & Mills (1991) have employed ordering according to the earlier studies or used ordering based on the chronology of the opening and closing of the financial markets or reversed chronology based on the closing and opening. According to Baur (2007) ordering can also be based on for example the capitalization of the markets.

However, according to Karolyi & Stulz (1996) and Alaganar & Bhar (2001), different time zones of the international markets can be important factor in the shot-run integration studies. Therefore, in estimation, it might be important that we consider the time differences between markets. Given that the US closing stock price of a day $t-1$ before Asian stock market opening price, what follows is that if Asian stock prices are sensitive to the US stock price changes and the market is efficient, the US stock price information in day $t-1$ should be reflected in the opening price on day t of the Asian stocks. If the Asian stock market is partly efficient, only part of the information will be reflected in the Asian opening price of day t, with the remaining changes spilling over during the course of the day. Another important factor is that national holidays also differ between countries. According to Vo (2006) we can use the closing values from the previous day for non-trading days to fix this problem.

6 RESULTS

6.1 Unit root test

We have employed the ADF test for all time series and the optimal lag length selection is done by employing AIC. Optimal lag length selection is very important because it removes the possible autocorrelation problems. We have made the ADF test by using the all three models, i.e., without constant, with constant, with constant and deterministic trend. Testing is conducted at the levels and by differencing the time series once. Chosen model has effect on simulated critical values of ADF test results as we can see in Table 8. If a constant or deterministic time trend is added, more evidence to reject the null hypothesis is needed. The null hypothesis of a unit-root is rejected if the test value is smaller than the critical value. These critical values are used for all tests.

Table 8. Critical values of Dickey-Fuller test. Critical values at 1% and 5% significance levels without constant, with constant, with constant and deterministic trend. τ **,** τ_{μ} and τ_{τ} denotes these models respectively.

1%			**5%**		
τ	τ_{μ}	τ_{τ}	τ	τ_{μ}	τ_{τ}
-2.58	-3.43	-3.96	-1.95	-2.86	-3.41

(Source: Brooks (2002))

The results considering stock and bond indices are presented in Tables 9 and 10 respectively. One can immediately notice that at 1% significance level all of indices are from $\mathrm{I}(d)$ process which mean that they have d unit roots and them to be integrated d times to make them stationary. This indicates that they are all from non-stationary and following a random walk process. Thus, they are suitable for the Johansen cointegration test.

Table 9. ADF test results for stock indices. ADF test is conducted at the level and by differencing the time series once. We have used three ADF models, i.e., without constant, with constant, with constant and deterministic trend. τ , τ_μ and τ_τ denotes these models respectively. The lag lengths used are marked between parentheses. H_0 time series contains a unit root, i.e., series is non-stationary. ** represents rejecting hypothesis at 1% significance level and * at 5% level.

Index	Test values					
	Level			First difference		
	τ	τ_μ	τ_τ	τ	τ_μ	τ_τ
USA	2.299 (7)	-0.756 (7)	-3.045 (7)	-15.791** (6)	-16.013** (6)	-16.007** (6)
UK	2.491 (5)	-0.489 (5)	-3.471* (5)	-17.790** (4)	-18.040** (4)	-18.033** (4)
Germany	3.697 (6)	1.097 (6)	-1.320 (6)	-26.602**(1)	-16.269** (5)	-16.348** (5)
Czech	4.179 (6)	1.733 (6)	-1.130 (6)	-32.685** (0)	-16.296** (5)	-16.445** (5)
Poland	2.158 (7)	0.112 (7)	-3.491* (2)	-34.385** (0)	-34.506** (0)	-34.510** (0)
Russia	2.296 (0)	0.284 (0)	-2.195 (0)	-36.549** (0)	-36.702** (0)	-36.716** (0)
China	2.454 (3)	1.025 (3)	-0.946 (3)	-17.647** (2)	-17.816** (2)	-17.914** (2)
Japan	1.012 (0)	-1.473 (0)	-2.515 (0)	-36.559** (0)	-36.601** (0)	-36.603** (0)

Regarding the stock indices only with the UK and Poland the null hypotheses of non-stationary has to be rejected at 5% significance level when using constant and deterministic trend. Regarding the bond indices only with the UK the null hypotheses is rejected at 5% significance level when using constant and deterministic trend. However, we cannot fully reject the null hypothesis because at the 1% significance level series all non-stationary and also the lag lengths are not extremely big. One should know that the lag length tells us how quickly the autocorrelation dies off from the series. Therefore the bigger is the lag length the stronger is the autocorrelation of a time series. By looking at the results we can notice that the Russian government bond index has needed 10 lags to remove the autocorrelation which is remarkably more than for other indices.

Table 10. ADF test results for bond indices. ADF test is conducted at the level and by differencing the time series once. We have used three ADF models, i.e., without constant, with constant, with constant and deterministic trend. τ , τ_μ and τ_τ denotes these models respectively. The lag lengths used are marked between parentheses. H_0 time series contains a unit root, i.e., series is non-stationary. ** represents rejecting hypothesis at 1% significance level and * at 5% level.

Index	Test values					
	Level			First difference		
	τ	τ_μ	τ_τ	τ	τ_μ	τ_τ
USA	2.170 (0)	0.454 (0)	-1.820 (0)	-36.190** (0)	-36.319** (0)	-36.332** (0)
UK	1.792 (0)	-0.840 (0)	-3.503* (0)	-35.550** (0)	-35.639** (0)	-35.625** (0)
Germany	2.138 (0)	-0.996 (0)	-2.590 (0)	-36.556** (0)	-36.696** (0)	-36.682** (0)
Czech	2.665 (1)	0.054 (1)	-2.290 (1)	-41.950** (0)	-42.137** (0)	-42.134** (0)
Poland	2.556 (1)	0.493 (1)	-2.593 (1)	-33.002** (0)	-33.164** (0)	-33.191** (0)
Russia	2.979 (1)	-1.315 (2)	-2.938 (1)	-30.036** (0)	-30.311** (0)	-25.023** (1)
China	2.223 (0)	-0.263 (0)	-2.685 (0)	-36.185** (0)	-36.318** (0)	-36.309** (0)
Japan	0.382 (0)	-2.302 (0)	-2.321 (0)	-35.222** (0)	-35.216** (0)	-35.202** (0)
Government	1.996 (10)	-0.465 (10)	-1.930 (10)	-8.359** (9)	-8.615** (9)	-8.617** (9)

When we difference our indices once all indices become stationary $\mathrm{I}(0)$ and the null hypothesis is rejected at 1% significance level. This is a robustness check which tells us that every time series with three models testing (without constant, with constant, with constant and deterministic trend) has one unit root and concludes that without differencing our series are from $\mathrm{I}(1)$ process.

6.2 Long-run integration

We have employed the Johansen cointegration test to find out the long-run relationships of the indices. We have chosen to use a bivariate model because results from a multivariate model are not very informative considering our study. Results from the multivariate model would only tell us how many cointegrating vectors the test has found, without any specification between which variables. Therefore we will use a bivariate model to discover probable cointegrating relationships more specifically.

We have employed the both trace and maximum eigenvalue tests. The optimal lag length selection is done with AIC. We have included a constant to our model but not a deterministic trend. This model selection is based on the fact that our ADF test slightly rejected the null hypotheses of non-stationary at 5% significance level for the UK and Poland stock indices and the UK bond index. Therefore, we want to be on the safe side and avoid any possible bias in our model. Also, most of the earlier studies have also used a model with constant but without deterministic time trend. Table 11 presents the Ostewald-Lenum critical values.

Table 11. Ostewald-Lenum critical values. Critical values for trace statistic and the maximum eigenvalue statistics at 1% and 5% significance for null hypothesis of 0 cointegrating vectors against the alternative of 1 or less cointegrating vectors.

	λ_{trace}		$\lambda_{\max}$	
	0.05	**0.01**	**0.05**	**0.01**
$r = 0$	15.410	20.040	14.070	18.630
$r \leq 1$	3.760	6.650	3.760	6.650

(Source: Osterwald-Lenum (1992))

These Ostewald-Lenum critical values are used for all of our Johansen cointegration tests. If the test statistic is greater than the critical value we reject the null hypothesis.

6.2.1 Long-run intra-country integration

Table 12 gives us the results considering the intra-country integration of the Russian stock and bond markets. The trace and maximum eigenvalue test statistics are reported. Results provided demonstrate that the null hypothesis of $r = 0$ and $r \leq 1$ with λ_{trace} and $\lambda_{\max}$ tests is not rejected for any of the three market pairs in the group which implicates that no cointegration vectors have been found.

It can bee seen in Table 12 at first glance that none of the pairs are not even close the critical values. These results mean important economic implications. The highest trace test values for $r = 0$ are reported for Stock/Corporate bond 7.866 and the lowest for Corporate bond/Government bond 3.256. The highest maximum eigenvalue test values for $r = 0$ are reported for Stock/Corporate bond 7.058 and the lowest for Corporate bond/Government bond 2.879. After these results, $r \leq 1$ results are already out of our interests because the null hypotheses of $r = 0$ are not rejected. It is very interesting to notice that the Russian corporate and government bond markets do not have almost any relationships together but the stock markets have almost equal relationships with the both corporate and corporate bond markets.

Table 12. Johansen bivariate cointegration test results for domestic markets. Trace statistic and the maximum eigenvalue statistics are for null hypothesis of 0 cointegrating vectors against the alternative of 1 or less cointegrating vectors. The results are reported for VAR specification with unrestricted constant and lags based on AIC. ** and * denotes significance at 1% and 5% levels respectively.

		λ_{trace}		$\lambda_{\max}$	
Index pair	**Lag length**	$r = 0$	$r \leq 1$	$r = 0$	$r \leq 1$
Stock-Corporate bond	2	7.866	0.807	7.058	0.807
Stock-Government bond	2	6.081	0.003	6.078	0.003
Corporate bond-Government bond	3	3.256	0.376	2.879	0.376

According to the Johansen cointegration analysis, Russian stock and bond markets do not greatly follow movements of each others in the long-run which means that the markets are relatively segmented. The absence of a long-run stable relationship between the stock and bond markets implies the presence of potential gains from a diversification. An investor willing to operate in the Russian financial markets should consider investing in more than one asset group.

Best to our knowledge, this is the first paper investigating the intra-country integration of the Russian financial markets our results has no direct benchmark. However, these kinds of results are not uncommon. According to the reviewed integration studies of Antell (2004), Johnson & Youn, Li & Zou (2006) and Kim & al. (2006) the Russian stock and bond markets are often relatively segmented or weakly integrated.

6.2.2 Long-run cross-country integration

Tables 13 and 14 give us the results considering the cross-country integration of global stock and corporate bond markets respectively. The both trace and maximum eigenvalue test statistics are reported.

The results considering global stock markets in Table 13 demonstrate that the null hypothesis of $r=0$ and $r \leq 1$ with λ_{trace} and $\lambda_{\max}$ tests is not rejected for any of the seven market pairs the group which implicates that no cointegration vectors have been found. Also, none of the pairs are not even close the critical values. The highest trace test values for $r=0$ are reported for Russia/Czech Republic 7.372 and the lowest for Russia/UK 3.423. The highest maximum eigenvalue test values for $r=0$ are reported for Russia/Poland 6.121 and the lowest for Russia/China 3.212. After these results, $r \leq 1$ results are already out of our interests because the null hypotheses of $r=0$ are not rejected. It can be seen that the Russian stock market movements are closer to the other emerging European markets and than the mature European, Japanese or quite surprisingly the US markets.

Table 13. Johansen bivariate cointegration test results for global stock markets. Trace statistic and the maximum eigenvalue statistics are for null hypothesis of 0 cointegrating vectors against the alternative of 1 or less cointegrating vectors. The results are reported for VAR specification with unrestricted constant and lags based on AIC. ** and * denotes significance at 1% and 5% levels respectively.

		λ_{trace}		$\lambda_{\max}$	
Index pair	**Lag length**	$r = 0$	$r \leq 1$	$r = 0$	$r \leq 1$
Russia-USA	3	4.778	0.074	4.704	0.074
Russia-UK	2	3.423	0.018	3.405	0.018
Russia-Germany	2	5.009	0.780	4.230	0.780
Russia-Czech	2	7.372	1.547	5.797	1.574
Russia-Poland	2	6.133	0.012	6.121	0.012
Russia-China	8	5.184	1.972	3.212	1.972
Russia-Japan	2	4.097	0.016	4.081	0.016

If we compare our findings with earlier studies on the Russian stock markets, using the same methodology, the results are somewhat understandable. According to the studies of Anatoliev (2005) and Lucey & Voronkova (2005), there is no clear positive trend in the degree of integration of the Russian stock market with other stock markets not integrated with other markets but the interactions have strengthened after the financial crisis which occurred during 1997-1998. However, in our investigations the relevancy of the USA was not as high as it was in the some of earlier studies. On the contrary most of the countries in our study were more significant than the USA as it was correspondently in the study of Anatoliev (2005).

The results considering global corporate bond markets in Table 14 demonstrate that the null hypothesis of $r = 0$ and $r \leq 1$ with λ_{trace} and $\lambda_{\max}$ tests is not rejected for any of the seven market pairs in the group which implicates that no cointegration vectors have been found. However, the Russian bond markets seem to be moving more closely with its peers than the Russian stock markets. The highest trace test values for $r = 0$ are reported for Russia/Poland 12.216 and the lowest for Russia/China 6.490. The highest maximum eigenvalue test values for $r = 0$ are reported for Russia/Poland 12.188 and the lowest for Russia/Germany 5.669. After these results, $r \leq 1$ results are already out of our interests because the null hypotheses for $r = 0$ are not rejected. The results considering the bond market movements vary quite strongly from the stock market movements. It can be seen that the Russian bond market movements are closest to the movements of Poland, the UK and Japan. Again, quite surprisingly the US is not one of the biggest explanatory but neither is China.

Table 14. Johansen bivariate cointegration test results for global corporate bond markets. Trace statistic and the maximum eigenvalue statistics are for null hypothesis of 0 cointegrating vectors against the alternative of 1 or less cointegrating vectors. The results are reported for VAR specification with unrestricted constant and lags based on AIC. ** and * denotes significance at 1% and 5% levels respectively.

		λ_{trace}		$\lambda_{\max}$	
Index pair	**Lag length**	$r = 0$	$r \leq 1$	$r = 0$	$r \leq 1$
Russia-USA	3	6.731	0.203	6.528	0.203
Russia-UK	3	9.279	0.814	8.465	0.814
Russia-Germany	3	6.677	1.008	5.669	1.008
Russia-Czech	5	6.433	0.108	6.325	0.108
Russia-Poland	3	12.216	0.028	12.188	0.028
Russia-China	4	6.490	0.161	6.329	0.161
Russia-Japan	3	7.722	1.616	6.106	1.616

Best to our knowledge, this is the first paper investigating the long-run cross-country integration of the Russian bond markets more widely, our results has no direct benchmark. However, these kinds of results are not uncommon. According to the studies of Hunter & Simon (2005), Kim & al. (2005), and Vo (2006) the global bond markets are often relatively segmented or weakly integrated.

By summing up, the absence of cointegration relationships, at least according to the Johansen cointegration analysis, suggests that the Russian financial markets do not greatly follow movements of its peers in the long-run which means that the markets are relatively segmented. This implies the presence of potential gains from a diversification. A global investor should consider investing in the Russian stocks and bonds in the long-run. However, the results implicates that the Russian corporate bond markets are employing more co-movements with the global corporate bond markets in the long-run than the Russian stock markets are with the global stock markets.

6.3 Short-run integration

To test the short run integration, we use a VAR's variance decompositions and impulse responses to find out the short-run dynamics of the indices. The optimal lag length selection is based on AIC and the factorization is based on Cholesky decomposition. Test is employed for a period from 1 to 10 days from a shock. However, to conserve space only days 1, 3, 5 and 10 are reported. One should know that variance decompositions and impulse responses are always at some level affected by the ordering of the variables.[4] Regarding the intra-country investigations the variables are ordered by a capitalization of the markets and regarding the cross-country investigations the variables are ordered chronologically of the opening and closing of the financial markets starting from the USA and ending to Japan.[5]

[4] However, according to the study of Baur (2007), re-ordering of the variables did not bring any major impacts to their results.
[5] Mills & Mills (1991) and Baur (2007) used same criterions for ordering the variables in their studies.

6.3.1 Short-run intra-country integration

Table 15 presents the variance decompositions for VAR of the Russian stock and bond markets. The optimal lag length for variance decomposition and impulse responses according to AIC was 1. As one may have expected from the lack of cointegration the decompositions are low. The Russian stock and bond markets seem to be very independent of one another.

Table 15. Variance decompositions for VAR of domestic markets. Results of the decompositions for 1, 3, 5 and 10 days ahead of a shock. The factorization is based on Cholesky decomposition and the optimal lag length based on AIC is 1.

		Explained by movements in		
Explanatory	**Days ahead**	**Stock**	**Corporate bond**	**Government bond**
Stock	**1**	100	0.000	0.000
	3	97.618	2.333	0.049
	5	97.616	2.335	0.049
	10	97.616	2.335	0.049
Corporate bond	**1**	2.894	97.106	0.000
	3	2.817	97.182	0.001
	5	2.817	97.182	0.001
	10	2.817	97.182	0.001
Government bond	**1**	1.117	0.397	98.486
	3	1.556	1.397	97.047
	5	1.556	1.398	97.046
	10	1.556	1.398	97.046

The variance decompositions, which show the proportion of the movements in the dependent variables are due to their own shocks, versus shocks to the other variables, seem to suggest that all variable are to a certain extent exogenous in this system. That is, little of the movements can be explained by movements of others. The stock market index and the corporate bond index seem to employ the “highest” decompositions reaching to 2.894%. It is interesting to notice that the changes in the compositions are very small during 1-10 days.

A similar pattern emerges from the impulse responses in Table 16, which shows the effect of a unit shock applied separately to the error of each equation of the VAR. The impulse values are extremely low in the system. This implicates that the Russian stock and bond markets appear relatively independent of one another, and also informationally efficient in the sense that shocks work though the system very quickly. There is never return more than 0.1% to shocks in any series after three days after they have happened. Such a result implies that that the possibility of making excess returns by trading in one market on the basis of old news from another appears very unlikely.

Table 16. Impulse responses for VAR of domestic markets. Results of the impulse responses for 1, 3, 5 and 10 days after a shock. The factorization is based on Cholesky decomposition and the optimal lag length based on AIC is 1.

		Response to innovations in		
Responder	**Days after**	**Stock**	**Corporate bond**	**Government bond**
Stock	**1**	0.019	0.000	0.000
	3	< 0.001	0.001	< -0.001
	5	< 0.001	< 0.001	< -0.001
	10	< 0.001	< 0.001	< -0.001
Corporate bond	**1**	0.001	0.004	0.000
	3	< 0.001	< 0.001	< -0.001
	5	< 0.001	< 0.001	< -0.001
	10	< 0.001	< 0.001	< -0.001
Government bond	**1**	< 0.001	< 0.001	0.003
	3	< -0.001	< 0.001	< 0.001
	5	< 0.001	< 0.001	< -0.001
	10	< 0.001	< 0.001	< -0.001

Best to our knowledge, this is the first paper investigating the short-run intra-country integration of the Russian financial markets. If we look studies on the other countries, according to the studies of Kim & al. (2006) and Baur (2007) our results are following the same implications of low mutual short-run movements. If we compare our short-run results to the long-run results we can see that the markets are having even less co-movements in the short-run than in the long-run.

6.3.2 Short-run cross-country integration

Table 17 presents the variance decompositions for VAR of the global stock markets. The optimal lag length according to AIC for variance decompositions and impulse responses was 2. As we can se Russia is one of the most independent in the system. Only the USA and Czech Republic are more independent in the system. China and Japan are more independent for a start but after one day they become more dependent from the other markets. This is an obvious consequence from the time lag. The USA is a clear market proxy for all countries and the USA, the UK and Germany are having a lot of mutual composition.

According to the results USA, the UK, Czech Republic and Poland are the most explanatory for Russia and after one day 78% of movements in the Russian yield is explained by Russian shocks. After 10 days only 74.6% of the movements are explained by Russian shocks and 7.3% is explained by the USA, 6.7 by the UK, 7.4% by Czech Republic and 3.1% by Poland while the other countries have explained 0.4% or less. However, it is interesting to notice that Russia is not almost non-explanatory for any of the countries. The highest decomposition is 1.4% and it is for Japan while the explanatory power for the remaining countries is <1%.

Table 18 presents the impulse responses for VAR of the global stock markets. The impulse values are extremely low in the system. This implicates that the stock markets of these countries are relatively independent of one another and also efficient in the sense that shocks work though the system very quickly. There is never return more than 0.1% to shocks in any series.

If we compare stock market short-run dynamics results to the earlier reviewed studies on the Russian markets the results are following the results of Lucey & Voronkova (2005). However, in their study the USA was weaker than in our study. If we compare our short-run results to the long-run results we can see that especially the USA and the UK were more explanatory and Germany less explanatory in the short-run dynamics than in the long-run.

Table 19 shows the variance decompositions for VAR of the global corporate bond markets. The optimal lag length according to AIC for variance decompositions and impulse responses was 3. Results are mostly following the results for the stock markets. Russian is one of the most independent among the group. Only the USA and Czech Republic are more exogenous in the system. China and Japan are more independent for a start but after one day they become more dependent from the other markets. This is an obvious consequence from the time lag between countries. The USA is a clear market proxy for all other countries and the USA, the UK and Germany are having a lot of mutual composition. An interesting curiosity is that the USA is very explanatory for China explaining at highest 89% of the Chinese stock market movements.

However, the Russian bond markets are less independent in the model than the Russian stock markets. The USA, the UK, Czech Republic and Poland are the most explanatory for Russia and after one 74% of movements in the Russian yield is explained by Russian shocks. After 10 days only 70.6% of the movements are explained by Russian shocks and 23.9% is explained by the USA and 2.1% by Poland while the other countries have explained 1.4% or less. As it was with the stock markets, Russia is not almost non-explanatory for any of these countries. The highest decomposition is 0.8% and it is for China while the explanatory power for the remaining countries is <0.5%.

Table 20 presents the impulse responses for VAR of the global corporate bond markets. As it was the case with stock markets the impulse values are extremely low in the system. This implicates that the corporate bond markets are relatively independent of one another, and also more efficient. There is never return more than 0.1% to shocks in any series.

As mentioned before, best to our knowledge, this is the first paper investigating the short-run cross-country integration of the Russian bond markets this widely our results has no good direct benchmarks. The study of Hayo & Kutan (2002) on the Russian bond markets used only USA as a country peer in their study. According to their results the USA had explanatory power to the Russian bond markets as our study resulted also. However, our results are not uncommon considering studies on other countries. According to the study of Mills & Mills (1991) on global bond markets, countries are not necessary employing high short-run dynamics. Their results are backed with the results of Vo (2006). If we compare our short-run results to the long-run results we can see that also in the short-run the Russian corporate bond markets seems to be more integrated with its peers than the Russian stock markets. However, it is interesting that the USA was a highly more explanatory and Poland a highly less explanatory in the short-run than in the long-run.

By summing up, according to the VAR, the Russian stock and corporate bond markets do not greatly follow movements of its peers in the short-run which means that the markets are relatively segmented. This implies the presence of potential gains from a diversification. A global investor should consider investing in to the Russian stocks and bonds also in the short-run.

Table 17. Variance decompositions for VAR of global stock markets. Results of the decompositions for 1, 3, 5 and 10 days ahead of a shock. The factorization is based on Cholesky decomposition and the optimal lag length based on AIC is 2.

		Explained by movements in							
Explanatory	**Days ahead**	**USA**	**UK**	**Germany**	**Czech**	**Poland**	**Russia**	**China**	**Japan**
USA	**1**	100	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	3	98.882	0.027	0.308	0.015	0.185	0.022	0.591	0.029
	5	98.756	0.029	0.339	0.021	0.188	0.024	0.599	0.037
	10	98.763	0.029	0.339	0.021	0.188	0.024	0.600	0.037
UK	**1**	24.307	75.692	0.000	0.000	0.000	0.000	0.000	0.000
	3	27.452	71.600	0.050	0.390	0.243	0.012	0.167	0.086
	5	27.502	71.393	0.121	0.394	0.243	0.015	0.227	0.088
	10	37.521	71.389	0.121	0.393	0.243	0.015	0.230	0.088
Germany	**1**	32.944	30.475	36.581	0.000	0.000	0.000	0.000	0.000
	3	33.617	30.559	34.867	0.243	0.427	0.083	0.074	0.129
	5	33.730	30.483	34.792	0.246	0.433	0.084	0.096	0.136
	10	33.730	30.482	34.791	0.246	0.434	0.084	0.098	0.136
Czech	**1**	2.965	12.379	1.224	83.432	0.000	0.000	0.000	0.000
	3	6.461	11.876	1.327	78.982	0.895	0.163	0.252	0.045
	5	6.513	11.861	1.350	78.861	0.898	0.174	0.296	0.047
	10	6.517	11.860	1.350	78.856	0.898	0.174	0.297	0.047
Poland	**1**	6.936	14.292	1.656	9.754	67.363	0.000	0.000	0.000
	3	11.114	14.029	1.567	9.494	63.441	0.079	0.257	0.018
	5	11.123	14.021	1.582	9.488	63.405	0.081	0.279	0.020
	10	11.123	14.021	1.582	9.488	63.404	0.081	0.280	0.020
Russia	**1**	4.424	7.057	0.202	7.307	3.158	78.032	0.000	0.000
	3	7.269	6.752	0.335	7.391	3.095	74.703	0.346	0.109
	5	7.277	6.747	0.359	7.391	3.093	74.648	0.374	0.111
	10	7.278	6.747	0.359	7.391	3.093	74.646	0.374	0.111
China	**1**	2.605	4.459	0.732	1.533	3.502	0.311	86.856	0.000
	3	18.423	4.160	1.032	1.722	3.723	0.327	69.844	0.769
	5	18.569	4.146	1.054	1.727	3.710	0.348	69.662	0.783
	10	18.578	4.145	1.055	1.728	3.710	0.348	69.652	0.784
Japan	**1**	1.093	2.241	1.972	2.354	0.150	0.022	5.637	86.531
	3	16.477	2.704	1.694	2.571	0.323	1.384	5.115	69.732
	5	16.614	2.696	1.704	2.577	0.327	1.436	5.172	69.474
	10	16.623	2.696	1.704	2.578	0.327	1.437	5.173	69.463

Table 18. Impulse responses for VAR of global stock markets. Results of the impulse responses for 1, 3, 5 and 10 days after a shock. The factorization is based on Cholesky decomposition and the optimal lag length based on AIC is 2.

		Response to innovations in							
Responder	**Days after**	**USA**	**UK**	**Germany**	**Czech**	**Poland**	**Russia**	**China**	**Japan**
USA	**1**	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	3	-0.001	< 0.001	< 0.001	< -0.001	< -0.001	< -0.001	< 0.001	< -0.001
	5	< -0.001	< 0.001	< 0.001	< 0.001	< 0.001	< -0.001	< -0.001	< -0.001
	10	< -0.001	< 0.001	< 0.001	< -0.001	< -0.001	< -0.001	< 0.001	< 0.001
UK	**1**	0.004	0.008	0.000	0.000	0.000	0.000	0.000	0.000
	3	< 0.001	< 0.001	< -0.001	< -0.001	< -0.001	< -0.001	< 0.001	< 0.001
	5	< 0.001	< 0.001	< -0.001	< 0.001	< 0.001	< -0.001	< -0.001	< 0.001
	10	< -0.001	< -0.001	< 0.001	< -0.001	< -0.001	< -0.001	< 0.001	< 0.001
Germany	**1**	0.007	0.006	0.007	0.000	0.000	0.000	0.000	0.000
	3	0.001	< 0.001	< 0.001	< 0.001	< -0.001	< -0.001	< 0.001	< -0.001
	5	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< -0.001	< 0.001	< -0.001
	10	< -0.001	< -0.001	< 0.001	< 0.001	< 0.001	< -0.001	< -0.001	< 0.001
Czech	**1**	0.002	0.005	0.001	0.012	0.000	0.000	0.000	0.000
	3	< 0.001	< 0.001	< 0.001	-0.001	0.001	-0.001	< -0.001	< -0.001
	5	< 0.001	< 0.001	< -0.001	< 0.001	< -0.001	< 0.001	< 0.001	< -0.001
	10	< 0.001	< -0.001	< -0.001	< 0.001	< 0.001	< 0.001	< -0.001	< -0.001
Poland	**1**	0.004	0.006	0.002	0.005	0.013	0.000	0.000	0.000
	3	< 0.001	0.001	< -0.001	< 0.001	0.001	< 0.001	0.001	< -0.001
	5	< 0.001	< 0.001	< -0.001	< 0.001	< 0.001	< 0.001	< -0.001	< -0.001
	10	< -0.001	< -0.001	< 0.001	< -0.001	< 0.001	< -0.001	< 0.001	< 0.001
Russia	**1**	0.004	0.005	0.001	0.005	0.003	0.016	0.000	0.000
	3	< 0.001	< 0.001	< -0.001	< -0.001	< 0.001	-0.001	< -0.001	< 0.001
	5	< 0.001	< 0.001	< -0.001	< 0.001	< -0.001	< 0.001	< 0.001	< -0.001
	10	< -0.001	< -0.001	< 0.001	< 0.001	< 0.001	< 0.001	< -0.001	< 0.001
China	**1**	0.002	0.003	0.001	0.002	0.003	0.001	0.013	0.000
	3	< 0.001	< -0.001	< 0.001	< 0.001	0.001	< -0.001	-0.001	< -0.001
	5	< 0.001	< 0.001	< -0.001	< 0.001	< -0.001	< 0.001	< 0.001	< -0.001
	10	< 0.001	< -0.001	< -0.001	< 0.001	< 0.001	< 0.001	< -0.001	< -0.001
Japan	**1**	0.001	0.002	0.002	0.002	0.002	< 0.001	0.003	0.010
	3	0.001	< -0.001	< 0.001	< 0.001	0.001	< 0.001	-0.001	< -0.001
	5	< 0.001	< 0.001	< 0.001	< -0.001	< -0.001	< 0.001	< 0.001	< -0.001
	10	< 0.001	< -0.001	< -0.001	< 0.001	< 0.001	< 0.001	< -0.001	< -0.001

Table 19. Variance decompositions for VAR of global corporate bond markets. Results of the decompositions for 1, 3, 5 and 10 days ahead of a shock. The factorization is based on Cholesky decomposition and the optimal lag length based on AIC is 3.

		Explained by movements in							
Explanatory	**Days ahead**	**USA**	**UK**	**Germany**	**Czech**	**Poland**	**Russia**	**China**	**Japan**
USA	**1**	100	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	3	98.623	0.163	0.074	0.219	0.164	0.251	0.419	0.095
	5	98.584	0.164	0.200	0.233	0.167	0.262	0.438	0.098
	10	98.583	0.164	0.205	0.233	0.167	0.262	0.438	0.098
UK	**1**	16.284	83.716	0.000	0.000	0.000	0.000	0.000	0.000
	3	17.556	81.162	0.361	0.103	0.095	0.344	0.144	0.245
	5	17.549	81.123	0.362	0.126	0.097	0.346	0.149	0.249
	10	17.550	81.121	0.362	0.126	0.097	0.346	0.194	0.249
Germany	**1**	15.110	52.643	32.246	0.000	0.000	0.000	0.000	0.000
	3	17.347	50.664	30.681	0.255	0.230	0.379	0.091	0.301
	5	17.342	50.652	30.675	0.312	0.230	0.392	0.096	0.302
	10	17.342	50.651	30.675	0.312	0.230	0.392	0.096	0.302
Czech	**1**	2.121	21.273	12.001	64.606	0.000	0.000	0.000	0.000
	3	3.478	19.679	11.171	64.162	1.239	0.228	0.011	0.033
	5	3.481	19.681	11.152	64.114	1.247	0.245	0.016	0.074
	10	3.481	19.681	11.151	64.113	1.247	0.235	0.016	0.074
Poland	**1**	2.202	28.958	12.225	2.181	54.343	0.000	0.000	0.000
	3	3.945	27.816	12.198	2.339	52.819	0.530	0.104	0.250
	5	3.958	27.795	12.188	2.384	52.772	0.537	0.107	0.259
	10	3.958	27.795	12.187	2.384	52.772	0.538	0.107	0.259
Russia	**1**	20.675	1.311	1.398	0.029	1.854	74.734	0.000	0.000
	3	23.806	1.304	1.344	0.089	2.106	70.722	0.107	0.522
	5	23.893	1.304	1.346	0.090	2.103	70.629	0.109	0.525
	10	23.893	1.304	1.347	0.090	2.104	70.628	0.109	0.526
China	**1**	89.531	0.044	0.003	0.002	0.002	0.269	10.152	0.000
	3	87.136	0.182	0.258	0.204	0.012	0.809	11.304	0.096
	5	87.050	0.183	0.266	0.205	0.013	0.835	11.348	0.099
	10	87.048	0.183	0.266	0.205	0.013	0.836	11.500	0.100
Japan	**1**	5.893	15.619	4.677	0.036	0.014	0.106	0.201	73.453
	3	10.652	14.888	4.477	0.096	0.275	0.390	0.249	68.972
	5	10.648	14.879	4.483	0.111	0.276	0.406	0.262	68.935
	10	10.649	14.879	4.483	0.111	0.276	0.407	0.262	68.934

Table 20. Impulse responses for VAR of global corporate bond markets. Results of the impulse responses for 1, 3, 5 and 10 days after a shock. The factorization is based on Cholesky decomposition and the optimal lag length based on AIC is 3.

		Response to innovations in							
Responder	**Days after**	**USA**	**UK**	**Germany**	**Czech**	**Poland**	**Russia**	**China**	**Japan**
USA	**1**	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	3	< -0.001	< 0.001	< -0.001	< 0.001	< -0.001	< 0.001	< -0.001	< -0.001
	5	< 0.001	< -0.001	< 0.001	< -0.001	< -0.001	< -0.001	< 0.001	< 0.001
	10	< -0.001	< 0.001	< -0.001	< -0.001	< 0.001	< 0.001	< -0.001	< 0.001
UK	**1**	0.002	0.006	0.000	0.000	0.000	0.000	0.000	0.000
	3	< -0.001	< -0.001	< 0.001	< -0.001	< 0.001	< 0.001	< -0.001	< -0.001
	5	< -0.001	< -0.001	< -0.001	< 0.001	< 0.001	< -0.001	< 0.001	< -0.001
	10	< -0.001	< -0.001	< -0.001	< 0.001	< 0.001	< 0.001	< -0.001	< -0.001
Germany	**1**	0.002	0.004	0.003	0.000	0.000	0.000	0.000	0.000
	3	< -0.001	< -0.001	< 0.001	< -0.001	< 0.001	< 0.001	< -0.001	< -0.001
	5	< -0.001	< -0.001	< -0.001	< 0.001	< -0.001	< -0.001	< 0.001	< -0.001
	10	< -0.001	< -0.001	< -0.001	< 0.001	< 0.001	< 0.001	< -0.001	< -0.001
Czech	**1**	0.001	0.004	0.003	0.006	0.000	0.000	0.000	0.000
	3	< 0.001	< 0.001	< 0.001	< -0.001	< 0.001	< 0.001	< -0.001	< 0.001
	5	< -0.001	< -0.001	< -0.001	< -0.001	< 0.001	< -0.001	< 0.001	< -0.001
	10	< -0.001	< -0.001	< -0.001	< -0.001	< 0.001	< -0.001	< -0.001	< -0.001
Poland	**1**	0.001	0.004	0.003	0.001	0.006	0.000	0.000	0.000
	3	< -0.001	< -0.001	< 0.001	< -0.001	< 0.001	< 0.001	< -0.001	< -0.001
	5	< -0.001	< -0.001	< -0.001	< -0.001	< 0.001	< -0.001	< 0.001	< 0.001
	10	< -0.001	< -0.001	< -0.001	< 0.001	< 0.001	< 0.001	< -0.001	< -0.001
Russia	**1**	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.000
	3	< -0.001	< 0.001	< -0.001	< 0.001	< 0.001	< 0.001	< -0.001	< -0.001
	5	< -0.001	< -0.001	< 0.001	< 0.001	< -0.001	< -0.001	< 0.001	< 0.001
	10	< 0.001	< 0.001	< -0.001	< -0.001	< 0.001	< 0.001	< -0.001	< 0.001
China	**1**	0.003	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.000
	3	< -0.001	< 0.001	< -0.001	< 0.001	< 0.001	< 0.001	< -0.001	< -0.001
	5	< 0.001	< -0.001	< 0.001	< 0.001	< -0.001	< -0.001	< 0.001	< 0.001
	10	< -0.001	< 0.001	< -0.001	< -0.001	< 0.001	< 0.001	< -0.001	< 0.001
Japan	**1**	0.001	0.002	0.001	< 0.001	< -0.001	< 0.001	< -0.001	0.005
	3	< 0.001	< 0.001	< 0.001	< -0.001	< 0.001	< 0.001	< -0.001	< -0.001
	5	< -0.001	< -0.001	< -0.001	< -0.001	< 0.001	< -0.001	< 0.001	< -0.001
	10	< -0.001	< -0.001	< -0.001	< 0.001	< 0.001	< -0.001	< 0.001	< -0.001

7 CONCLUSIONS

This study investigates integration of the Russian financial markets in the time period of January 1, 2003 to December 28, 2007 using daily data. The aim is to test the intra-country and cross-country integration of the Russian stock and bond markets in the short-run and in the long-run.

Test methodology for the short-run dynamics testing is the vector autoregressive model (VAR) and for the long-run cointegration the Johansen cointegration test which is an extension to VAR. The innovation of integration studies to investors is to discover more diversification possibilities in the markets. Typically, portfolio diversification is achieved using two main strategies: investing in different classes of assets thought to have little or negative correlations or investing in similar classes of assets in multiple markets through international diversification.

The contribution of this study is twofold. First, best to our knowledge there are no earlier studies on the intra-country integration of the Russian stock and bond markets. Second, there are no earlier studies considering cross-country bond market integration covering also the Russian bond market.

Empirical results indicate that the Russian financial markets are not cointegrated in the long-run at intra-country or cross-country level. The short-run dynamics are also relatively weak. Hence, the Russian financial markets offer diversification possibilities for intra-country and cross-country diversification. However, the results implicates that the Russian corporate bond markets are having more co-movements with the global corporate bond markets than the Russian stock markets are having with the global stock markets. As announced earlier, there are no direct benchmark studies considering the results of our intra-country integration of Russia financial markets but our results are mostly in line with the earlier studies considering other countries. The results considering cross-country integrations indicate that our results are mostly in line with the earlier studies.

There is a lot of space for a further research considering the Russian financial markets integration. An obvious extension to our study would be to employ a non-linear model like GARCH to catch possible ARCH effects in our data. This kind of volatility modelling might reveal some undiscovered linkages between our indices. Another interesting methodology contribution would be to employ a model to test time varying integrations and factors which are possibly explaining co-movements. Furthermore, during our timeline the global markets were basically on a happy rise and it would be very interesting for a further research to test how the market linkages would change if markets for example crashed in the USA and Europe.

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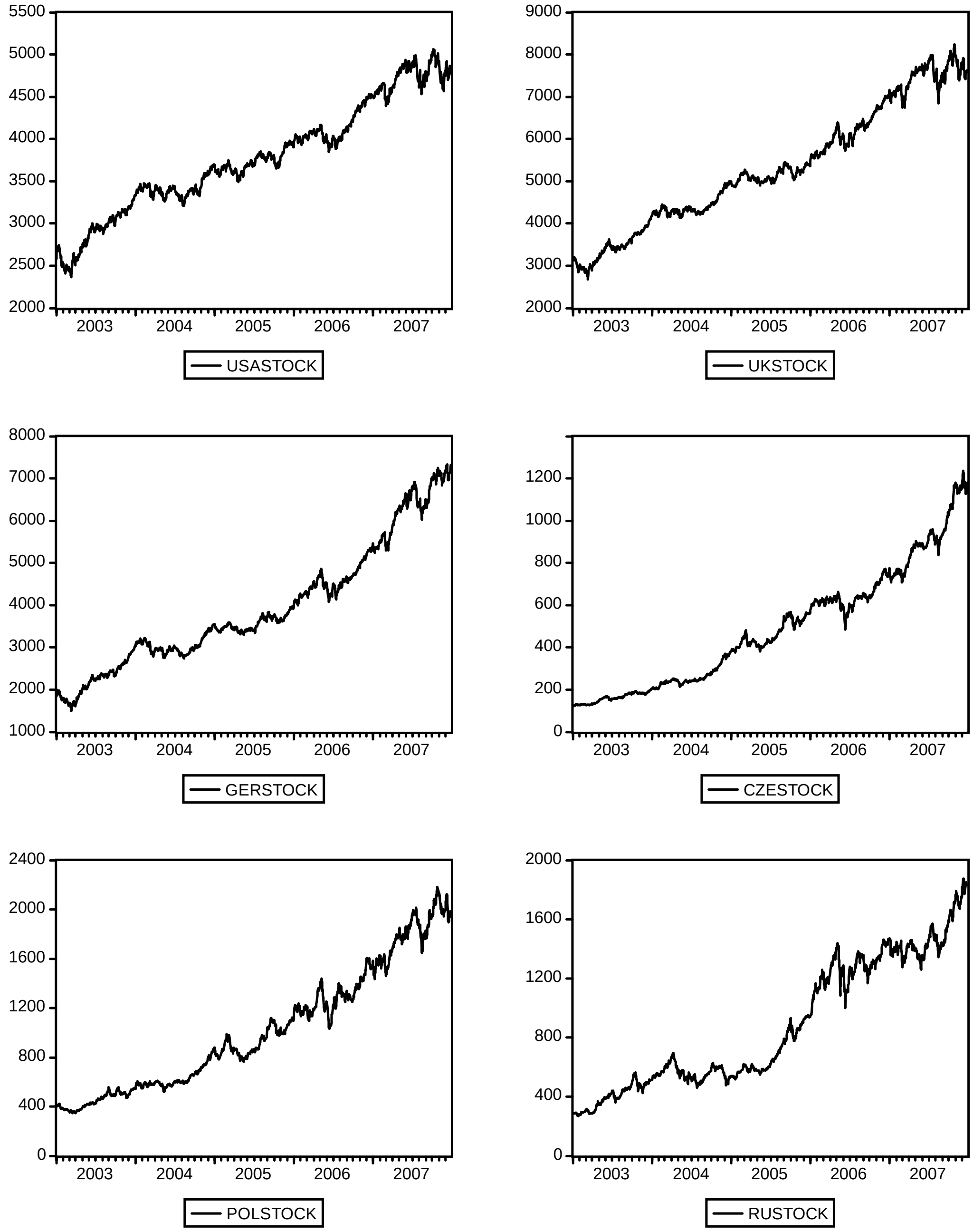
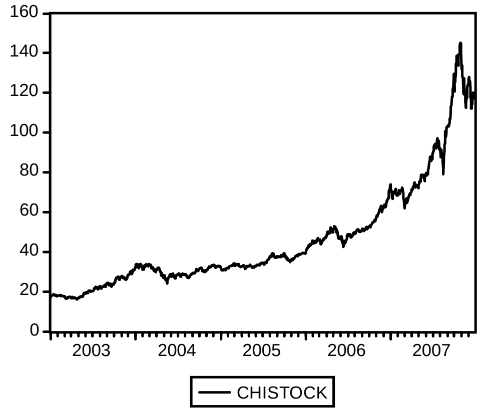
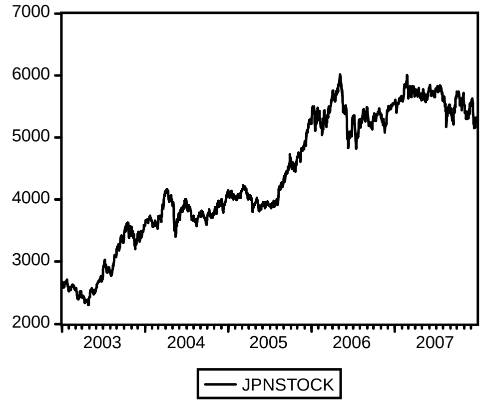
APPENDIX

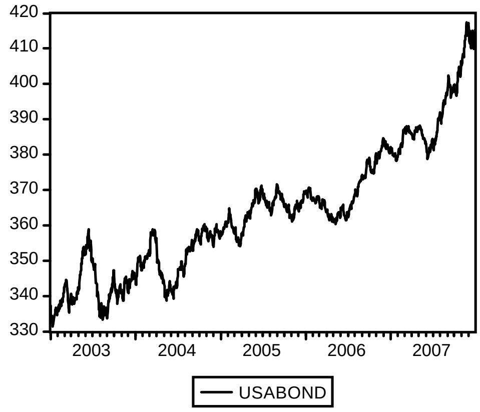
The performance of the stock and bond indices used in the study.

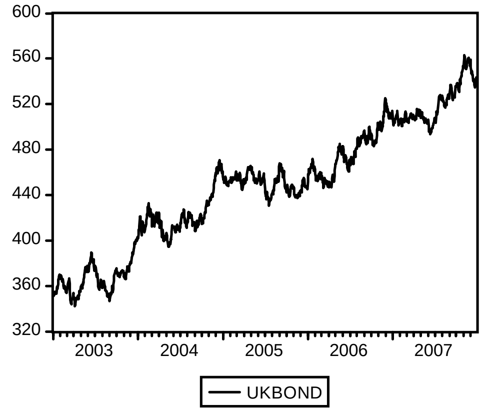


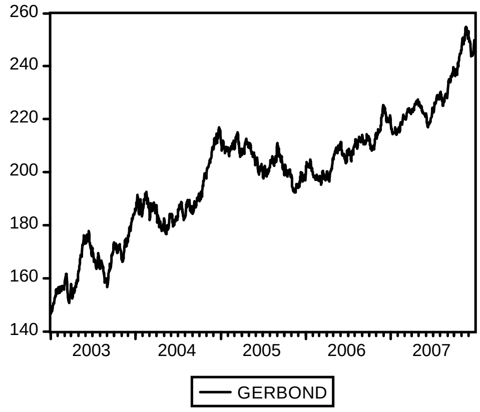
APPENDIX *Continued*

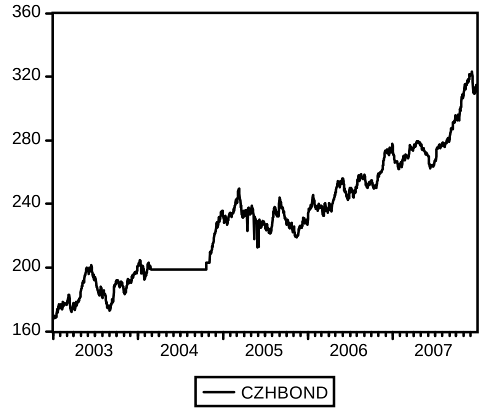












APPENDIX *Continued*