University of Tartu
Faculty of Economics and Business Administration

CONTAGION OF FINANCIAL CRISES WITH SPECIAL EMPHASIS ON CEE ECONOMIES: A META-ANALYSIS

Andres Kuusk, Tiiu Paas

Tartu 2010

ISSN-L 1406-5967
ISSN 1736-8995
ISBN 978-9985-4-0571-0
The University of Tartu FEBA
www.mtk.ut.ee/research/workingpapers

Contagion of financial crises with special emphasis on CEE economies: a meta-analysis

Andres Kuusk, Tiiu Paas[1]

Abstract

The paper offers new insights on the subject of financial contagion using a meta-analysis methodology and paying particular attention to the transition economies of Central and Eastern Europe (CEE). The results show that on average, asset market correlations have increased during turbulent periods, but the increase is rather moderate. When correlation coefficients are adjusted for the presence of heteroscedasticity, the increase is considerably smaller, but still statistically significant. The crises have been more and less contagious, but the level of development of the chosen afflicted country seems not to have played a significant role in determining whether crises spread there or not. Transition economies in CEE have on average been somewhat less susceptible to financial contagion than the sample as a whole, but the increase in the asset prices correlation during times of crisis is statistically insignificant. Interestingly, the financial contagion 'snowball' seems to have affected the CEE transition economies most after crises in the US rather than one in Russia or the Czech Republic.

Keywords: financial contagion; meta-analysis.

[1] Andres Kuusk, PhD Student, Faculty of Economics and Business Administration, University of Tartu, Estonia. Narva Rd. 4, Tartu, 51009, Estonia. E-mail: hakeem@mtk.ut.ee

Tiiu Paas, Professor, Faculty of Economics and Business Administration, University of Tartu, Narva Rd. 4, Tartu, 51009, Estonia. E-mail: tiiu.paas@ut.ee.

The authors of the paper are grateful to the Estonian Science Foundation (research grant No 7756) and for the Estonian Ministry of Science and Education (grant No SF0180037s08) for their financial support. Views expressed in the paper are solely those of the authors and, as such, should not be attributed to other parties.

1. INTRODUCTION

Financial contagion has become an increasingly popular research topic recently. Several crises in 1980's, 1990's and in the present century have spread rapidly to other countries that were sometimes quite different in size and economic structure and even hemisphere than the country of origin. Economics researchers have borrowed an expression from epidemiology to describe this phenomenon as financial *contagion*. According to Rigobon (2002) the issue of *contagion* has been one of the most debated topics in international finance since the Asian crises. The events of the last year that have involved yet another financial crisis' 'snowball' rolling around the world, show that developing an understanding of financial contagion would clearly be beneficial for policy makers hoping to manage and avoid future spreads of crises.

One of the main interests of contagion studies is connected to the merits of international diversification of risks. The rationale being that international diversification should theoretically significantly reduce the portfolio risk, but when cross-country correlations increase during crises, much of the rationale is undermined. Questions about appropriate financial architecture and investment opportunities and risks to local markets can also be answered by studies of financial contagion. The phenomenon of contagion is by no means merely historic. As argued by Didier, Mauro and Schmukler (2008) the factors underlying the channels that generated contagion during the crises of the 1990s seem to be potentially at least as strong today as a decade ago.

The case of transition countries in Central and Eastern Europe (CEE) is particularly interesting in view of their entry into the third stage of European Economic and Monetary Union. The Maastricht criteria require that candidate countries should not have devalued their currency in the two years before adoption of the euro and should also have avoided sharp movements of some other financial variables like inflation and long-term interest rates. In the context of financial turmoil these criteria are not likely to be met. This paper examines the question of whether recent frequent instabilities in transition countries' stock markets and exchange

rates have been rather due to financial contagion or poor policies and fundamentals. It also investigates whether transition economies in CEE have been more or less susceptible to the financial contagion than the developed and other developing countries.

The paper adopts meta-analysis as its methodology, and as far as the authors are aware. No meta-analysis on the subject of financial contagion has been conducted before. It is hoped that the meta-analysis will provide answers to the questions above and some new insights into the financial contagion puzzle.

The paper consists of three sections. In the next section alternative definitions, channels spreading contagion, testing methodologies and recent empirical results are discussed. In the third section, a quantitative analysis of empirical findings using meta-analytic tools is conducted and finally, the paper's brief conclusions are presented.

2. THEORETICAL CONSIDERATIONS AND EMPIRICAL EVIDENCE OF FINANCIAL CONTAGION

2.1. Alternative definitions of financial contagion

In spite of significant theoretical and empirical interest in the topic there is still no consensus on either the definition or the transmission channels of financial contagion. Economic literature offers conceptually different definitions of financial contagion. Using the Contagion of Financial Crises Website summary (The World Bank Group 2001), we can distinguish at least three different definitions of financial contagion:

1) Definition 1. Contagion is the cross-country transmission of shocks or the general cross-country spillover effects which have been emphasized during the time of a crisis. Contagion

can be observed through co-movements of different financial indices in different countries or rising probabilities of default if the crisis occurs elsewhere. Unlike other definitions, this one includes fundamental linkages as a channel of contagion.

2) Definition 2. Contagion is the transmission of shocks to other countries or the cross-country correlation, beyond any fundamental link shared by the countries and beyond common shocks. For example Masson (2004) defines contagion as meaning only those transmissions of crises that cannot be identified with observed changes in macroeconomic fundamentals. Using an alternate testing methodology, Eichengreen *et al* (1996) argue that there is contagion if the probability of a crisis in a given country increases conditionally on the occurrence of a crisis elsewhere, after controlling for the standard set of macroeconomic fundamentals. This definition is sometimes referred as *excess co-movement* – a correlation that remains even after controlling for fundamentals and common shocks. Herding behaviour is usually said to be responsible for comovement beyond that expected. Fundamental linkages are distinguished from contagion in most of the literature.

3) Definition 3. Contagion occurs when cross-country correlations increase during "crisis times" relative to correlations during "tranquil times." Alternatively, as Forbes and Rigobon (1999) put it: contagion is a significant increase in cross-market linkages after a shock. This definition is sometimes referred as shift-contagion. Forbes and Rigobon (1999) stress that this notion of contagion excludes a constant high degree of comovement in a crisis period. In this case, markets are just interdependent.

In addition to the abovementioned approaches to explain financial contagion, we can also rely on some other and even more extreme definitions of this phenomenon. For example according to Sola *et al* (2002) there is contagion if the probability of having a crisis at home is equal to one if the crisis hits another market; on the other hand Bae *et al* (2003) consider coincidence of extreme return shocks across countries as evidence for contagion.

2.2. Transmission channels

The understanding of the financial contagion phenomenon is closely related to its transmission channels. However, authors of papers on financial crises have not yet achieved consensus on the channels through which contagion spreads. Several trade issues, the macro environment, the common lender, market psychology amongst others, have been considered as determinants of the degree of contagion. The different opinions are well summarized by The World Bank Group (2001): "Some claim that contagion is explained by real links, while others provide a financial explanation. At the same time, other studies argue that herding behavior is the key element to understand the recent contagious episodes. Although one can show that these factors are present in the cross-country transmission of crises, an even more difficult problem is to determine the relative importance of each component." This summary accords with the statement by Dornbusch *et al* (2000): "not only the exact causes and channels of contagion are not known, neither are the precise policy interventions which can most effectively reduce it".

In the last decade a distinction has been made between *contagion* and *interdependence* according to the transmission channels of each (see also Rigobon 1999 and Kleimeier *et al* 2008). If crises are transmitted through stable fundamental linkages, then only countries with weak economic fundamentals will be affected and good fundamentals can offer protection. On the other hand, if irrational behaviour by the agents (in the form of speculative attacks, financial panic and/or herd behaviour) is the transmission force, then even countries with good fundamentals can be seriously affected. In the former case we have only interdependence and not contagion between countries, while in the latter case we have true contagion. Considering this distinction the first definition presented above may be only of interdependence and not contagion.

In summary, it is possible to distinguish at least three fundamental links that explain transmission channels (see also The World Bank Group 2001). These links are: 1) financial; 2) real; 3) political.

There are financial links between countries when those countries are connected through international financial system. Two examples are given by The World Bank Group (2001). Firstly, financial links can be distinguished when leveraged institutions face margin calls. When the value of their collateral falls, due to a negative shock in one country, leveraged companies need to increase their reserves. Therefore, they sell part of their valuable holdings in the countries that are still unaffected by the initial shock. This mechanism propagates the shock to other economies. Secondly, financial links can be distinguished if open-end mutual funds foresee future redemptions after there is a shock in one country. Mutual funds need to raise cash and, consequently, they sell assets in third countries. According to Didier, Mauro and Schmukler (2008) financial links appear to have been the main transmission channel of the Mexican 1994 crisis. Also Baig and Goldfajn (1999), Caramazza *et al* (2004), Kaminsky and Reinhart (2000) and Van Rijckeghem and Weder (2001) have argued that financial links formed the main channel of transmission of shocks across countries during the 1990s. (For those models see Calvo 2005, Calvo and Mendoza 2000 and Kaminsky and Reinhart 2000).

Fundamental economic relationships between countries are labelled real links. The most commonly considered economic relationships are when countries are connected through international trade. An example given by The World Bank Group (2001) says that when two countries trade among themselves or if they compete in the same foreign markets, a devaluation of the exchange rate in one country deteriorates the other country's competitive advantage. As a consequence, both countries will likely end up devaluing their currencies to re-balance their external sectors. Eichengreen and Rose (1999), Forbes (2001) and (2004) and Glick and Rose (1999) investigated the 1992–1993 European Exchange Rate Mechanism (ERM) crisis, the 1994 Mexican crisis, the 1997 Asian crisis, and the 1999 Brazilian crisis and have argued that trade links are the primary channel through which crises were transmitted to other countries. On the other hand Didier, Mauro, Schmukler (2008) argue that although the trade channel seems to have played a role, to different degrees, in the crises of the 1990s, it does not explain the contagion observed in

the context of the 1998 Russian crisis, where trade links, either bilateral trade or third party competition, among the affected countries were quite limited. Thus, the experience of the Russian crisis suggests that trade is unlikely to be the only channel of contagion and also other channels are necessary to account for the evidence. (For models of contagion based on trade linkage and macroeconomic similarities see Eichengreen *et al* 1996, Goldstein 1998 and Gerlach and Smets 1995).

Political links describes the situation when there are political relationships between countries. Usually that means that countries' exchange rates are closely tied. The World Bank Group (2001) gives the following example based on a country belonging to an association or "club of countries," with an exchange rate arrangement – then the political cost of devaluing is much lower when other countries have devalued. Therefore, crises tend to be clustered. A crisis in one country is followed by crises elsewhere.

Hernandez and Valdez (2001) investigate the relative importance of alternative fundamental links during the Thai, Russian, and Brazilian crises. Results differ according to whether the dept of a crisis is measured by changes in sovereign bond spreads or by stock market returns. In the former case, financial links seem to be the clearly dominant transmission channel. In the latter case both trade links and neighbourhood effects appear to be relevant contagion channels during the Thai and Brazilian crises, while financial competition remains the only relevant channel in the case of the Russian crisis.

Many authors have found that fundamental links (and common shocks) do not fully explain the relationship and changes in relationships among countries. That being the case, herding behaviour is suggested as a reason for spillover effects between countries. Herding behaviour arises when information about countries' fundamentals is incomplete and asymmetric, there are no serious restrictions for investors choosing their moves and information is too costly for the less informed investors. So instead of making expenses for getting information these rather un-informed investors are watching the action of others, supposedly well informed, investors and then trying to follow them as they

think these actions reflect the future price changes. It follows that the whole market moves jointly. In reality, those supposedly well-informed investors may not be acting based on their information about countries' fundamentals, but just adjusting their portfolios after being damaged by a crisis elsewhere. In the circumstances of that kind of herd behaviour and the world of multiple equilibria, even countries with sound fundamentals are not protected. According to Alvarez-Plata and Schrooten (2003) the pull effect caused by investors all behaving in the same way makes economic fundamentals unimportant and leads to the rapid withdrawal of capital from the economies concerned, and possibly even from entire regions. Claessens *et al* (2001) argue that as spreads are directly reflecting the risk perception of financial markets, pure contagion may be solely the result of the behaviour of investors or other financial agents.

Support for the idea of the transmission of crises based on herd behaviour has been found by many authors. Eichengreen, Rose and Wyplosz (1996) highlight that the countries that came under speculative attack during the ERM crisis had heterogeneous macroeconomic fundamentals, and only in some cases could the attack be justified by the fundamentals. Pindyck and Rotemberg (1990 and 1993) find that after taking into account common fundamentals there is still residual co-movement across stocks with very different industry and idiosyncratic fundamentals. These results point to the important role played during the crisis by investors and speculators behaving irrationally. Also Moussalli (2007), Alvarez-Plata and Schrooten (2003) and Woo (2000) have argued that herding is the main channel for spillover effects between countries.

Somewhat ironically, at a private level, it might be rational to follow the herd for the same reason that information is too costly for the individual investor, so looking at the market reaction or to opt for general investment strategies may be the rational solution. However, as seen from the previous, at a public level, contagion can be very costly. In addition, and even more alarmingly, asymmetric information seems not to be an absolutely necessary condition for multiple equilibria to occur. Jeanne and Masson (2000) have pointed out, that there can be multiple equilibria even

with complete and symmetric information - if investors are sufficiently forward-looking.

2.3. Empirical studies of financial contagion

Thus, economic literature provides heterogeneous views on financial contagion and its transmission channels and it is therefore understandable that the results of empirical studies vary significantly depending on several factors. The drawing of some final conclusions on financial contagion based on empirical evidence is therefore undermined. We investigated around 75 empirical analyses of financial contagion (see also appendix) in one of our earlier papers and found that there are almost no pairs of studies that are identical in their definitions of financial contagion, testing methodology, chosen crises, financial markets and destination countries, but all of these aspects may influence the results of empirical studies. Even in the most widely used approach of focusing on co-movements in asset prices, there are substantial differences caused by whether correlations are adjusted for the presence of heteroscedasticity or not. In addition, the problems of omitted variables, feedback dependencies between stock markets, different time zones, and arbitrary choices of the crisis window can all affect tests of contagion (see also Billio and Pellizon (2003) and Dungey and Zhumabekova (2001) for an informed study on the subject). The results of the analysis confirm the opinion that empirical studies mainly provide heterogeneous results depending on applied definitions and methods and chosen crises, destination countries and financial indices.

Evidence both confirming and denying the presence of financial contagion has been widely found in recent empirical analyses and there is no clearly dominant finding. Naively counting numbers examining several aspects of contagion, we can conclude that evidence for contagion during financial crises has been found more often than not. On the other hand, this result is mostly obtained when the presence of heteroscedasticity is not taken into account; the papers that control for heteroscedasticity find evidence for financial contagion far less often. Therefore we are aware that in

many cases the results of empirical analyses may be biased and serious additional investments into examining possible consequences of financial crises are still necessary. We conclude that qualitative analysis of published research materials (see appendix) about previous financial crises does not give sufficient information to elaborate proper measures to permit prevention of serious consequences of financial crises, and propose that it is possible to obtain a better picture of financial contagion by using a meta-analysis.

2.4. Financial contagion in case of CEE transition economies

The literature investigating financial contagion in the case of transition economies is rather vague focusing mainly on three CEE economies (Hungary, Poland and the Czech Republic). Wang and Moore (2008) investigate the co-movement of these three major CEE emerging markets with the aggregate euro zone market by using the DCC technique[2] and find significant dynamic correlations for these markets with the euro zone market during the financial crises and a higher level of linkage in the aftermath of crises. Their findings include the fact that the increase in stock market co-movements cannot be explained by the macroeconomic convergence process, nor by monetary convergence with the euro zone, thus they find evidence in favour of financial contagion.

Gelos and Sahay (2001) find that correlations in exchange market pressures can be explained by direct trade linkages, but not by measures of other fundamentals. They find no contagion from the Czech Republic and Asia to CEE stock markets but shocks to the Russian stock market Granger-caused movements in the Czech, Hungarian and Polish stock markets – clear evidence for the presence of spillover channels other than standard macroeconomic linkages, that is, contagion.

[2] The DCC measures the contemporaneous conditional correlation between the two series and has been used to provide an indirect measure of the degree of integration between the stock market in the eurozone and the new EU countries.

Weller and Morzuch (2000) argue that both historically as well as during the recent global financial turmoil, default risk has been lower in CEE countries than in other emerging economies. Serwa (2005) use the extension of the models presented by Forbes and Rigobon (2002) and Corsetti, Pericoli, and Sbracia (2005) to investigate seven crises in a sample of some CEE and Western European countries and found that contagion occurred at best infrequently during the investigated crises.

Jokipii and Lucey (2006) investigate the co-movements in the banking sector in Poland, Hungary and the Czech Republic over about 10 years. They find that contagion seemed to move from the Czech Republic to Hungary.

In summary, recent studies that focus on financial contagion issues in the CEE countries have found evidence both for and against financial contagion. The limited number of these studies makes it difficult to draw any definitive conclusions from a qualitative literature review.

3. META-ANALYSIS OF FINANCIAL CONTAGION

3.1. The main features of meta-analysis

Meta-analysis is a research method to synthesize previously obtained empirical research results. The purpose of meta-analysis is reviewing and quantitatively summarizing the literature using statistical approach (de Dominicis *et al* 2006). There are different approaches and methodologies used in what may be termed meta-analysis, and there is as yet no unequivocal definition of meta-analysis.

The term meta-analysis was first coined by Gene Glass in 1976, although some procedures later known as meta-analytic (for example the concept of effect size) were already present in Karl Pearson's study in 1904. In Glass's definition "Meta-analysis refers to the statistical analysis of a large collection of results from

individual studies for the purpose of integrating the findings. It connotes a rigorous alternative to the casual, narrative discussions of research studies which typify our attempt to make sense of the rapidly expanding research literature" (Glass 1976). For Schultze (2004), meta-analysis is a method for systematic literature reviews on a certain substantive question of interest, more specifically in his words: "meta-analysis is a systematic process of quantitatively combining empirical reports to arrive at a summary and an evaluation of research findings".

Basu (2003) defines meta-analysis as "the synthesis of available literature about a topic. Ideally, synthesis of randomized trials to arrive at a single summary estimate is used". In James Neill's (2006) version "Meta-analysis is a statistical technique for amalgamating, summarizing, and reviewing previous quantitative research". The simplest definition we have seen was given by Hunter and Schmidt (1990) who defined meta-analysis as the "analysis of analyses".

In abstract term, meta-analysis combines the results of several studies that address a set of related research hypotheses. Usually this is done by identification of a common measure. This common measure is called effect size. Individual effect sizes are aggregated and after study characteristics are controlled, the resulting overall results can be considered meta-effect sizes.

The many advantages meta-analysis has over the traditional literature review have been pointed out, of which the most important are:

- Quantitative estimation and statistical testing of overall effect sizes
- Generalization to the population of studies
- Finding moderator variables to explain heterogeneity in distribution

3.2. Data

To find very recent appropriate studies for meta-analysis we used the ISI Web of Knowledge database and additionally the Contagion of Financial Crisis Website by The World Bank Group for somewhat older ones. From the ISI Web of Knowledge database the studies including the keywords *financial contagion* are used. We define financial contagion as the increase in cross-country correlations during "crisis times" relative to correlations during "tranquil times." Thus we follow the most common definition sometimes called shift-contagion that was first proposed by Forbes and Rigobon (1999) who stated that contagion is a significant increase in cross-market linkages after a shock. This notion of contagion excludes a constant high degree of co-movement in a crisis period, in which case markets are merely interdependent. Therefore only the studies that report both pre- and post-crisis asset prices correlations (or their difference) between countries are included in the sample. Because of these restrictions we are left with 716 effect sizes in our dataset (394 of which are independent) from 30 constructs (17 independent). If both short- and long-term post-crisis correlations are reported we use the short-term data, as we cannot use both because of the independency problems (about independency problems see further).

3.3. The steps to implementation of the meta-analysis

Our analysis can be divided into five parts which include:

1) calculating relevant individual effect sizes and controlling for their independency

2) compute the effect size weighted mean for which special weights have to be calculated

3) determine the confidence interval and statistical significance of the effect size weighted mean

4) homogeneity testing

5) conclusions and interpretations.

Conducting the first step relies on finding appropriate individual effect sizes. Different effect size statistics are worked out to code the different forms of the quantitative study findings. The various effect size statistics are based on the concept of standardization. The effect size statistic produces a statistical standardization of the study findings, such that the resulting numerical values are interpretable in a consistent fashion across all the variables and measures involved. Therefore, we have to define an effect size statistic capable of representing the quantitative findings of financial contagion studies in a standardized form that permits meaningful numerical comparison and analysis across the studies. (see Lipsey and Wilson 2001). It is found that good effect size statistics consider both the magnitude and the direction of a relationship, not merely its statistical significance. In addition, they are defined so that there is relatively little confounding with other issues, such as sample size (Lipsey and Wilson 2001).

A single research finding in the field of financial contagion is a statistical representation of one empirical relationship between the pre- and post-crisis correlation of asset prices. A purpose of the meta-analysis is to aggregate all these individual findings into one meta-effect size. The literature provides no rules for which are the correct effect sizes for changes in correlation coefficients. For one thing, it is not obvious whether we should handle the data as pre-post contrasts or as an association between variables. On the one hand, we have correlation coefficients and even if we are not interested in themselves, but their changes across two points in time, it is not quite clear why these two approaches differ so much (in terms of the properties of effect sizes) that we could not use the same computational procedures. So, why not just take the effect sizes as correlations and live with that? On the other hand, we have data points for both before and after crises (which we can take as treatment) and we are interested in difference between them, the gain to be precise. Classical pre-post contrasts situation, is not it?

Whichever of these two approaches we choose, it seems that the real difference comes into play while calculating the (weighted) mean effect sizes (step 2) and their variances. When calculating individual effect sizes it seems irrelevant. The difference between post- and pre-crisis correlations is by far the most logical

individual effect size for a given study (construct). Mathematically, our individual effect sizes are computed as:

$$(1) \qquad ES_i = r_{post_i} - r_{pre_i}$$

where ES_i is the individual effect size for study (construct) i and r_{pre_i} and r_{post_i} are pre- and post-crisis correlations respectively for study (construct) i.

In dealing with our effect sizes as correlations we modify the effect sizes somewhat, because of the problematic standard error formulation (these problems are discussed in more depth by Rosenthal 1994). The widely accepted method for doing that is by transforming the correlations using Fischer's Z_r-transformation (see Hedges and Olkin 1985):

$$(2) \qquad ES_{Z_r} = 0.5 \ln\left(\frac{1+r}{1-r}\right)$$

where r is the correlation coefficient. The necessity for calculating standard errors (and therefore need for Fischer's Z_r-transformation) comes into play when calculating weighted mean effect sizes (see further (step 2 and 3)).

Note that not all authors agree on the necessity of Fischer's Z_r-transformation for correlation coefficients as effect sizes. For example Hunter and Schmidt (1990) argue that the transformation gives results that are upward biased and standard correlations are more precise. However, some other authors claim that standard correlation effect sizes are downward biased and it is not clear which bias is greater and the main problem with standard correlations, that is problematic computation of standard errors and weights, remains.

Later to interpret the results we transform them back into the standard correlation form using the inverse of the Z_r-transformation (Hedges and Olkin 1985):

(3) $$r = \frac{e^{2ES_{Z_r}} - 1}{e^{2ES_{Z_r}} + 1}$$

Moving forward to step 2 we need to aggregate all individual effect sizes into one meta-effect size. Therefore, we have to derive an overall value from the meta-sample by pooling all the estimates and deriving an overall summary statistic. We use the traditional approach of meta-analysis assuming that the best estimate for the population effect size is the weighted average of the individual effect sizes.

We use standard statistical software SPSS and some macros written by David Wilson, that are available via his home page for computational and statistical purposes.

After calculating the individual effect sizes their weights have to be determined so that an overall value can be found. Hedges (Hedges 1982; Hedges and Olkin 1985) has demonstrated, that the optimal weights are based on the standard error of the effect size. Because a larger standard error corresponds to a less precise effect size value, the actual weights are computed as the inverse of the squared standard error value - called the inverse variance weight in meta-analysis. For the mean differences (gains) and correlation coefficients that are used in the present analysis, the standard error formulation has been worked out.

We use those standard error based inverse variance weights for calculating correlation coefficients based effect size mean. The standard error formula for correlation based (after Fischer's z-transformation (see earlier)) effect size mean is the following:

(4) $$SE_{Z_r} = \frac{1}{\sqrt{n-3}}$$

and inverse variance weights therefore:

(5) $$w_{z_r} = n - 3$$

where n is the sample size of the individual effect size in both formulas.

However we do not have the data necessary to calculate the effect size mean when treating individual effect sizes as treatment effects. More precisely, we lack information on the correlations between pre- and post-treatment asset prices in individual studies. Therefore the sample size is used as the weights instead.

The formula for calculating the weighted mean effect size is the following:

$$\bar{d} = \frac{\sum d_i w_i}{\sum w_i} \tag{6}$$

where d_i is the *i*-th individual effect size and w_i is weight (inverse variance weight in case of correlation coefficients and sample size for treatment effects) of the *i*-th effect size.

The next step raises the question of the homogeneity of the effect size distribution. In other words, whether the various effect sizes that are averaged into a mean value all estimate the same population effect (see Hedges 1982, Rosenthal and Rubin 1982). In a homogeneous distribution, the dispersion of the effect sizes around their mean is no greater than that expected from sampling error alone (the sampling error associated with the subject samples upon which the individual effect sizes are based). In other words, in a homogeneous distribution an individual effect size differs from the population mean only by sampling error. A statistical test that rejects the null hypothesis of homogeneity indicates that the variability of the effect sizes is larger than would be expected from sampling error and, therefore, each effect size does not estimate a common population mean. In other words, there are differences among the effect sizes that have some source other than subject-level sampling error, perhaps differences associated with different study characteristics. The homogeneity test is based on the Q statistic, which is distributed as a chi-square with $k-1$ degrees of freedom where k is the number of effect sizes (Hedges and Olkin 1985). The formula for Q is:

(7) $$Q = \sum \left[w_i \left(ES_i - \overline{ES} \right)^2 \right]$$

where ES_i is the individual effect size for $i = 1$ to k (the number of effect sizes), $\overline{ES}$ is the weighted mean effect size over the k effect sizes, and w_i is the individual weight for ES_i. If Q exceeds the critical value for a chi-square with $k - 1$ degrees of freedom, then the null hypothesis of homogeneity is rejected. A statistically significant Q, therefore, indicates a heterogeneous distribution.

An alternative approach to homogeneity testing, known as the 75% rule, is provided by Hunter and Schmidt (1990). It involves partitioning the observed effect size variability into two components - the portion attributable to subject-level sampling error and the portion attributable to other between-study differences. According to their rule of thumb, the distribution is homogeneous if sampling error accounts for 75% or more of the observed variability.

3.4. Results and discussion

The results of the analysis based on the whole sample

As a preliminary analysis we use all 716 effect sizes in the sample as independent data points. This approach is admittedly somewhat dubious because there are some effect sizes within the studies that differ only by the methods of measurement chosen, and therefore the independency assumption between different data points is violated. Later on we deal with that problem by choosing the appropriate weights to avoid overestimating the results of those duplicate effect sizes within the studies.

Using the abovementioned formulas (1)-(6) we arrive at an estimate of the population effect size of 0.054 when we treat the individual effect sizes as treatment effects (here Approach 1) and 0.065 when we treat the individual effect sizes as correlation coefficients (here Approach 2). Thus on average the asset prices

correlations have indeed increased during the turbulent periods but to a quite moderate extent. The standard errors are 0.0035 and 0.0036 respectively and the 95% confidence intervals well above zero in both cases.

By calculating the Q statistic using the abovementioned formula (7) we arrive at a of 3680.5 which is clearly over the critical value of 778 (degrees of freedom = sample size – 1; probability (p-value) = 0.05). Therefore, the dispersion of the effect sizes around their mean is greater than that expected from a sampling error alone and therefore each effect size does not estimate a common population mean.

As stated above, we have some independence problems in the data. There are cases for multiple effect sizes within the same studies. That negates the independence assumption and overestimates the weights of the studies with multiple effect sizes. The traditional way to deal with the situation is to choose only one effect size per study per construct. However, this approach does not use some information contained in the primary studies and we definitely do not want to lose the information on different correlation measurement methodologies as possible moderators. It is well known that correlation coefficients adjusted for heteroscedasticity are lower than unadjusted ones and therefore the contagion seems to be more likely to occur in case of unadjusted correlation coefficients. Therefore, rather than dropping some of the data points, we diminish the weights of studies with multiple effect sizes per construct by dividing the sample size by the number of effect sizes per construct. (For discussion on multiple measurements within studies see also Rosenthal 1994)

Using this slightly modified sample (results are given in Table 1 below) we find the weighted average effect size to be 0.053 in approach 1 and 0.072 in approach 2 with standard errors of 0.0047 and 0.0049 respectively. With 95%-confidence intervals easily above zero, we can conclude that asset prices' correlations have increased during turbulent periods.

Table 1. Results of financial contagion meta-analysis

	Sample size	Effect sizes as treatment effects (Approach 1)			Effect sizes as correlation coefficients (Approach 2)		
		Mean ES	Stand. error (ES)	Q statistic	Mean ES	Stand. error (ES)	Q statistic
All	716	0.053*	0.005	2782.0*	0.072*	0.005	5568.0*
U	159	0.168*	0.007	956.7*	0.208*	0.007	3432.2*
A	545	0.030*	0.007	668.0*	0.030*	0.007	716.1*
Tha 1997	86	0.132*	0.007	853.9*	0.173*	0.007	3367.1*
HK 1997	154	0.010*	0.009	295.6*	0.098*	0.009	323.0*
Rus 1998	46	-0.001	0.027	48.8	0.006	0.027	52.5
Bra 1999	33	-0.016	0.039	17.33	-0.014	0.039	15.4
Prewar	344	0.045	0.026	165.8*	0.059*	0.028*	197.3*
Mex 1994	372	0.141*	0.038	45.7	0.161*	0.045	39.0
US 1987	70	0.185*	0.062	5.8	0.181*	0.071	4.7
Ind 2004	68	-0.091*	0.028	122.0*	-0.116*	0.031	153.5*
Tur 2001	19	-0.194*	0.055	22.2	-0.209*	0.066	19.3
US 2001	82	0.014	0.055	22.4	0.019	0.066	17.8
Arg 2001	33	-0.374*	0.015	126.6*	-0.391*	0.015	156.6*
US 2002	33	0.126*	0.055	12.8	0.133*	0.066	10.3
Cze 1997	45	0.057	0.039	26.2*	0.058	0.041	26.3*
Emerg	33	0.054*	0.006	2254.3*	0.078*	0.006	5116.5*
Devel	14	0.052*	0.009	527.6*	0.051*	0.008	555.8*

ES - effect size
U – cases with unadjusted (for heteroscedasticity) correlation coefficients
A - cases with adjusted (for heteroscedasticity) correlation coefficients
Tha – Thai crisis, HK – Hong Kong crisis, Rus – Russian crisis, Bra – Brazilian crisis, Mex – Mexican crisis, US – United States of American crisis, Ind – Indian crisis, Tur – Turkish crisis, Arg – Argentine crisis, Cze – Czech crisis, Prewar – average of 6 pre-World War II crises (Argentine crisis 1890, Baring crisis (UK) 1890, US banking crisis 1893, US stock market crash 1929, Sterling crisis (UK) 1931, devaluation of the dollar (US) 1933)
Emerg – cases with countries outside top 30 according to Human Development Index 2008
Devel – cases with first 30 countries according to Human Development Index 2008

Source: authors' calculations

However, testing for homogeneity and calculating Q-statistics for that purpose reveals that the distribution is heterogeneous and therefore the individual effect sizes may not estimate the same population effect. Therefore we continue by searching for moderators to explain the variability in effect sizes. As mentioned

above, the correlation coefficients' calculating methodology is widely accepted as a significant explanatory variable for financial contagion. The logic being that when not adjusted for heteroscedasticity, the post-crisis correlations are higher and therefore finding evidence for contagion is more probable. To control the correlation coefficients measurement as a potential moderator, we divide our sample into two parts that distinguish heteroscedasticity adjusted (A) and unadjusted (U) correlation coefficients in turbulent periods. For the sample with unadjusted correlation coefficients, we find the weighted mean effect size to be 0.168 using approach 1 and 0.208 with approach 2. For the sample with heteroscedasticity adjusted correlation coefficients, the respective values are 0.030 for both approaches 1 and 2. The difference is more than clear and we can conclude that whether correlation coefficients are heteroscedasticity adjusted or not significantly affects the results of financial contagion analyses. Dividing the overall Q into the within and between groups components, reveals that the between groups Q is highly significant, which also indicates that the differences in correlation measurement (heteroscedasticity adjusted or not) accounts for significant variability in effect sizes.

Still, there is some heterogeneity left in the distribution. Therefore we also control for other possible moderator variables. The interest is in, for example, if different crises have been contagious to differing extents. For the Thai 1997 crisis, the treatment effects based (Approach 1) weighted mean effect size is 0.132 and 0.173 if effect sizes are treated as correlation coefficients (Approach 2). For the Hong Kong 1997 crisis the same values are 0.100 and 0.098; for the Mexican 1994 crisis 0.141 and 0.160; for the Russian 1998 crisis -0.001 and 0.006; for the Brazilian 1999 crisis -0.016 and -0.014 respectively. From these numbers it is clearly seen that the Mexican, the Thai and the Hong Kong crises were contagious while the Russian and the Brazilian crises were not.

Among other crises, the US 1987 and the US 2002 crises were contagious; for the Argentine crisis 2001, the Turkish crisis 2001 and the Indian crisis 2004 the opposite is true – asset prices correlations decreased during turbulent periods; pre-World War II crises on average were not contagious, and nor were the Czech

crisis 1997 or the US crisis 2001, which resulted in some increase in average asset prices correlations, albeit an insignificant one. Again the given crisis as a grouping variable accounts for significant variability in effect sizes, but there is still some heterogeneity left within groups.

Using only data where correlation coefficients are adjusted for the presence of heteroscedasticity (not reported in Table 1 above, but available on request) does little to change the results. The Mexican, Thai and the Hong Kong crises are still contagious, although the weighted mean effect sizes are somewhat smaller. In addition, the Russian and Brazilian crises are not contagious with weighted mean effect sizes that are slightly negative. The only change relates to the US 1987 crisis, which is no longer contagious in the 95% confidence interval. However, with the weighted mean effect size clearly above zero (0.17) and only slightly below the unadjusted (U) case, the reason seems to be mainly due to small sample size.

We also investigate whether the level of development of the destination country makes it more or less susceptible to the spread of the crisis. The need for that differentiation is suggested for example by Hartmann *et al* (2001) who find only very weak evidence of contagion on the sample of G5 countries and speculated that it may be different for emerging economies. We use Human Development Index (HDI) 2008 values for grading countries as more or less developed. We nominate the first 30 countries in the HDI as developed and all other countries as developing. This produces quite comparable sample sizes for both groups with 372 and 344 respectively. For the sample of less developed countries, the weighted mean effect size is 0.054 according to Approach 1 (effect sizes as treatment effects) and 0.077 according to Approach 2 (effect sizes as correlations). For the sample of more developed countries the corresponding values are 0.052 and 0.051 respectively. So with Approach 1, there is no difference in susceptibility to the spread of crises between developed and developing countries, while according to Approach 2, less developed countries are somewhat more susceptible to the carryover of financial crises. The variability analysis reveals that the level of development of the destination country does not

account for significant variability in effect sizes. From that we may judge that herding behaviour seems to be the more likely transmission force for financial crises than real and stable linkages. This finding is in line with that of Serwa (2005) who found that CEE stock markets are no more vulnerable to contagion than Western European markets. On the other hand the finding contradicts that of Dungey and Tambakis (2003) who argue that developing countries are more affected by contagion than developed countries.

However, we also compare these two groups separately for adjusted (A) and unadjusted (U) cases (not reported in Table 1). The findings reveal that in the unadjusted cases, the less developed countries are indeed more susceptible to contagion of financial crises according to both approaches 1 and 2. Using Approach 1 the weighted mean effect sizes are 0.19 for developing and 0.12 for developed countries with non-overlapping confidence intervals and in the case of Approach 2 the differences are even greater at: 0.24 and 0.12 respectively. In the adjusted cases, the associated numbers are 0.04 for developing and 0.02 for developed countries (according to both approaches 1 and 2) but the differences are not significant at the 95% confidence level.

The results of the analysis in the case of the CEE countries

Next we concentrate on the transition economies in CEE (see Table 2). We have 89 individual effect sizes of CEE transition economies in the sample, including eight crises and four countries: Czech Republic, Estonia, Hungary and Poland. The weighted mean effect size for these 89 individual effect sizes is 0.02 according to both Approach 1 (effect sizes as treatment effects) and Approach 2 (effect sizes as correlation coefficients) respectively. Recalling that corresponding effect sizes for the whole sample were 0.05 (Approach 1) and 0.07 (Approach 2) we see that, on average, asset prices correlations during crises have increased less between CEE transition countries and the countries of the origin of crises compared to the whole sample. In addition, the increases in the correlation coefficients for the transition economies in the CEE are not statistically significant. This finding is in line with Serwa and Bohl (2005) and Serwa (2005) who argue that there is no evidence

of CEE being more prone to contagion as compared to western countries. If only heteroscedasticity adjusted correlation coefficients are included in the sample the weighted mean effect sizes for CEE transition economies are -0.05 and -0.06 according to Approach 1 and 2 respectively, which shows that asset prices correlations have even decreased on average during times of crisis and therefore there are no signs of financial contagion. In addition, the value is lower than the corresponding number of the whole sample.

Table 2. Results for CEE transition economies

	Sample size	Effect sizes as treatment effects (Approach 1)			Effect sizes as correlation coefficients (Approach 2)		
		Mean ES	Stand. error (ES)	Q statistic	Mean ES	Stand. error (ES)	Q statistic
All	89	0.019	0,020	108,7	0,023	0,021	107,1
U	15	0,148*	0,034	32,6*	0,161*	0,034	35,0*
A	74	-0,051	0,025	53,6	-0,057	0,027	46,7
HK 1997	15	-0,004	0,037	14,9	-0,005	0,038	13,7
Rus 1998	19	0,057	0,039	35,4*	0,071	0,041	39,0*
Bra 1999	9	-0,084	0,075	5,3	-0,087	0,081	4,7
Tur 2001	9	-0,187	0,105	5,6	-0,203	0,126	5,1
US 2001	9	0,024	0,105	4,2	0,026	0,126	3,2
Arg 2001	9	-0,052	0,071	2,6	-0,053	0,079	2,3
US 2002	9	0,297*	0,105	2,8	0,308*	0,126	2,6
Cze 1997	10	0,056	0,045	22,2*	0,057	0,046	22,5*
All	89	0.019	0,020	108,7	0,023	0,021	107,1
U	15	0,148*	0,034	32,6*	0,161*	0,034	35,0*
A	74	-0,051	0,025	53,6	-0,057	0,027	46,7
HK 1997	15	-0,004	0,037	14,9	-0,005	0,038	13,7
Rus 1998	19	0,057	0,039	35,4*	0,071	0,041	39,0*
Bra 1999	9	-0,084	0,075	5,3	-0,087	0,081	4,7
Tur 2001	9	-0,187	0,105	5,6	-0,203	0,126	5,1

ES - effect size
U – cases with unadjusted (for heteroscedasticity) correlation coefficients
A - cases with adjusted (for heteroscedasticity) correlation coefficients
HK – Hong Kong crisis, Rus – Russian crisis, Bra – Brazilian crisis, US – United States of America crisis, Tur – Turkish crisis, Arg – Argentine crisis, Cze – Czech Republic crisis.
Source: authors' calculations

There is no straightforward explanation of why CEE transition economies are less prone to financial contagion than one might expect. We could refer to Weller and Morzuch (2003) and their claim that there seems to be less speculative financing and a smaller chance of asset market bubbles in CEE transition economies than in other developing countries. They also argue that "default and maturity risks are generally lower in CEECs than in other emerging economies during the recent global financial turmoil, interest rate and exchange risks are also less likely to materialize. Therefore, as long as there are no discernible problems in the financial or the real sector, international investors are less likely to withdraw their funds".

Comparing different financial crises, we see that on average the US 2002 crisis (accounting scandals) has been the most harmful crisis for CEE transition countries with a weighted mean effect size of 0.30 according to Approach 1 and 0.31 according to Approach 2 with both values statistically significant. Next come the Russian crisis 1998 and the Czech crisis 1997 with meta-effect sizes above 0.05 but statistically insignificant in 95% confidence intervals. Other crises seem not to have spread over to the transition economies in CEE. Compared to the average, CEE transition economies seem to have been affected more by the Russian 1998 and US 2002 crises, while the Hong Kong 1997 crisis has had no impact on CEE transition countries despite being contagious overall. The finding is in line with Weller and Morzuch (2003) who argue that while the Asian financial crisis spread to Russia and Brazil, the transition economies in CEE were largely unaffected by it. If we only use heteroscedasticity-adjusted data (results not reported in Table 2) the US 2002 crisis is the only contagious crisis in respect of the CEE transition economies. The only other crisis during which adjusted asset prices correlations have increased is the US 2001 crisis. In all other crises in the sample, asset prices correlations have remained the same or even decreased during the crisis. One interesting conclusion is that for some reason CEE transition economies are more affected by the contagion of crises occurring in the US than to those originating somewhere else (including even in Russia and Czech Republic). We cannot adequately explain this phenomenon and cannot rule out small sample size as the reason.

Summing up the results of the section we can conclude that, on average, asset market correlations have increased during turbulent periods, which gives some support to the concept of financial contagion. Nevertheless, the increase is quite moderate, and after controlling for heterogeneity in turbulent periods' correlations, it is even smaller (although still statistically significant at the 95% confidence level). Both the correlations' calculating methodology (heteroscedasticity adjusted or not) and the crisis under observation are significant moderators explaining heterogeneity in distribution. Among the most important financial crises in the past decade and a half the Mexican, the Thai and the Hong Kong crises were contagious while the Russian and the Brazilian crises were not. The level of development of the destination country overall does not account for the significant variability in effect sizes. That said, less developed countries are on average somewhat more susceptible to financial crises contagion than well-developed countries. The transition economies in CEE have been less than averagely susceptible to the spread of crises.

4. CONCLUSION

The 'financial contagion' puzzle has become one of the most newsworthy research tasks for economists during the last decades. This elevated level of attention has been caused by the rapid transmission of initial country-specific shocks to other economies, some of which were very different in size and structure to the country of origin. The crises spread across the world like snowballs becoming bigger and bigger and even countries with apparently sound fundamentals were not immune. The events of the last year with yet another 'snowball' rolling around the world show that developing an understanding of the subject of financial contagion is clearly beneficial for policy makers hoping to manage crises and avoid their future spreads.

Financial contagion is an extremely complex and multidimensional phenomena with no unequivocally accepted definition or testing methodology. The empirical results on the theme of financial contagion are mixed, and in our view, no unique conclusion can be

drawn based on qualitative analysis of empirical literature. Thus, we propose that using a meta-analysis provides a more profound and adequate picture of financial contagion.

The results of the meta-analysis indicate that on average asset market correlations have increased during turbulent periods, but the increase is rather moderate. The fact whether correlation coefficients are adjusted for the presence of heteroscedasticity or not is a clear moderator variable to explain heterogeneity in distribution. In the case of adjusted correlation coefficients, the increase in correlations during turbulent periods is considerably smaller. Still, we find some evidence of financial contagion even after the turbulent periods' correlations are adjusted for the presence of heteroscedasticity.

The results of the meta-analysis show that the crises originating in Mexico 1994, Thailand 1997 and Hong Kong 1997 were contagious while the Russian 1998, the Brazilian 1999 and the Argentinean 2001 crises were not. The level of development of the destination country seems not to be a significant contributory factor to whether financial crises spread over or not. However, on average, less developed countries are somewhat more susceptible to financial crises contagion than the well-developed ones.

The study has paid special attention to the transition economies in CEE. The case of these countries is particularly interesting in view of their aspirations to enter the third stage of European Economic and Monetary Union. The Maastricht criteria require that a candidate country should not have devalued its currency during the last two years and also should have avoided the occurrence of violent movements in some other financial variables like inflation rate or long-term interest rate. In the case of financial turmoil these criteria are unlikely to be met. The results of the meta-analysis indicate that on average the transition economies in CEE are less susceptible to the financial contagion than the sample mean. The meta-effect size for CEE transition countries is statistically insignificant and, after controlling for heteroscedasticity, is actually negative. The result is somewhat surprising given the earlier finding that developing countries are rather more than less more susceptible to financial crises than developed ones (although

the difference is not statistically significant. The only crisis in the sample to have a significant impact on the CEE transition countries is the US 2002 accounting scandals. Interestingly the US crises (2001 and 2002) spilled over to the CEE transition economies more than the Russian crisis 1998 or the Czech Republic crisis 1997 (or any other crisis).

One of the main limitations of the paper is that our meta-analysis is restricted to correlation coefficients based analyses only. Studies using this methodology constitute the vast majority and it is no simple task to conduct the comparable individual effect sizes necessary for the meta-analytic approach from the studies using other methodologies. Nonetheless, this might be one of the subjects future research could focus on.

REFERENCES

Alvarez-Plata, P. and Schrooten, M. (2003). Latin America After the Argentine Crisis: Diminishing Financial Market Integration. – *Economic Bulletin*, 40, Number 12 / December, 2003.

Bae, K; Karolyi, A. and R. Stulz, R. (2003). A new approach to measuring financial contagion. - *Review of Financial Studies*, 16, pp. 717–763.

Baig, T. and Goldfajn, I. (1999). Financial market contagion in the Asian crisis. - *IMF Staff Papers*, 46 (1999), pp. 167–195.

Basu, A. (2003). How to conduct a meta-analysis. [http:// www.pitt.edu/~super1/lecture/lec1171].

Billio, M. and Pelizzon, L. (2003). Contagion and Interdependence in Stock Markets: Have they been misdiagnosed? - *Journal of Economics and Business*, *55*, pp. 405–426.

Calvo, G. A. (2005). Contagion in emerging markets: When wall street is a carrier. In: G. Calvo, Editor, *Emerging capital markets in turmoil: Bad luck or bad policy?*, MIT Press, Cambridge (2005), pp. 313–328.

Calvo, G. and Mendoza, E. (2000), Rational Contagion and the Globalization of Securities Markets. -*Journal of International Economics*, 51, No. 1, June 2000, pp. 79-113.

Caramazza, F.; Ricci, L.; Salgado, R.F. (2004) International financial contagion in currency crises. - *Journal of International Money and Finance*, 23, pp. 51–70.

Claessens, S.; Dornbusch, R. and Park, Y.C. (2001). Contagion: why crises spread and how this can be stopped. In: S. Claessens and K. Forbes, Editors, *International Financial Contagion*, Kluwer Academic Publishers, Boston, pp. 19–42.

Corsetti, G.; Pericoli, M. and Sbracia, M. (2005) Some contagion, some interdependence: more pitfalls in tests of financial contagion. - *Journal of International Money and Finance*, 8 (2005), pp. 1177–1199.

De Dominicis, L; de Groot, H and Florax, R. 2006. Growth and inequality: a meta-analysis. [http://www.tinbergen.nl/discussionpapers/06064.pdf].

Didier, T.; Mauro, P. and Schmukler, S. L. (2008). Vanishing financial contagion? – *Journal of Policy Modeling*, 30, Issue 5, September-October 2008, pp. 775–791.

Dornbusch, R.; Park Y.C. and Claessens S. (2000) Contagion: Understanding how it spreads. - *World Bank Research Observer*, 15 (2000), pp. 177–197.

Dungey, M. and Dambakis, D. (2003). Financial contagion: What do we mean? What do we know? [http://www.g24.org/Dungey-Tambakis2003.pdf].

Dungey, M. and Zhumabekova, D. (2001). Testing for contagion using correlations: some words of caution. - *Working Paper No. PB01-09, Pacific Basin Working Paper Series*, Federal Reserve Bank of San Francisco.

Eichengreen, B.; Rose A.K. and Wyplosz C. (1996). Contagious currency crises: First tests, *The Scandinavian Journal of Economics*, 98, pp. 463–484.

Eichengreen, B.; Rose A. (1999). Contagious currency crises: Channels of conveyance. In: T. Ito and A. Krueger, Editors, *Changes in exchange rates in rapidly developing countries: Theory, practice, and policy issues*, University of Chicago Press, pp. 29–50.

Forbes, K. (2001). Are trade links important determinants of country vulnerability to crises? *NBER Working Paper*, No. 8194. Cambridge, Massachusetts: National Bureau of Economic Research.

Forbes, K. (2004). The Asian flu and Russian virus: The international transmission of crises in firm-level data. - *Journal of International Economics*, 63 (1), pp. 59–92.

Forbes, K. and Rigobon, R. (1999). No Contagion, Only Interdependence: Measuring Stock Market Co-Movements. - *National Bureau of Economic Research Working Paper* No. 7267.

Forbes, K. and Rigobon, R.K. (2002), Measuring contagion: Conceptual and empirical issues. In: S. Claessens and K. Forbes, Editors, *International financial contagion*, Kluwer Academic Publishers (2001), pp. 43–66.

Gelos, R. G. and Sahay, R. (2001). Financial market spillovers in transition economies. - *Economics of Transition*, 9, pp. 53–86.

Gerlach, S. and Smets, F. (1995), Contagious speculative attacks. - *European Journal of Political Economy*, 11, pp. 45–63.

Glass, G. V. 1976. Primary, secondary and meta-analysis research. – *Educational Researcher*, 5, pp. 3–8.

Glick R. and Rose, A.K. (1999) Contagion and trade: Why are currency crises regional? - *Journal of International Money and Finance*, 18, pp. 603–617.

Goldstein, M. (1998) The Asian financial crisis: Causes, cures, and systemic implications. - *Policy analyses in international economics*, 55, Institute for International Economics, Washington.

Hartmann, P.; Straetmans, S. and de Vries, C.G. (2001). Asset Market Linkages in Crisis Periods. – *Tinbergen Institute Discussion Paper*, TI 2001-071/2.

Hedges, L.V. (1982). Fitting categorical models to effect sizes from a series of experiments. – *Journal of Educational Statistics*, 7, pp. 119-137.

Hedges, L. V., Olkin, I. 1985. Statistical methods for meta-analysis. Orlando, FL: Academic Press, viidatud: Lipsey, Mark, W., Wilson, David, B. 2001. Practical meta-analysis. Applied Social Research Methods Series, 49. SAGE Publications.

Hernandez, L.F. and Valdes, R.O. (2001) What drives contagion: Trade, neighborhood, or financial links? - *International Review of Financial Analysis*, 10, pp. 203–218.

Hunter, J. E., Schmidt, F. L. 1990. Methods of meta-analysis: Correcting error and bias in research findings. Newbury Park, CA: Sage.

Jeanne, O. and Masson, P. (2000). Currency crises and markov-switching regimes. - *Journal of International Economics*, 50, pp. 327–350.

Jokipii, T. and Lucey, B. (2006) Contagion and interdependence: measuring CEE banking sector co–movements. – *Bank of Finland Research Discussion Papers*, 15, 47 p.

Kaminsky, G.L. and Reinhart, C.M. (2000). On crises, contagion, and confusion. - *Journal of International Economics*, 51, pp. 145–168.

Kleimeier, S.; Lehnert, T. and Verschoor, W.F.C. (2008). Measuring financial contagion using time-aligned data: the importance of the speed of transmission of shocks. – *Oxford Bulletin of Economics and Statistics*, 70, Issue 4, pp. 493–508.

Lipsey, Mark, W., Wilson, David, B. 2001. Practical meta-analysis. - *Applied Social Research Methods Series*, 49. SAGE Publications.

Masson, P. (2004) Contagion: Monsoonal effects, spillovers, and jumps between multiple equilibria. In: Pierre-Richard Agenor, Marcus Miller, David Vines and Axel Weber, Editors, *The Asian financial crises: Causes, contagion and consequences*, Cambridge University Press, Cambridge.

Moussalli, C.B. (2007). Financial Crises, Panic and Contagion: Evidence from a Cross-country Comparison Using Two Time Frames. – *Business and Public Affairs*, 1, ISSN 1934-7219, Issue 2, 2007.

Neill, J. 2006. Meta-analysis research methodology. [http://wilderdom.com/research/meta-analysis.html].

Pearson, K. (1904). Mathematical contributions to the theory of evolution. [http://visualiseur.bnf.fr/Visualiseur?Destination=Gallica&O=NUMM-55992].

Pindyck, R. and J. Rotemberg, J. (1990) The excess comovement of commodity prices. - *Economic Journal*, 100, pp. 1173–1189.

Pindyck, R. and J. Rotemberg, J. (1993) The comovement of stock prices. - *Quarterly Journal of Economics*, 108, pp. 1073–1104.

Rigobon, R. (1999). On the Measurement of the International Propagation of Shocks. - *National Bureau of Economic Research Working Paper*, 7354.

Rigobon, R. (2002) Contagion: How to measure it? In: S. Edwards and J. Frankel, Editors, *Preventing currency crises in emerging markets*, The University Chicago Press, Chicago, pp. 269–334.

Rosenthal, R. 1994. Statistically describing and combining studies. – The handbook of research synthesis, Eds. H. Cooper & L. V. Hedges. New York: Russell Sage Foundation, pp. 231-244.

Rosenthal, R. and Rubin, D. B. (1982). A simple, general purpose display of magnitude of experimental effect. - *Journal of Educational Psychology*, 74, pp. 166-169.

Serwa, D. (2005). Empirical evidence on financial spillovers and contagion to international stock markets. [http://opus.kobv.de/euv/volltexte/2007/20/pdf/serwa.dobromil.pdf].

Serwa, D. and Bohl, M. (2005). Financial Contagion Vulnerability and Resistance: A Comparison of European Capital Markets. – *Economic Systems*, 29, Issue 3, September, pp. 344–365.

Schultze, R. (2004). Meta-Analysis. A Comparison of Approaches. Hogrefe & Huber Publishers, 242 p.

Sola, M.; Spagnolo, F. and Spagnolo, N. (2002). A test for volatility spillovers. – *Economics Letters* 76, pp. 77 – 84.

Van Rijckeghem, C. and Weder, B. (2001) Sources of contagion: Is it finance or trade? - *Journal of International Economics*, 54, pp. 293–308.

Wang, P. and Moore, T. (2008). Stock market integration for the transition economies: time-varying conditional correlation approach. – *The Manchester School, 76, Issue s1*, pp. 116-133.

Weller, C.E. and Morzuch B. (2003). International Financial Contagion: Why are Eastern Europe's banks not failing when everybody else's are? – *Economics of Transition*, 8 Issue 3, pp. 639-663.

Woo, W.T. (2000). Coping with accelerated capital flows from the globalization of financial markets. - *ASEAN Economic Bulletin, 17*, pp. 193-204.

World Bank Group (2001). Contagion of financial crises website. [http://www1.worldbank.org/economicpolicy/managing%20volatility/contagion/index.html]

KOKKUVÕTE

Finantskriiside nakkuslikkuse metaanalüüs erilise rõhuasetusega Kesk- ja Ida-Euroopa riikidele

Finantskriiside ülekandumist riigist riiki on epidemioloogiast tulenevast terminoloogiast lähtudes hakatud majandusteadlaste seas nimetama nakkuslikkuseks (ka lumepalliefektiks). On täheldatud, et finantskriisid kandusid viimastel kümnenditel ootamatult kiiresti paljudesse maailma riikidesse ning sealhulgas nendesse riikidesse, mis olid tugevad nii makromajanduslike näitajate kui rakendatava finantspoliitika osas. Samuti ei pruukinud nn nakatatud riigid omada kriisi lähteriigiga sarnast majanduse struktuuri.

Finantskriiside kiirest levikust tulenevalt on ka mõistetav, et nende nakkuslikkus ehk kriiside nn lumepalliefekt on rahvusvahelises majanduskirjanduses kujunenud viimastel aastatel oluliseks uurimisteemaks. Olulise tõuke finantskriiside riikidevahelise ülekandumise tõsisemaks uurimiseks andis 1990-te aastate krahhide tagajärgede kiire levik üle paljude maailma riikide. Iseenesest mõistetavalt kaasnes kriiside ja krahhide kiire levikuga ka vastuse otsimine küsimustele, kas finantskriiside puhul saab rääkida nende nakkuslikkusest st ülekandumisest, selle põhjustest, ulatusest ja täpsematest seostest. 2008. aasta finantskriis koos sellele järgneva majandussurutisega on taas teravalt päevakorda tõstnud finantskriiside nakkuslikkuse (edaspidi *finantsnakkus*) uurimise vajaduse. Oluline on finantskriiside kiire ülekandumise õppetunde üldistada ning selgitada võimalusi ja välja töötada meetmeid finantskriiside lumepalliefekti pehmendamiseks.

Kuigi finantskriiside ülekandumise uurimisele on viimastel aastakümnetel pööratud olulist tähelepanu, on lähenemised finantsnakkuse mõistele, aga ka finantsnakkuse uurimisel kasutatavad metoodikad ning uuringute tulemused väga heterogeensed. Käesoleva uurimise eesmärgiks on välja selgitada, kas finantskriiside ülekandumist käsitlevate empiiriliste uuringute tulemusi kajastava erialakirjanduse kvalitatiivse analüüsi alusel

tehtavad järeldused on kooskõlas nende empiiriliste uuringute põhjal läbiviidava meta-analüüsi tulemustega. Otsime vastust küsimusele, kas arvestades finantsnakkust käsitlevate mõistete, empiiriliste uuringute metoodikate ja tulemuste suurt heterogeensust on meta-analüüsi metoodikale tuginevalt võimalik saada kinnitust finantsnakkuse olemasolule. Eraldi tähelepanu all on siinjuures finantskriiside ülekandumisega seonduvad küsimused Kesk- ja Ida-Euroopa üleminekuriikide näitel. Eesmärgi saavutamiseks on läbi viidud kvalitatiivne kirjanduse ülevaade senistest olulisematest empiirilistest tulemustest ning seda on täiendatud kvantitatiivse analüüsiga meta-analüüsi raamistikku ja metodoloogiat kasutades. Autoritele teadaolevalt ei ole finantsnakkuslikkuse uurimiseks meta-analüüsi seni veel kuigi ulatuslikult kasutatud.

Oluline on rõhutada, et vaatamata intensiivsele uurimisele ja empiiriliste analüüside rohkusele, pole majandusteadlasete seas seni saavutatud üksmeelt finantsnakkuse täpse definitsiooni ega ka levimiskanalite kohta. Üksmeel on põhiliselt selles osas, et tarvilik tingimus finantsnakkuse kui nähtuse esinemiseks on finantskriiside ja krahhide ülekandumine kriisi lähteriigist teistesse riikidesse. Erimeelsused tekivad aga selle tingimuse piisavuse suhtes. Osa uurijaid loeb kriiside ülekandumist piisavaks tingimuseks finantsnakkuse olemasolu kinnitamiseks. Teise suuna esindajad väidavad, et finantsnakkuse avaldumise testimiseks on vaja kontrollida ka riikide fundamentaalnäitajate (majanduse suurus ja struktuur, rakendatav poliitika jms) omavahelist korrelatsiooni. Kolmandate arvates leiab finantsnakkuse olemasolu kinnitust vaid siis, kui nakkuse levimise kanalid on pärast kriisi ilmnemist (võrreldes nö rahuliku ajaga) oluliselt tugevnenud.

Ka finantsnakkuse levimise kanalite osas ei ole majandusteadlased üksmeelsed. Kõige üldisemalt on kriiside ülekandumise kanaleid jagatud fundamentaalseteks ehk stabiilseteks ja investorite käitumisest tulenevateks ebastabiilseteks ühenduskanaliteks. Olulisimateks fundamentaalseteks ühenduskanaliteks loetakse: 1) finantskanalid (*financial linkages*) – riigid on omavahel seotud läbi rahvusvahelise finantssüsteemi; 2) reaalkanalid (*real linkages*) – riigid on seotud läbi rahvusvahelise kaubanduse, kas olles kaubanduspartnerid või konkureerides samal välisturul; 3)

poliitilised kanalid (*political links*) – riikidevahelised poliitilised suhted.

Viimasel kümnendil alates R. Rigoboni (1999, 2002) töödest on levima hakanud ka seisukoht, et kriiside ülekandumisel fundamentaalsete levimiskanalite kaudu ei ole tegemist finantsnakkusega vaid lihtsalt vastastikuse sõltuvusega (*interdependence*). See omakorda seab kahtluse alla kõige laiema ehk nn tingimusteta finantsnakkuse definitsiooni. Siinjuures on oluline märkida, et käesoleval sajandil käsitletaksegi finantsnakkusena reeglina selle nähtuse kitsamaid avaldumisvorme.

Paljud autorid on jõudnud seisukohale, et fundamentaalsed ühenduslülid ei suuda täielikult selgitada riikidevahelisi seoseid ning muutusi nendes seostes. Tähelepanu tuleb pöörata ka nvestorite käitumisega seotud irratsionaalsetele aspektidele, eriti nn *herding*-kontseptsioonile ehk karjakäitumisele. *Herding*-kontseptsiooni südameks on informatsiooni asümmeetrilisus, mis põhjustab informatsiooni hankimise kulukuse tõttu väheminformeeritud investorite poolse (eeldatavalt) paremini informeeritud agentide tegevuse järgimise ja matkimise. Nii võib kogu turg liikuda kiiresti ja ühekorraga ajutiselt ühes suunas. Kui eeldatavalt informeeritud investorid juhtusid näiteks mingist riigist raha välja tõmbama mujal tekkinud kriisist tulenevate probleemide tõttu investeerimisportfellis, siis võivad tõsised finantsprobleemid tekkida ka väga heade fundamentaalnäitajatega riikidel.

Nagu juba eespool mainitud on finantsnakkuse avaldumist viimastel kümnenditel empiiriliselt väga palju analüüsitud. Seejuures on saadud ka väga erinevaid tulemusi, mis on ka mõistetav arvestades käsitletava uuritava probleemideringi mitmedimensionaalsust. Läbiviidud empiirilised uuringud erinevad lisaks finantsnakkuse mõiste erinevale tõlgendamisele ka kasutatava analüüsimetoodika, vaadeldavate kriiside, valimisse kuuluvate sihtriikide ja mitmete muude üksikasjade osas. Heaks näiteks on siinkohal Serwa (2005) uurimus, kes kasutas nelja erinevat testimismetoodikat ja nelja erinevat valimit ning sai ka oluliselt erinevad uurimistulemused.

Tulemuste üldistamiseks on käesolevas uurimuses käsitletud võimalikku finantsnakkust käsitleva empiirilise analüüsi tulemusi ca 75 juhu kohta (vt lisa). Liigitades saadud tulemusi *Jah* ja *Ei* tulemusteks ning neid loendades saab teha järelduse, et finantsnakkuse esinemist toetavaid tulemusi (*Jah*-tulemus) on ligi kaks korda rohkem kui mittetoetavaid (*Ei*-tulemustes). Suur osa *Jah*-tulemustest on aga saavutatud korrelatsioonikoefitsientide muutusel põhinevate testidega, kus tulemusi pole heteroskedastiivsuse esinemise suhtes kontrollitud ega kohandatud. Viimase kümnendi uurimused on aga selgelt näidanud sellise kohandamise vajalikkust. Selliseid tulemusi mitte arvestades on *Jah*- ning *Ei*-tulemused ligikaudu tasakaalus. Mitmete uuringute puhul ei ole ühtne järeldus *Jah* või *Ei* kasuks päriselt õigustatud, kuna ühe uuringu raames võib esineda nii finantsnakkust toetavaid kui ka mittetoetavaid tulemusi.

Peamiseks probleemiks konkreetsete üldistavate järelduste tegemisel on aga siiski juba mainitud uurimisprobleemi mitmedimensionaalsus. Uuringusse kaasatud kolmveerandsaja empiirilise analüüsi seas on vaid üksikud, mis kasutavad sama definitsiooni mõiste avamiseks, sama testimismetoodikat, samu kriise ning kriiside ülekandumise sihtriike. Selline heterogeensus uurimistöödes mõjutab ka tulemusi. Seega erialakirjanduse kvalitatiivsele analüüsile lisaks on oluline kasutada ka meta-analüüsi st kvantitatiivset analüüsimetoodikat, et saada täiendavat infot varasemate empiiriliste uuringute tulemuste üldistamiseks.

Meta-analüüsi jaoks vajaliku andmestiku kogumiseks on kaasatud uuringud Maailmapanga *Financial Crisis Website* leheküljelt ning *ISI Web of Knowledge* andmebaasist vatavalt märksõnadele *financial contagion*. Valimisse on kaasatud ainult need uuringud, milles finants-nakkuslikkus on defineeritud statistiliselt olulise erinevusena kriisieelse ja kriisijärgse finantsvahendite hindade korrelatsiooni vahel ning kus nii kriisieelne kui –järgne korrelatsioon (või nende vahe) on selgelt välja toodud. Sel viisil on saadud 30 uuringut ja 716 individuaaltulemust. Neist sõltumatud on 17 uuringut ja 394 individuaaltulemust. Juhul, kui raporteeritud on nii lühiajalise kui pikaajalise perioodi kriisijärgne korrelatsioon, on sõltumatuse probleemi tõttu uuringusse kaasatud vaid lühiajalist perioodi iseloomustav tulemus.

Iga konstruktsiooni korral on leitud kaks metatulemust: ühel juhul on korrelatsioonikoefitsientide muutu käsitletud kui mõjuefekti (*kontseptsioon 1*) ja teisel juhul kui korrelatsiooni (*kontseptsioon 2*). Kumb lähenemine on õigem? Meta-analüüsi käsitlevas kirjanduses pole seda teemat käsitletud ning autorite arvates pole ka intuitiivselt selge, millise neist valima peaks. Seetõttu ongi paralleelselt toodud tulemused mõlema kontseptsiooni korral.

Kontseptsiooni 1 kasutades on keskmiseks kaalutud korrelatsioonikoefitsientide muuduks 0,053 standardhälbega 0,0047 ja *kontseptsiooni 2* kohaselt 0,072 standardhälbega 0,0049. Mõlemal juhul jäävad 95% usalduspiirid selgelt üle nulli ning võib järeldada, et keskmiselt on kriisiperioodidel korrelatsioonid tugevnenud. Kontrollides jaotuse homogeensust Q-statistiku abil selgub aga, et jaotus on heterogeenne ning seega ei pruugi kõik individuaaltulemused esindada ühte ja sama üldkogumit. Seetõttu on vajalik jätkata analüüsi otsimaks võimalikke varieeruvust põhjustavaid moderaatoreid. Esmalt on võimaliku moderaatorina kontrollitud heteroskedastiivsuse suhtes kohandamist kriisijärgsete korrelatsioonide arvutamisel. Selleks on valim jagatud kaheks vastavalt sellele, kas heteroskedastiivsuse suhtes kohandamist on teostatud (juht A) või mitte (juht U). Selgub, et kaalutud keskmine korrelatsioonide muut on juhul A tunduvalt väiksem, olles 0,030 nii *kontseptsiooni 1* kui *2* korral. Juhu U korral on vastavad tulemused 0,168 ja 0,208. Saab järeldada, et tegu on olulise moderaator-muutujaga, mida kinnitab ka gruppide vahelise Q-statistiku statistiline olulisus.

Kuna Q-statistiku väärtuse põhjal võib arvata, et jaotuses on endiselt veel järel teatud määral heterogeensust, siis on moderaator-muutujana kontrollitud ka erinevaid kriise. Selgub, et viimaste kümnendite suurematest kriisidest Tai 1997, Mehhiko 1994 ja Hong Kongi 1997 kriis olid selgelt rohkem nakkuslikud kui Vene 1998, Brasiilia 1999 ja Argentiina 2001 kriisid. Samuti olid nakkuslikud USA 1987. ja 2002. aasta kriisid, mitte aga Türgi 2001, India 2004, Tšehhi 1997 ega USA 2001 kriisid.

Võimaliku moderaatorina on kontrollitud ka sihtriigi arengutaset jagades valimi arenenud ja vähemarenenud riikideks vastavalt 2008. aasta inimarengu indeksile. Arenenud riikidena on siinkohal

defineeritud nimetatud indeksi järgi 30 esimest riiki, mis on valitud eesmärgiga hoida valimi mahud mõlemas grupis umbkaudu võrdsed (vastavalt 372 ja 344). Sihtriigi arengutase võimaliku moderaatorina statistilist kinnitust ei leidnud. Seega saame teha järelduse, et riigi hea arengutase ei paku küllaldast kaitset kriiside nakkusliku leviku eest.

Kesk- ja Ida-Euroopa üleminekumajanduste uurimiseks on valimis 89 individuaaltulemust kaheksa kriisi ja nelja riigi (Tšehhi Vabariik, Eesti, Poola, Ungari) kohta. Mõlema kontseptsiooni (individuaaltulemused kui korrelatsioonid ja kui mõjuefektid) rakendamise korral on metatulemuseks 0,02; mis kogu valimi tulemustega - vastavalt 0,05 (*kontseptsioon 1* ja 0,07 (*kontseptsioon 2*) – võrreldes on mõnevõrra väiksem. Siit tulenevalt saame teha järelduse, et Kesk- ja Ida-Euroopa üleminekumajandused on finantsnakkusele keskmiselt vähem vastuvõtlikud kui kogu valim tervikuna. Sarnasele tulemusele on varem jõudnud ka Serwa ja Bohl (2005) ja Serwa (2005). Ka neil ei õnnestunud leida tõendeid selle kohta, et Kesk- ja Ida-Euroopa riigid oleksid *finantsnakkuse* poolt kergemini haavatavad kui läänеriigid. Veelgi selgemalt tuleb see tulemus esile, kui valimisse kaasata vaid uuringud, kus korrelatsioonikoefitsiendid on heteroskedastiivsuse suhtes kontrollitud. Mõlema kontseptsiooni korral on meta-efekt nüüd negatiivne, näidates isegi korrelatsioonide vähenemist kriisiperioodidel. Üheks selgituseks oodatust väiksemale finantsnakkuse vastuvõtlikkusele Kesk- ja Ida-Euroopa riikides võib tuua suhteliselt väiksema spekulatiivsel eesmärgil tehtud investeeringute osakaalu ning väiksema tõenäosuse mullide tekkeks teiste arengumaadega võrreldes. Uurimistulemused näitavad ka seda, et kõige tugevamini on Kesk- ja Ida-Euroopa üleminekuriikidesse üle kandunud kriisid, mis on alguse saanud USA-st.

Käesoleva uurimuse üheks olulisemaks piiranguks on meta-analüüsi läbiviimisel piirdumine vaid korrelatsioonikoefitsientidel põhinevate uuringutega. Muid mõõtmismetoodikaid kasutatavate uuringute kaasamist komplitseerivad raskused ühtselt interpreteeritavate individuaaltulemuste leidmiseks uuringute erinevate testimismetoodikate korral.

APPENDIX

Papers investigating financial contagion

Authors	Year	Contagion	Method	Sample	Market
Hartmann, Straetmans, de Vries	2001	Weak	extreme value analysis	G5 countries	Asset prices
Forbes, Rigobon	1999	No	Increase in correlation, adjusted	28 countries, 1987 US stock market crash, 1994 Mexican peso collapse, 1997 East Asian crisis	Stocks
Lomakin, Paiz	1999	No	Probit analysis	various countries	Bonds
Rigobon	1999	No (Yes less 10%)	Directly identified model; shift-contagion	Mexican, Asian, Russian crises	Stocks
Rigobon	2000	No	HS based identification method	Argentina, Mexico 1994-1999	Brady bonds
Craig, Dravid and Richardson	1995	No	CDR approach	US and Japanese stocks	Stocks
King, Wadhwani	1995	Yes	Correlation coefficient based tests	US, UK and Japan after 1987 US crash	Stocks, bonds
Lee, Kim	1993	Yes	Correlation coefficient based tests	12 major markets after US 1987 crash	Stocks
Calvo, Reinhart	1996	Yes	Correlation coefficient based tests	1994 Mexican peso crisis, Asian and Latin American emerging markets	bonds and equities
Baig and Goldfajn	1999	Mixed	Correlation coefficient based tests, adjusted	emerging markets during the 1997-98 East Asian crisis	Stocks, exchange rates, interest rates
Chou, Ng, Pi	1994	Yes	Var-covar transm mechanism (ARCH/GARCH)	1987 U.S. stock market crash	Stocks
Hamao, Masulis, Ng	1990	Yes	Var-covar transm mechanism (ARCH/GARCH)	1987 U.S. stock market crash	Stocks
Edwards	1998	No	Var-covar transm mechanism (ARCH/GARCH)	Mexican peso crisis, Mexico to Chile	Bonds

Edwards	1998	Yes	Var-covar transm mechanism (ARCH/GARCH)	Mexican peso crisis, Mexico to Argentina	Bonds
Longin and Solnik	1995	Yes	Co-integration based tests	seven OECD countries from 1960 to 1990	Stocks
Baig and Goldfajn	1999	Yes	Increase in correlation	1997-98 East Asian crisis	Sovereign spreads
Forbes	1999	Yes	Directly measure changes	Asian and Russian crises, individual companies around the world	Stocks
Eichengreen, Rose and Wyplosz	1996	Yes	Probit model	ERM countries in 1992-3	currencies
Kaminsky and Reinhart	1998	Yes	Probit model	Mexican 1995 and Asian 1997	Assets
Gravelle, Kichian, Morley	2003	No	Shift-contagion	4 emerging-market countries 1991-2001	Brady bonds
Gravelle, Kichian, Morley	2003	Yes	Shift-contagion	7 developed countries 1985-2001	Currencies
Kali, Reyes	2005	Yes	Network approach	Tequila Crisis Mexican 1994), the Asian Flu, and the Russian Virus	Stocks
Kali, Reyes	2005	No	Network approach	Venezuelan and Argentine crises	Stocks
Iwatsubo, Inagaki	2006	Yes	CDR approach	22 Asian firma and 7 indexes, Asian crises	Stocks
Didier, Mauro, Shmukler	2008	Yes	Theoretical analysis		
Sander, Kleimeier	2003	Yes	Increase in correl using Granger-causality methodology	Asian crisis, 1996-2000	Bonds
Arestis, Caporale, Cipollini, Spagnolo	2005	Yes/Mixed	Shift-contagion	1997 Asian crisis; from Thailand, Indonesia, Korea, Malaysia to Japan, UK, Germany, France	Assets
Bordo, Murshid	2000b	No/Weak	Correlation coefficient based tests	Different historical and current crises	Bonds, interest rates
Wolf	1996	Weak	Granger-causality	21 sectors of 24 developing countries, 1976-1995	Equity
Cerra, Saxena	2002	Yes	Probit model	Indonesian currency crisis	stocks, currency
Moussalli	2007	Yes	Directly measure changes	Asian, Russian, Brazilian crisis; Asian, East-European, Latin-	Stocks, currencies

				American countries	
Woo, Carleton, Rosario	2000	Yes	Logit model	Asian crisis; 6 Asian countries 1990-1998	Currency
Woo	2000	Yes	Qualitative analysis	Asian crisis; from Thailand to 4 Asian countries	Bonds
Tornell	1999	No	Directly measure changes	Mexican 1995 and Asian 1997	Currency
Corsetti, Pesenti, Roubini	1998	No	Directly measure changes	Asian crisis; 24 developing countries	Currency
Kelejian, Tavlas, Hondroyiannis	2006	Yes	Directly measure changes	6 crisis; 25 developing countries	Currency
Corsetti, Pericoli, Scrabcia	2005	Yes	Increase in correlation, adjusted	Hong Kong stock market crisis 1997	Stocks
Favero, Giavazzi	1999	Yes	VAR model	7 European countries; ERM crisis, 1988-1992	Interest rates
Serwa	2005	Weak	Increase in correlation	7 crises, 1997-2002; 17 Western Europe and CEE countries	stocks
Serwa	2005	Yes	VAR model	Asian crisis 1997	capital markets
Serwa	2005	No	Markov switching framework	HSI and Nikkei 225; 1997 Asian crisis	stocks
Serwa	2005	Weak/No	transition matrices	US, UK , Japan, Germany	stocks
Forbes, Rigobon	2000	No	Shift-contagion	1990s	bonds, stocks
Hon, Strauss, Yong	2004	Yes	Increase in correlation, adjusted	2001 terrorist attack, 25 economies, OECD and Asia	stocks
Lee, Wu, Wang	2007	No	Increase in correlation, adjusted	earthquake in South-East Asia on Dec 26, 2004, 26 international stock indexes	stocks
Lee, Wu, Wang	2007	Yes	Increase in correlation, adjusted	earthquake in South-East Asia on Dec 26, 2004, 26 international exchange rates	exchange market
Wang, Thi	2006	Yes	Increase in dynamic conditional correlation coef	Asian crisis 1997, Thailand, China, Hong Kong, Taiwan	stocks
Kleimeier, Lenhert,	2008	Yes	Increase in correlation	Asian crisis, Thailand + 14 countries	stocks

Verschoor					
Candelon, Hecq, Verschoor	2005	No	serial correlation common feature	Mexican 1994, Asian 1997	stocks
Arestis, Caporale, Cipollini	2003	No/Weak	Shift-contagion, adjusted	Asian 1997; from 4 Asian countries to five developed countries	stocks
Fazio	2007	Weak	Probit analysis	1990-1999, 14 emerging market economies	currency
Bayoumi, Fazio, Kumar	2007	Yes	correlations and distance relationships	15 countries, 1991-2001	stocks, exchange rates
Bayoumi, Fazio, Kumar	2003	Yes	correlations and distance relationships	16 countries, 1991-2001 (Tequila, Asian, Russia, Argentine)	stock
Alvarez-Plata, Schrooten	2003	No	correlations	7 Latin-American countries, 2001-02 Argentinean crisis	stocks, interest rates
Wang, Moore	2008	Yes	dynamic conditional correlation	4 CEE countries, 1994-2006	stocks
Kallberg, Pasquariello	2008	Yes	excess comovement, adj	82 US industry indexes, 1976-2001	stocks
Chiang, Jeon, Li	2007	Yes	dynamic conditional correlation	9 Asian countries, 1990-2003	stocks
McAleer, Nam	2005	Yes	increase in co-movement (FR)	6 Asian countries, Asian crisis 1997	exchange rates
Haile, Pozo	2008	Yes	panel probit model	37 advanced and emerging market economies, quarterly data 1960-1998	currency
Sola, Spagnolo, Spagnolo	2002	Yes	Markov switching framework	Asian crisis 1997; from Thailand to South-Korea	stocks
Sola, Spagnolo, Spagnolo	2002	No	Markov switching framework	Asian crisis 1997; from South-Korea to Brazil	stocks
Baur	2003	Yes	regression analysis	Asian crisis, 11 Asian markets	stocks
Alba, Bhattacharya, Claessens, Ghosh, Hernandez	1998	unclear	Qualitative analysis	Asian crisis	stocks, exchange rates
Frankel, Schmukler	1996	Yes	Correlation coefficient based tests	Mexican 1994, to Asia and Latin-America	Country fund prices
Valdes	1997	Yes	Correlation coefficient based tests	Mexican 1994, from Mexico to Latin-America	secondary market debt prices and

					credit ratings
Agenor, Aizenman, Hoffmaister	1999	Yes	Correlation coefficient based tests	Mexican 1994, from Mexico to Argentina	Interest rates
Boyer, Gibson, Loretan	1999	No	Increase in correlation, adjusted	Gernany, Japan, USA; 1991-1998	Exchange rates
Loretan, English	2000	No	Increase in correlation, adjusted		3 pairs of asset returns
Gelos, Sahay	2001	No	Increase in correlation, adjusted	from the Czech Republic, Asia, and Russia to CEE	Stocks, exchange rates, sovereign spreads
De Gregorio, Valdes	1999	Not tested	conditional probability	1982 debt crisis, Mexican 1994, 1997 Asian	Exchange rates, credit ratings
Caramazza, Ricci, Salgado	2004	Yes	conditional probability	Mexican 1994, Asian 1997, Russian 1998; 41 countries	currency
Glick, Rose	1999	Not tested (assumed Yes)	conditional probability	5 crises and 161 countries	Currency
Park, Song	1998	Yes	conditional probability	Asian crisis, 8 Asian countries	Exchange rates, stocks, interests
Gelos, Sahay	2001	Mixed	conditional probability	Czech, Asian, Russian crisis, 12 transition economies	stocks, exchange rates
Longin, Solnik	2001	Y	GARCH framework	US, UK, France, Germany, Japan; 1959-1996	Stocks