RESEARCH PAPERS OF WROCŁAW UNIVERSITY OF ECONOMICS
No. 59 2009
Global Challenges and Policies of the European Union
– Consequences for the "New Member States"

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ANALYZING THE FINANCIAL MARKETS LINKAGES – THE SUBPRIME CRISIS CASE

1. Introduction

Recent period of an extraordinary financial markets turbulence tends to ask an important question about the sources of this high volatility. "Crisis" seems to be the obvious but far too general answer. Thinking about the consequences of an extreme volatility we should be able to assess the significance of the fundamental and non-fundamental reasons that constitute financial market linkages during the time of crisis. In other words, we need to find out if we really do face contagion. However, before answering this serious question, we think some remarks about the phenomena of contagion would be very useful.

The theory of "contagion" has become widely popular among economists since Russian crisis in 1998. Russian default caused significant markets decline in far regions of the world, like Latin America, that seemed highly independent from Russian economic situation. This observation clearly revealed that during crisis, impulses from one financial market may be transmitted to foreign financial markets via different channels. This unusual transmission mechanism is called contagion.

Researchers split financial market linkages into two groups, i.e. fundamental and non-fundamental [Forbes, Rigobon 1999; Dornbusch et al. 2001], concluding these non-fundamental channels may be observed only, but not always, during the time of crisis.

International trade is an example of the fundamental-type linkage. When the country's A economy is expanding, its stock market usually soars. In the same time the demand for foreign goods rises, hence the volume of export of country's A main trade partners grows, causing foreign stock markets surge as the foreign investors discount higher expected sales according to better export results. The reverse situation occurs when country A steps into a phase of recession.

Another path of spreading fundamental impulses is a common response to the global shocks like oil price increase. Such adverse random shock may significantly alter the supply side of all affected economies causing fluctuations of the countries GDP rates and therefore constituting volatility of local financial markets.

Discussing crisis-specific market interconnections establishing the phenomenon of contagion economists emphasize the role of financial intermediaries that operate globally [Valdés 1997]. The typical balance sheet of financial institution consists of liquid liabilities and illiquid assets. When the depositors want to withdraw their deposits because of, e.g., idiosyncratic liquidity shock, the institution may be forced to liquidate its assets in order not to become insolvent. In such a case institution may sell its assets in these foreign countries where the economic fundamentals are still healthy, hence foreign assets are still fairly valued. Withdrawing capital on a large scale causes markets decline and a depreciation of the local currencies. In a case of currency peg central bank may be even forced to run devaluation. The described effects may significantly and adversely influence country's conditions despite the sound initial economic standing.

The second wide group of reasons causing increased market co-movements during crisis has its roots in information asymmetries and coordination problems [Dornbusch et al. 2001]. Investors whose portfolios are diversified globally may not have full information about particular country's economic condition. Receiving news that in some parts of the world one country is facing serious economic problems, they may think all neighborhood countries can be seriously influenced via fundamental channels, even if these fundamental linkages (e.g. foreign trade) are weaker than presumed. Nevertheless, information asymmetry may trigger herding behavior mechanism, which is very similar to this one described in the models of bank runs [Freixas, Rochet 2007]. Coordinated investors' expectations may therefore shift from "good" equilibrium to "bad" one for "suspected" economy, leading finally to serious economic troubles in a "suspected" country.

Both of these non-fundamental groups of reasons seem to be important in explaining observed high market volatility in CEE countries in recent months.

Since 2007 American financial institutions have experienced enormous liquidity problems. Forced to satisfy margin calls or to meet regulatory requirements they have had to sell their foreign assets in order to collect the necessary capital. At the same time the real threat of default of some CEE countries (Ukraine, Hungary, Latvia) might have created bad "market sentiment" to the whole region. In many press comments we could have read that global risk appetite has decreased hence foreign investors sell CEE countries assets [Bielecki 2009]. In spite of significant differences between countries of the region, foreign investors tended to assess for some time all CEE countries homogeneously (potentially insolvent) and market commentators concluded that all countries have been in the same risk basket [Jankowiak 2009].

We should think, however, whether distinguishing between fundamental and non-fundamental inter-markets linkages has any practical consequences. What conclusions can we draw testing empirically if during crisis periods markets interdependence rises significantly? There are at least two reasons leading us to the final inference that such exploration should be done [Forbes, Rigobon 1999].

First of all, changing correlations may undermine the sense of international diversification as the method of reducing portfolio risk. Such a finding may stimulate the research on other strategies of successful risk management in a global environment.

Secondly, information about potential channels of transmission can lead to valuable conclusions if there are considerations for using bail-out funds. If one country is adversely affected due to non-fundamental market linkages, loan from IMF may prevent its economy from serious decline. In another case, i.e. if country is affected because of strong fundamental relationships with country where crisis has originated, bail-out may not be as effective and may only prolong the period of necessary economy's adjustment.

In this paper we try to make the first step that approaches us to the final answer about the channels of spreading the subprime crisis from US to CEE countries.

2. Data and methodology

The dataset for this study consists of daily returns calculated for the most representative stock market indexes of 12 Eastern and Central European countries and the United States. Our sample covers different time periods, depending on availability of the data for particular country. Most of the data are drawn from the database of the financial information website http://stooq.com. A more detailed description of the contents and components of the examined dataset is presented in Table 1.

There are several methodologies that can be used for quantification of propagations of shocks across countries [Forbes, Rigobon 1999]. Firstly, the transmission of crisis is measured as the propagation of volatility using an autoregressive conditional heteroscedasticity (ARCH) framework. Secondly, changes in the long run relationship between two stock markets are measured as shifts in the co-integrating vector. Third, the propagation has been measured in terms of the contemporaneous correlation between stock markets: if the correlation coefficient increases significantly after the shock, this suggests that the transmission mechanism between the two markets increased and contagion occurred. The properties of the data introduces some limitations on the implementation of ARCH and co-integration[1] procedures, as well as on the proper interpretation of the results. Therefore in this study we will employ the latter, model-independent correlation approach.

[1] The most of the observed contagion events have been short run events and co-integrating techniques are unlikely to detect such dynamics.

Table 1. The description of the dataset components

Country	Name of the stock exchange	Stock market index	Data period	
			start date	end date
Bulgaria	Bulgarian Stock Exchange	SOFIX	2001-11-26	2009-03-03
Croatia	Zagreb Stock Exchange	CROBEX	1997-09-02	2009-03-03
Czech	Prague Stock Exchange	PX	1994-10-03	2009-03-03
Estonia	Tallinn Stock Exchange	OMX Tallinn	2000-01-03	2009-03-03
Hungary	Budapest Stock Exchange	BUX	1991-01-02	2009-03-03
Latvia	Riga Stock Exchange	OMX Riga	2000-01-03	2009-03-03
Lithuania	Vilnius Stock Exchange	OMX Vilnius	2000-01-03	2009-03-03
Poland	Warsaw Stock Exchange	WIG	1995-01-03	2009-03-03
Romania	Bucharest Stock Exchange	BET	2000-10-31	2009-03-03
Russia	RTS Stock Exchange	RTS	1995-09-01	2009-03-03
Slovakia	Bratislava Stock Exchange	SAX	1995-07-03	2009-03-03
Ukraine	PFTS Stock Exchange	PFTS	1997-11-03	2009-03-03
USA	NYSE/NASDAQ	DJCA*	–**	2009-03-03

* Dow Jones Composite Average is primarily made up of large market capitalization stocks; most of the components of the average are traded on the New York Stock Exchange, with the few others being traded on the NASDAQ.

** Starting date for the USA depends on starting date for a country in question.

Although the Pearson correlation coefficient is most common and widely used measure of the strength of linear dependence between two variables, Forbes and Rigobon [1999] present a proof which shows that heteroscedasticity in stock market returns can have a significant impact on estimates of cross-market correlations. For any distribution, when market volatility increases after the crisis, the unadjusted correlation coefficient will be biased upward. Since the correlation is biased, we could incorrectly conclude that the propagation mechanism increased and contagion occurred. In the same work, Forbes and Rigobon propose a technique for adjusting this bias. As a first step, they choose the threshold date and divide the sample which corresponds to the country under crisis (in this case – the USA) into two sets, so that the variance of stock returns x_t is lower in one group (l) and higher in the second group (h):

$$\sigma_x^h > \sigma_x^l . \tag{1}$$

The low-variance group is the period of relative market stability and the high-variance group is the period of market turmoil. Next, they define the relative increase in the conditional variance in the crisis country:

$$\delta = \frac{\sigma_x^h}{\sigma_x^l} - 1 . \tag{2}$$

Finally, they derive the following formula for the unconditional (adjusted) correlation coefficient:

$$\rho_t = \frac{\rho_t^u}{\sqrt{1+\delta\left(1-\left(\rho_t^u\right)^2\right)}}, \tag{3}$$

where: ρ_t – adjusted cross-market correlation coefficient,

ρ_t^u – unadjusted cross-market correlation coefficient.

The correlations in the form given by equation (3) will be utilized in this paper by performing the following pair-wise calculations:

$$\rho_t^k \equiv \left\{x_t^{\text{USA}}, x_t^j\right\}, \tag{4}$$

where: x_t^{USA} – returns in the USA stock market,

x_t^j – returns in market of the country *j*,

ρ_t^k – rolling-window adjusted cross-market correlation coefficient,

k – length of the window in days.

The parameter *k* may be interpreted as smoothing factor: the higher values of *k* will lead to less volatility in the resulting correlation series.

3. Empirical results

Before we proceed to the empirical results, three issues must be addressed. The first issue concerns the value of the parameter *k*. Due to fairly large number of observations, we set *k* = 180 days for all of the countries. The second issue is the choice of threshold date. We define our period of turmoil as lasting from 1th of July 2007 to the end of the sample. The one possible interpretation of this date is the start of the visible downward trend in the USA stock market, which is the most likely event to drive contagion. While this choice may appear debatable, the performed robustness tests[2] showed that this period definition does not affect substantially the central results. Lastly, consideration must also be given to the fact that markets in different countries are not open during the same hours. To control for this we compare opening value of the DJCA index with the closing value of the given country's index for the same working day.[3]

The resulting cross-market adjusted correlation series are grouped on the basis of geographical region and presented below in the form of the graphs (Figures 1-4).

[2] Not presented here due to space limitation.

[3] In the case of Russia we match DJCA closing value with the next day's RTS index opening value.

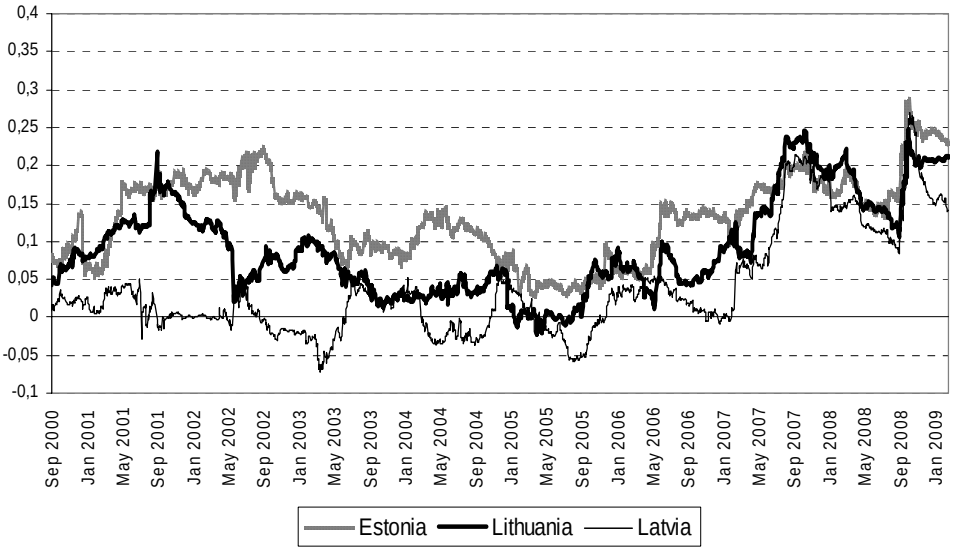

Figure 1. The adjusted correlation coefficients in stock returns: Estonia, Lithuania, Latvia

Source: own calculations.

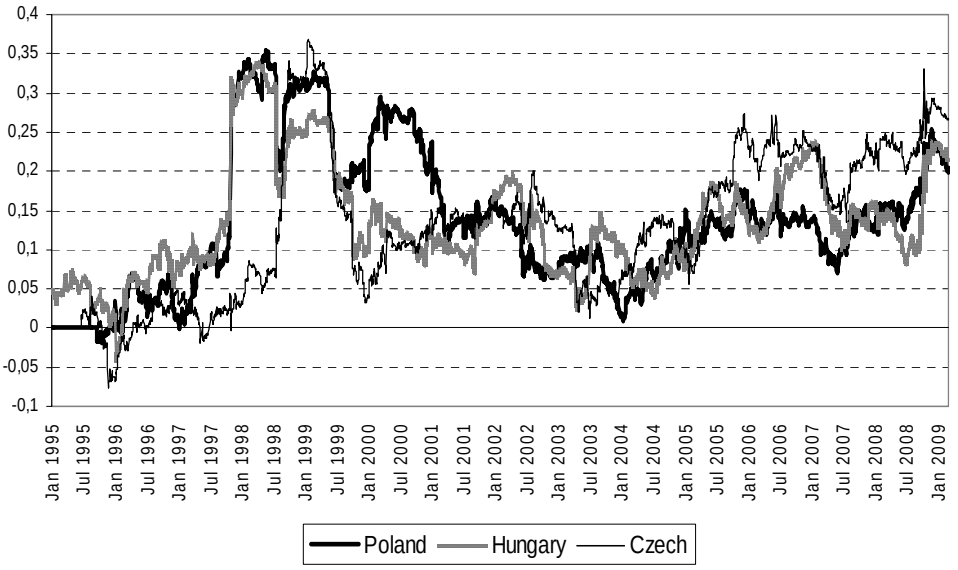

Figure 2. The adjusted correlation coefficients in stock returns: Poland, Hungary, the Czech Republic

Source: own calculations.

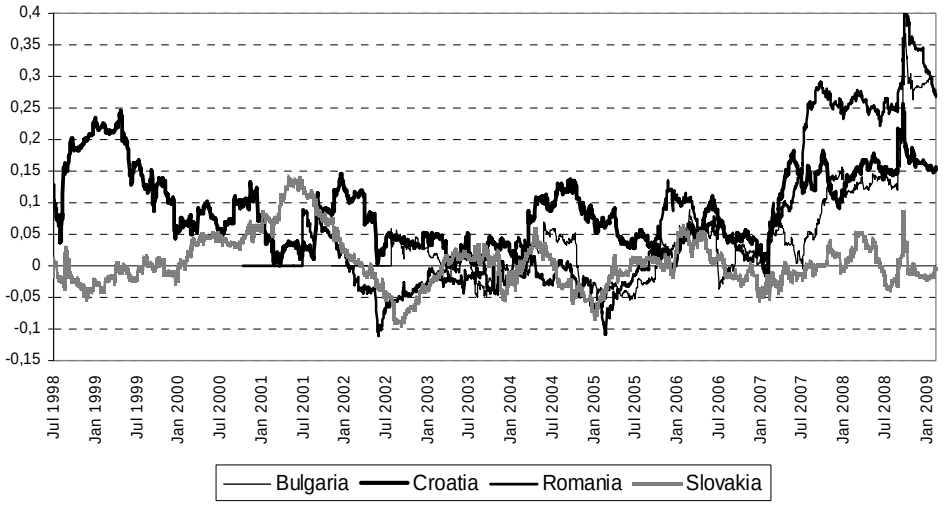

Figure 3. The adjusted correlation coefficients in stock returns: Bulgaria, Croatia, Romania, Slovakia

Source: own calculations.

Figure 4. The adjusted correlation coefficients in stock returns: Russia, Ukraine

Source: own calculations.

A serious limitation of this method is the lack of appropriate statistical test, which enables us to decide if the change in the value of correlation coefficient is significant, however, the eye-assessment may lead to some first findings in identifying the phenomenon of contagion.

Looking at the time series charts for the longest available period in cases of Poland, Hungary and the Czech Republic we find out that the highest values of the correlation were noticed in the year 1998. In that year we observe also the most rapid change of the coefficient's value. 1998 was the time when Russia defaulted, hence, we cannot reject the hypothesis that Russian crisis was transmitted to Europe not only via fundamental channels.

Analyzing data from the recent period we see that the interdependence between CEE and US stock markets gradually grows from the year 2007 reaching its local maximum in most cases in the end of 2008. The conclusion is therefore not straightforward: during the subprime crisis some new channels of transmission may have occurred, however, the gradualism of change is contrary in its nature to the "herding behavior" that is the essence of contagion. In our opinion higher interdependence between markets may be mainly the effect of predicting enormous in its size large negative global demand shock that significantly influences all the local economies.

The most surprising result, however, can be seen in the case of Slovakia. For the last few years, the correlation between Slovakian and US stock market was very low. This phenomenon can be explained by the fact that Slovakia is the only country in our sample that has already adopted euro currency. Foreign investors may then move out Slovakia from the "CEE risk basket".

4. Conclusions

Being aware of all the limitations of the method we use to identify contagion, we infer that the subprime crisis spreads somehow in a different way than the previous crisis, i.e. Russian default, where the presence of contagion was more evident due to the rapid change of correlation coefficient's value. We find out, however, another result that seems to be incontrovertible.

In the last years the hypothesis of decoupling the markets became one of the most widely discussed themes among both the academic and business economists. The hypothesis states that European and Asian markets, especially these emerging ones, no longer depend heavily on the US market performance. This theory is based on the observation that for the last years many emerging economies were growing very rapidly, hence their domestic markets are now much deeper and the domestic demand should become their main vehicle of the economic growth. After experiences from 2008, when market declines in emerging economies were usually bigger than in US, the hypothesis of decoupling was seriously weakened. We should therefore consider again the position of the US economy in the global world, paying special attention to the channels of transmission the market impulses.

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