WP/00/71

IMF Working Paper

Financial Market Spillovers in Transition Economies

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INTERNATIONAL MONETARY FUND

 WP/00/71

IMF Working Paper

European I and Research Department

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April 2000

Abstract

This paper examines financial market comovements across European transition economies and compares their experience to that of their regions. Correlations in monthly indices of exchange market pressures can partly be explained by direct trade linkages, but not by measures of other fundamentals. Higher-frequency data during three crisis periods reveals the presence of structural breaks in the relationship between exchange-, but not stock markets. While the reaction of markets during the Asian and Czech crises is muted, the pattern of high-frequency spillovers during the Russian crisis looks very similar to that observed in other regions during turbulent times.

JEL Classification Numbers: F30, G15, P34

Keywords: Stock Markets, contagion, transition economies, speculative attacks

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[1] The authors wish to thank Craig Beaumont, Torhjörn Becker, Andrew Berg, Mark de Broeck, Baláza Horváth, Laura Kodres, Thomas Laursen, Neven Mates, Nada Mora, David Owen, Sanjaya Panth, Uma Ramakrishnan, Anthony Richards, Robert Rigobon, Kevin Ross, Robert Wescott, Ann-Margret Westin, Charles Wyplosz, European I seminar participants and conference participants at LACEA '99 in Santiago, Chile and "International Financial Contagion," at the Fund for helpful discussions and comments. Grace Juhn and Freyan Panthaki provided excellent research assistance.

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I. INTRODUCTION

Motivated by recent financial crises, a large number of theoretical and empirical studies are attempting to understand how financial market shocks get transmitted across countries. Some of this research takes the form of large cross-country studies aiming to assess the importance of "contagion" effects.[2] Other studies focus on regional spillovers around a single event, mainly in Asia and Latin America.[3] This paper takes a closer look at the experience of transition economies, documenting spillover patterns and attempting to draw policy lessons from them.[4]

Following Poland in 1989, most transition economies liberalized their domestic markets and external regimes with a big bang. Given the large monetary overhang inherited from the communist era, the freeing of prices quickly led to high inflation. Faced with the daunting task of stabilizing their economies, a vast majority of the countries adopted, sooner or later, some form of a fixed exchange rate regime. As transition proceeded, the economies began to become increasingly integrated with the world economy. This opening up, however, also meant that the economies were more subjected to external shocks, making those with fixed exchange rate regimes potentially more vulnerable to currency crises.

The Mexican crisis came in 1994, spreading jitters to other financial markets. The transition economies seemed unaffected during this period. Three years later, the Thai crisis created havoc in Asia and affected other regions as well, such as Latin America. However, the transition countries did not feature in major news headlines at the time. By August 1998, with the eruption of the Russian crisis, the vulnerabilities of emerging markets to changes in market sentiment were revealed en masse. Yet somehow, the "contagion" effects in transition economies seemed more muted than elsewhere. Are these countries really less susceptible to capital market volatility? If so, is this likely to remain true for the near future? These are some of the questions explored in this paper.

At a general level, we examine the history of financial market spillovers since 1993 in Central and Eastern European economies, Russia, and the Baltics. Dictated by data availability, the Czech Republic, Hungary, Poland and Russia receive greater attention. We do not attempt to offer irrefutable evidence for "contagion" effects, however defined. Our aim is more modest: we explore and describe the propagation of "market jitters" across countries and examine whether there are systematic patterns. However, we also carry out tests intended to

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[2] See, for example, Eichengreen, Rose, and Wyplosz (1996), Glick and Rose (1998), and Kaminsky and Reinhart (1998), or Van Rijckeghem and Weder (1999).

[3] See, for example, Baig and Goldfajn (1998), Calvo and Reinhart (1996), Edwards (1998), or Tan (1998).

[4] To our knowledge, the only other studies examining "contagion" effects among transition economies are Darvas and Szapáry (1999), Fries, Raiser, and Stern (1998) and Krzak (1998).

shed some light on the nature of the propagation mechanisms and their relation to economic fundamentals. We proceed in four steps.

First, we discuss the potential relevance of different transmission channels for financial market shocks. Second, following Eichengreen, Rose, and Wyplosz (1996), we construct an index of exchange market pressure which is a weighted average of changes in interest rates, international reserves, and the nominal exchange rate. We analyze monthly movements in this index for the period 1993-98. Third, for the major episodes of exchange market pressures, we take a closer look at higher-frequency data from stock and exchange markets. Fourth, using the same metric, we compare these results with the reaction of Latin American financial markets to the Mexican and Russian crises and to that of the Asian countries during the Asian crisis. The main questions that this paper attempts to answer are: How large was the degree of comovements across financial markets in the region? Do comovements differ during crisis and tranquil periods? Can these comovements be easily related to economic fundamentals? Do financial market pressures in some countries systematically precede those in other countries? How do the characteristics of transition economies' spillovers during crises compare to the experience of other countries in other regions?

We find that exchange market pressures are moderately correlated across the countries considered here and that correlations appear to have increased recently. Interestingly, the observed correlations can partly be explained by direct trade links, but cannot be traced to measures of portfolio flow restrictions, crude measures of financial links, or the degree of macroeconomic similarity. However, during the Asian and Russian crises, the severity of the exchange market pressures was weakly negatively correlated with the initial ratio of international reserves to M1, the current account deficit, and the ratio of government short-term debt to GDP. Throughout the period, movements in the Russian index Granger cause those in a number of other countries.

Higher frequency data show that shock propagation mechanisms were weak during the Asian and Czech crises, but strong during the Russian crisis. Then, shocks to the Russian stock market clearly Granger caused movements in Czech, Hungarian, and Polish stock markets. This suggests the presence of spillover channels that extend beyond standard macroeconomic linkages. However, not all of the evidence points to the existence of pure "contagion" effects. For example, while tests for structural breaks using heteroskedasticity-adjusted correlations indicate significant changes in the relationship between exchange markets in the crisis-origin country (Czech Republic and Russia) and other markets during crisis times, this is not the case for stock markets.

A comparison with the experience of Latin American markets during the Mexican and Russian collapses as well as with the evidence of another study exploring the behavior of Asian markets during the Asian crisis shows large similarities between these experiences and the reaction of the transition economies' markets during the Russian crisis. This fact, together the broader evidence for recent increases in comovements suggests that with increased

financial market integration, the financial markets of the more advanced transition economies can be expected to behave more and more like their Asian and Latin American counterparts.

The remainder of the paper is structured as follows: In the next section, we briefly discuss the main channels of financial market shock propagation, and provide a short overview of the importance of these channels for the region considered here. In Section III, we construct a composite index of exchange market pressure and examine the behavior for all the countries in our sample. Section IV takes a closer look at higher frequency data, focusing on some of the crisis events identified in the third section. In particular, concentrating on the Czech Republic, Hungary, Poland, and Russia, we examine the propagation of shocks in the eurobond, exchange, and stock markets at a daily frequency during crisis episodes. Section V summarizes and concludes.

II. LINKAGES

A. Possible Propagation Mechanisms

There is considerable debate among economists about the relative importance of different propagation channels of financial shocks. There is even more discussion, and occasional confusion, about which of those should be labeled "contagion". We do not want to add to this debate, but in order to clarify some issues in view of the analysis to follow, it may be useful to briefly discuss the commonly mentioned channels of transmission and the difficulties inherent in empirically differentiating between them.

The obvious first suspect for the explanation of the spread of financial market shocks across countries are trade linkages.[5] Trade linkages can be direct, that is, due to trade among the affected countries, or indirect, i.e. through competition effects on third markets or through commodity prices. A second "fundamental" factor behind the propagation of shocks may lie in the presence of financial linkages. Financial linkages can take many forms; the exposure of one country's banking system to another country's debt constitutes a simple example. Lastly, there may be global shocks which simultaneously affect various countries, such as a rise in U.S. interest rates. When these global factors are not appropriately taken into account, one may erroneously attribute the origin of the financial turbulence to the country that is affected most strongly by the common shock.

Usually, comovements that cannot be explained by the above three channels fall under the label "contagion".[6] In this context, market observers often refer to "herding behavior" on

[5] For a formalization, see Gerlach and Smets (1995).

[6] See Rigobon and Forbes (1998) and Masson (1998). Note that Masson (1998) employs the term "spillovers" for effects that arise from macroeconomic interdependence among

(continued...)

the side of investors. This label characterizes the apparent tendency of certain international investors to "follow the pack", mimicking the behavior of other market participants without paying close attention to fundamentals. Theoretical rationalizations of herding behavior include informational models, in which investors learn from each other, and models based on the incentives structures faced by fund managers who are induced to follow their peers.[7] Another mechanism that may induce similar behavior is given by margin requirements. A psychological explanation for "contagion" proposed by Mullainathan (1998) focuses on the possibility that investors imperfectly recall past events; a new crisis suddenly reminds them of previous crises, inducing them to re-assess the probabilities of bad outcomes. In Masson (1998), there are multiple equilibria and a crisis in one country can result in a shift from a good to a bad equilibrium in another due to a change in expectations that is not driven by a change in fundamentals.

Empirically, it is nearly impossible to distinguish between the aforementioned possibilities. Trade linkages are hard to disentangle from financial linkages, since there is usually little information available about the latter and because trade links tend to be correlated with financial links.[8] It is even more difficult to differentiate between the other explanations offered above.

When trying to identify "contagion" effects, apart from the nearly hopeless strategy of attempting to control for all the relevant fundamental linkages, one route is to focus on changes in correlations between financial variables across countries. If a shock to one market results in an *increased* correlation between that and another country's market, this is interpreted if not as contagion, then at least as a structural break in the fundamental relationship between these markets. The idea is that during times of turmoil, cross-market linkages may be fundamentally different after a shock to one market, for example due to irrational panics , changes in expectations among investors, or similar mechanisms as the ones mentioned earlier.[9] While on the one hand, the approach is only consistent with a narrow interpretation of "contagion", excluding, for example constant contagion phenomena over tranquil and turbulent times, on the other hand, is also appealing. This is due to the fact that it is hard to construct a model that explains *increases* in correlation based merely on comovements in fundamentals.

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developing countries. In this paper, the usage of the term is broader; we label "spillover" effects as any type of impact on other countries' financial markets.

[7] See Calvo and Mendoza (1998). For an empirical study of these issues, see Borensztein and Gelos (1999).

[8] See Kaminsky and Reinhart (1998).

[9] See Forbes and Rigobon (1998), Masson (1997), and Mullainathan (1998).

After this brief survey of the difficulties involved in the study of the propagation of financial shocks, we hope to have made the reader sympathetic to the fact that the aim of our paper is rather modest. While we discuss financial and trade linkages, we make only limited attempts to systematically relate observed financial market spillovers to the strength of these linkages. In this light, the following subsections give a short overview over the importance of trade linkages and financial market integration. They are not intended to represent an exhaustive documentation of these issues.

B. Trade Linkages

As is well known, after the collapse of the communist regimes in Eastern Europe in 1989-91, trade links among these countries diminished drastically in importance. During 1993-97, however, trade shares have remained relatively constant. Exports to the European Union and developing countries account for most of the total. An obvious exception is trade between the Czech and Slovak Republics. Exports from the Czech Republic to the Slovak Republic accounted for around twenty percent of total exports in 1993, and still represent about thirteen percent of the total, while exports from the Slovak Republic to the Czech Republic dropped from 42 to 26 percent as a share of total. Another case worth mentioning is Poland, whose exports to Russia increased since 1993, from five to over eight percent of overall exports. Estonia, on the other hand, reduced its share of exports to Russia as a percentage of total from around 23 percent to approximately eight percent. Otherwise, direct trade linkages are small.

While direct trade linkages are not very important, indirect linkages may be more relevant for transition economies. For example, all of the countries studied here export the bulk of their products to the European Union; in the case of Hungary, this share is above 70 percent. This is one reason why, as will be discussed below, financial markets in the region are prone to show some degree of comovement.

C. Financial Sector Linkages and Financial Market Integration

Financial flows have been liberalized considerably in the region over the last six years. However, while most limitations on FDI transactions were lifted early in the transition process, other capital flows were subject to various restrictions which were only eased much more gradually.[10] In the context of the EU accession, the Czech Republic, Hungary and Poland have made further progress in liberalizing capital movements. Estonia and Latvia liberalized capital transactions quickly in the early nineties. Capital flows into Central and Eastern Europe (CEE) started to become sizeable only in 1993.[11] FDI was initially much more important than portfolio flows. Net short-term flows reached a peak for CEE countries in

[10] See Feldman et al. (1998) for a discussion of capital account regulations in selected countries and OECD (1993) for a description of exchange control policies in the early years.

[11] See Claessens et al. (1998), Koch (1997), Sobol (1996), and Garibaldi et al. (1999).

1995, and for the Baltics in 1996, dropping again in 1997. Net short term inflows to Russia were, by and large, negative throughout this period.

Table 1. Export Shares of Selected Transition Economies 1993 and 1997
(% of Total Exports, 1993 numbers in parentheses)

→	Bul	Cro	Czk	Est	Hun	Lat	Lth	Pol	Rom	Rus	Svn	Svk	EU	Dev. Coun.	Asia
Bulgaria	-	0.3 (0.0)	0.4 (0.4)	0.1 (0.0)	0.5 (0.6)	0.1 (0.0)	0.2 (0.0)	0.6 (0.6)	1.4 (1.9)	7.9 (6.6)	0.2 (0.0)	0.3 (0.0)	**43.3 (32.5)**	**49.0 (28.8)**	3.6 (8.6)
Croatia	0.2 (N/A)	-	1.1 (0.0)	0.0 (N/A)	1.1 (1.4)	0.0 (N/A)	0.0 (N/A)	1.1 (1.0)	0.3 (N/A)	3.8 (0.0)	**12.2 (18.2)**	0.5 (0.0)	**50.4 (56.7)**	**44.1 (38.8)**	0.6 (0.8)
Czeck Republic	0.3 (0.4)	0.8 (N/A)	-	0.0 (N/A)	1.9 (2.0)	0.0 (N/A)	0.0 (0.0)	5.8 (2.8)	0.4 (0.3)	3.3 (3.9)	1.0 (1.0)	**20.2 (12.9)**	**60.2 (55.5)**	**34.6 (39.8)**	3.0 (3.2)
Estonia	0.0 (0.3)	0.0 (N/A)	0.1 (0.6)	-	0.1 (0.5)	5.4 (8.6)	5.5 (3.7)	0.8 (1.1)	0.0 (0.1)	8.4 **(22.6)**	0.0 (0.0)	0.0 (N/A)	**62.3 (48.3)**	**29.5 (48.2)**	0.5 (0.4)
Hungary	0.2 (0.3)	1.2 (N/A)	1.7 (1.9)	0.1 (N/A)	-	0.1 (N/A)	0.3 (N/A)	2.7 (1.9)	1.7 (2.2)	5.0 (N/A)	1.5 (N/A)	1.4 (N/A)	**71.2 (57.9)**	**23.3 (33.9)**	1.0 (3.2)
Latvia	0.0 (0.4)	0.0 (0.0)	0.3 (0.0)	4.2 (1.9)	0.1 (0.6)	-	5.5 (3.7)	1.2 (2.8)	0.0 (0.1)	**20.9 (28.5)**	0.1 (0.0)	0.3 (0.0)	**48.9 (32.1)**	**47.6 (62.1)**	2.2 (3.5)
Lithuania	0.1 (0.0)	0.1 (0.0)	0.2 (0.6)	4.2 (2.3)	0.2 (0.0)	5.1 (7.9)	-	3.3 (7.1)	0.1 (0.0)	**13.3** (4.2)	0.0 (0.0)	0.1 (0.0)	**45.2 (67.2)**	**50.0 (27.5)**	2.1 (1.6)
Poland	0.2 (0.2)	0.2 (0.1)	3.5 (2.4)	0.2 (0.0)	1.5 (1.2)	0.4 (0.2)	1.3 (0.3)	-	0.3 (0.3)	8.4 (4.6)	0.0 (0.0)	1.2 (N/A)	**64.2 (69.3)**	**30.9 (24.8)**	2.6 (6.5)
Romania	0.7 (2.1)	(0.2 (0.1)	0.2 (0.2)	0.0 (0.0)	2.2 (2.4)	0.0 (0.0)	0.0 (0.0)	1.2 (0.4)	-	3.0 (4.5)	0.2 (0.2)	0.3 (0.1)	**54.9 (41.4)**	**37.0 (52.2)**	5.4 **(13.6)**
Russia	1.1 (2.1)	0.2 (0.2)	2.1 (3.1)	0.6 (0.2)	2.1 (4.8)	1.4 (0.4)	1.6 (1.2)	3.0 (3.0)	0.9 (1.1)	-	0.0 (0.0)	2.0 (2.1)	**32.9 (44.7)**	**52.5 (40.4)**	8.8 **(12.3)**
Slovenia	0.2 (0.7)	**10.0 (11.8)**	1.8 (1.0)	0.0 (0.0)	1.4 (1.4)	0.0 (0.0)	0.0 (0.0)	1.9 (1.4)	0.3 (0.3)	3.9 (4.0)	-	0.1 (0.0)	**63.6 (61.6)**	**31.7 (32.7)**	1.0 (2.5)
Slovak Republic	0.2 (0.3)	0.8 (0.9)	**25.6 (42.3)**	0.1 (0.0)	4.1 (4.5)	0.1 (0.0)	0.3 (0.1)	5.3 (2.9)	0.7 (0.4)	2.9 (4.7)	1.0 (1.0)	-	**46.7 (29.6)**	**49.7 (68.0)**	1.0 (3.8)

Source: Authors' calculation based on IMF data. Shares above 10 percent are marked bold. Note: Originating country in rows and destination countries in columns. Bul=Bulgaria, Cro=Croatia, Czk=Czech Republic, Est=Estonia, Hun=Hungary, Lat=Latvia, Lth=Lithuania, Pol=Poland, Rom=Romania, Rus=Russia, Svn=Slovenia, Svk=Slovak Republic.

Garibaldi, Mora, Sahay, and Zettelmeyer (1999) quantify the magnitude of capital controls in transition economies, relying on information provided in the IMF's *Annual Report on Exchange Arrangements and Restrictions*. Their two indices, one for foreign direct investment and another for portfolio investments, are reported in Table 2; larger values indicate higher restrictions.

Table 2. Index of Restrictions on Capital Flows

	Index on FDI Restrictions (Average 1993-97)	Index on Portfolio Investment Restrictions (1996-97)	Composite Index for 1997
Bulgaria	1.58	0.63	1.06
Czech Republic	0.40	0.13	0.06
Croatia	1.00	0.63	0.71
Estonia	-0.04	0.00	0.00
Hungary	1.37	0.50	0.63
Latvia	1.60	0.00	0.50
Lithuania	2.80	0.00	1.40
Poland	1.65	0.59	1.09
Romania	2.80	1.00	1.90
Slovak Republic	0.95	0.81	0.88
Slovenia	2.00	0.81	1.25
Russia	2.40	0.63	2.00

Source: Garibaldi, Mora, Sahay, and Zettelmeyer (1999). The FDI index can range from –0.2 to 6 and the portfolio investment index can range from 0 to 2. The composite index is an equally-weighted sum of FDI and portfolio restrictions for 1997. The negative value of the FDI restrictions index for Estonia indicates that incentives for inflows (such as tax breaks) were more important than restrictions.

According to these indices, the Baltic countries had the most liberal regimes with respect to portfolio flows in 1996-97. The countries with the lowest restrictions on FDI during 1993-97 were Estonia, the Czech and the Slovak Republics. Lithuania, Russia, and Romania, on the other hand, imposed the most restrictive regulations.[12] In general, by 1997, Estonia, the Czech Republic, and Latvia, had, in that order, the lowest restrictions on capital flows.

While domestic financial markets are developed unevenly in our sample of countries, important reforms have occurred in all economies. The banking sector remains the most important source of external financing for firms, but the privatization process has also fostered the development of stock markets. In many countries, market capitalization increased rapidly

[12] Feldman et al. (1998) compute a different composite measure of capital account liberalization for a subset of the countries examined here, yielding similar results.

between 1994 and 1996. However, except for the cases of the Czech Republic, Estonia, Hungary, and Russia, the importance of these markets has so far been minor.

Data on direct financial linkages are extremely difficult to obtain. The Consolidated International Banking Statistics, compiled biannually by the Bank for International Settlements (BIS) is one of the few publicly available databases in this area. The database provides the nationality distribution of banks' gross international asset position vis-à-vis countries outside the reporting area.[13] Since the transition economies are not part of the reporting area, we are not able to infer information about the lending within the region, allowing therefore very limited inferences about the strength of financial linkages. A look a the data, however, reveals that the largest creditor country in recent years has in most cases been Germany. For the Slovak Republic and Slovenia, Austria has been the predominant bank creditor country. While this does not provide information about individual countries' exposure, the concentration of bank lending suggests a potentially important role for this channel of spillover transmission.[14]

Next, we will examine comovements in the behavior stock returns over different time windows. This is interesting for the following reasons. First, a higher degree of comovements in stock markets is suggestive of an increase in financial integration. Second, it provides an additional clue as to which linkages may be considered important. For example, high correlations of Central European markets with the U.S. but not with Germany despite trade patterns pointing in the opposite directions would suggest a less important role for trade links in the transmission of shocks. Third, it may be worthwhile to examine whether there are breaks in the comovement of returns that can be associated with changes in investors' perceptions around some key events in emerging markets observed over the last few years. For example, a marked increase in correlation of Central European stock market returns with those of emerging markets in Asia after the Asian crisis might be regarded as supportive of the presumption that international investors differentiated little in their withdrawal from emerging markets.

However, the reported correlations below are only suggestive, and do not allow for a proper testing of the aforementioned hypotheses. Increases in correlations across different stock market returns may, for example, be the result of an increased frequency of common shocks. Moreover, a rigorous testing of increases in correlations needs to take into account changes in the variance of the series examined. We will go further into this issue in later sections, when we examine particular events with higher-frequency data.

In order to ensure comparability and consistency, we work with indices compiled by the International Finance Corporation (IFC) for a large number of emerging markets. Since

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[13] The reporting area comprises 18 industrialized countries and six other (offshore) reporting centers.

[14] See Van Rijckeghem and Weder (1999) for a discussion of these issues.

we are mainly interested in the perspective of a foreign investor, we study returns in US dollars.[15] Specifically, we use the Total Return Series in U.S. dollars for the Czech Republic, Hungary, Poland, Asian Emerging Markets and the worldwide Emerging Markets Composite Index. For Germany, we use the US$ MSCI index and for the US, the Standard and Poor's 500 index. Note that data for Russia is only available starting February 1997, so that it is excluded in the first two tables.

Tables 3-6 provide cross-correlations of transition countries' weekly stock market returns (calculated as first differences in the logarithms of the indices), including those with selected other international indices. The significant increase in correlations over time is truly striking. Since the Russian crisis in August 1998, all cross-correlations were significant at the five percent level.[16] Whereas this finding might be interpreted as the result of increased world integration of these countries' financial markets, it could also mainly reflect the increased volatility of recent times. While no obvious relation between trade shares and the degree of comovements in stock returns among transition economies can be detected, stock market correlations of the transition economies with their large trading partner Germany are higher than those with the U.S. or Asia, providing some indication for the importance of trade linkages.

III. Exchange Market Pressures

A. Composite Exchange Market Pressure Index

In this section, we follow a similar methodology as Eichengreen, Rose and Wyplosz (1996) (henceforth ERW), who construct a composite currency crisis indicator in order to study the contagion phenomenon for 20 industrial countries. This index is a weighted average of changes in short term interest rates, international reserves and the nominal exchange rate.[17]

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[15] Obviously, the choice of US$ returns is also problematic, since larger swings in the US$ exchange rate may yield larger observed correlations.

[16] To assess whether volatilities were also correlated, we computed the correlation of realized volatilities calculated using daily data as proposed by Andersen, Bollerslev, Diebold and Labys (1999). The results, using IFC data for the period 1997:2-1999:1 for the Czech Republic, Hungary, Poland, and Russia, show that the cross-country correlation of these volatilities is very high. Turbulent times in any of these countries' stock markets are associated with turbulences in the other markets in the region.
Daily data for 1997:2- 1999:1

[17] See the IMF's World Economic Outlook (1999) for an application of a similar methodology.

Table 3. Weekly Stock Return Correlations until the Start of the Mexican Crisis (1/7/94-12/16/94)

	Hungary	Poland	IFC Latin America	IFC Asia	IFC Composite	US S&P 500	Germany
Czech Rep.	**0.67**	0.20	-0.02	0.03	0.00	0.03	-0.01
Hungary	-	**0.30**	0.15	**-0.28**	-0.03	0.11	0.06
Poland	-	-	0.16	-0.12	0.07	**0.31**	0.13
IFC Lat Am	-	-	-	0.04	**0.85**	**0.33**	0.14
IFC Asia	-	-	-	-	**0.51**	0.12	**0.35**
IFC Comp	-	-	-	-	-	**0.33**	0.26
US S& P	-	-	-	-	-	-	**0.29**

Number of observations per series: 51.

Table 4. Weekly Stock Return Correlations during Mexican and before the Asian Crisis (12/23/94-7/2/97)

	Hungary	Poland	IFC Latin America	IFC Asia	IFC Composite	US S&P 500	Germany
Czech Rep.	**0.24**	**0.33**	0.06	**0.31**	**0.23**	-0.04	0.14
Hungary	-	**0.37**	**0.18**	0.13	**0.26**	0.15	0.13
Poland	-	-	0.10	0.11	**0.20**	0.02	**0.18**
IFC Lat Am	-	-	-	0.14	**0.84**	**0.27**	0.12
IFC Asia	-	-	-	-	**0.59**	0.10	**0.28**
IFC Comp	-	-	-	-	-	-	**0.28**
US S&P	-	-	-	-	-	-	**0.31**

Number of observations per series: 134.

Table 5. Weekly Stock Return Correlations during the Asian Crisis and before the Russian Crisis (79/97-7/31/98)

	Hungary	Poland	Russia	IFC Latin America	IFC Asia	IFC Composite	US S&P 500	Germany
Czech Rep.	**0.41**	**0.44**	**0.45**	**0.31**	**0.38**	**0.43**	0.15	0.10
Hungary	-	**0.52**	**0.67**	**0.58**	0.25	**0.60**	**0.45**	**0.50**
Poland	-	-	**0.56**	**0.59**	**0.51**	**0.70**	**0.40**	**0.47**
Russia	-	-	-	**0.63**	0.24	**0.62**	**0.40**	**0.42**
IFC Lat Am	-	-	-	-	**0.48**	**0.88**	**0.71**	**0.56**
IFC Asia	-	-	-	-	-	**0.78**	**0.48**	**0.38**
IFC Comp	-	-	-	-	-	-	**0.71**	**0.61**
US S&P	-	-	-	-	-	-	-	**0.61**

Number of observations per series: 134.
Source: Authors' calculations based on data from IFC, Bloomberg. Number of observations per series: 28.
Note: Coefficients that are significant at the 5 percent level are marked bold.

Table 6. Weekly Stock Return Correlations during and after the Russian Crisis (8/7/98-2/12/99)

	Hungary	Poland	Russia	IFC Latin America	Asia	IFC Composite	US S&P 500	Germany
Czech Rep.	**0.78**	**0.76**	**0.63**	**0.34**	**0.62**	**0.69**	**0.63**	**0.75**
Hungary	-	**0.87**	**0.59**	**0.61**	**0.54**	**0.81**	**0.66**	**0.58**
Poland	-	-	**0.60**	**0.56**	**0.59**	**0.82**	**0.66**	**0.68**
Russia	-	-	-	**0.43**	**0.48**	**0.65**	**0.54**	**0.71**
IFC Lat Am	-	-	-	-	**0.37**	**0.86**	**0.53**	**0.44**
IFC Asia	-	-	-	-		**0.73**	**0.49**	**0.54**
IFC Comp.	-	-	-	-	-		**0.70**	**0.70**
US S&P 500	-	-	-	-	-	-	-	**0.72**

Number of observations per series: 28.

Source: Authors' calculations based on data from IFC, Bloomberg. Number of observations per series: 28.
Note: Coefficients that are significant at the 5 percent level are marked bold.

A higher index indicates greater pressure on the exchange market since it will be reflected in higher values of these three variables, depending on the nature of the intervention of the respective central bank. This allows one to focus not exclusively on successful speculative attacks (that is those where the exchange rate depreciates rapidly by a large amount), but also on speculative pressures that were either accommodated by a loss of reserves or fended off by the monetary authorities through an increase in interest rates. Changes in the aforementioned variables are measured with respect to the mean of that series for each country. In contrast to ERW, who use quarterly data, we are able to construct monthly statistics. More formally, the index is given by:

$$EMP_{it} = \alpha \Delta e_{it} + \beta \Delta (i_{it} - \bar{i}_i) - \gamma (\Delta r_{it} - \Delta \bar{r}_i), \qquad (1)$$

where e_{it} is the nominal exchange rate vis-à-vis Germany (local currency per foreign currency),[18] i_{it} and r_{it} are the short term interest rate and the ratio of international reserves to M1 of country i, respectively. The bars and Δ's denote country-means and month-to-month growth rates, respectively. The choice of the DM-exchange rate for most countries was motivated by the importance of trade linkages between these countries and the European Union, as demonstrated in the previous section. The weights attached to the three components

[18]Due to the nature of their exchange rate pegs, we used the US dollar for the Lithuanian and Russian case, and the SDR for the case of Latvia. In all other cases, the foreign currency is the deutsche mark (DM). ERW, instead, compare all growth rates to German values.

of the index (α,β, and γ) are the inverse of the standard deviation for each series, in order to equalize volatilities.[19]

As in ERW, crises are defined as extreme values of this index. A "crisis" episode is defined as a month in which EMP exceeds its overall mean μ_{EMP} by 1.645 times its standard deviation σ_{EMP}. Under normally distributed errors, this is equivalent to a one-sided confidence level of 5 percent.

$$Crisis_{it} = 1 \ if \ EMP_{it} > \mu_{EMP} + 1.645\sigma_{EMP} \qquad (2)$$

$$Crisis_{it} = 0 \ otherwise.$$

Most of the countries considered here have some form of a fixed exchange rate regime.[20] Estonia and Lithuania adopted currency boards in 1992 and 1994, respectively. In Latvia, the currency has been pegged to the SDR since February 1994. Until the implementation of a currency board in July 1997, Bulgaria had a managed float regime. Hungary and Poland have been maintaining pre-announced crawling bands. The Czech Republic had to abandon its exchange rate peg in May 1997, and Russia did so in August 1998. Between 1993 and 1998, Romania had a "managed floating system without preannounced target" and in early 1997 undertook a comprehensive exchange reform which, inter alia, eliminated any differential between the National Bank reference rate and the market rate. The Slovak Republic let its exchange rate float in October 1998, after maintaining a fixed exchange rate regime throughout the period examined here. Croatia has kept a managed float regime since late 1993, and Slovenia did so since 1991.

Using the threshold given above, we find 18 episodes of strong exchange market pressures. In some cases, however, they precede each other and belong to the same larger event. Our definition correctly identifies the well-know crises, such as the Bulgarian turbulences prior to the introduction of the currency board in 1997, the abandonment of exchange controls in Romania in early 1997, the Czech crisis in May 1997, the pressures in the Baltics and Russia coinciding with the Asian crisis in the fall of 1997, and the Russian crisis of August 1998. The indices are displayed in Figure 1.

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[19] For short term interest rates, we used the money market rate as reported by the IFS (line 60b), with the exceptions of Czech Republic, Hungary, Romania, and the Slovak Republic, where an interbank-three month rate (source: Bloomberg), the Treasury-Bill rate (IFS line 60c), the average deposit rate (IFS line 60 l), and the Treasury-Bill rate (IFS line 60c) were used, respectively. The international reserves data were obtained from IFS (line 1l). We employed period average exchange rates (IFS line rf), except for Russia, where we used period averages from the RET Russian Economic Trends database.

[20] See Fischer, Sahay, and Végh (1996) for details.

There are several further noteworthy observations that can be made. First, the countries with the highest number of crises were Bulgaria and Russia. Interestingly, while Russia is commonly believed to have had only one crisis (in August 1998) since it adopted a fixed exchange rate regime, the index reveals that there were various instances of strong exchange market pressures. The main explanation for this is that the authorities preferred to defend the peg via interest rate hikes and reserve losses rather than devalue. Second, early reformers (such as the Czech Republic, Estonia, Hungary, Poland) appear to have been less prone to exchange market pressures than late reformers (Bulgaria, Romania, Russia). Third, three countries (Croatia, Slovenia, and the Slovak Republic) show higher fluctuations in the EMP index during the earlier years of the sample period. This is likely to be related to the fact that all these countries had recently been formed from the breakup of larger states. Fourth, surprisingly only two of the countries (Latvia and the Slovak Republic) experienced a crisis following the Russian crisis of August 1998. Fifth, it is worth mentioning that, apart from Russia, the countries with the most liberal capital account regimes according to Table 3 (the Baltics) witnessed the largest increase in the EMP index during the Asian crisis.

In attempting to identify clusters of crises, we observe that there are only four instances in which more than one country's index surpasses our crisis-threshold contemporaneously. In line with a-priori presumptions, these episodes are the (i) the liberalization of financial markets during a period of political instability and uncertainty about debt rescheduling in Bulgaria in July 1994, (ii) a period of high monetary instability in Bulgaria and Romania around February 1997, (iii) the months around the Asian crisis in late 1997 and (iv) an interval around the Russian crisis, between May and October 1998. In the case of the Czech crisis in May 1997, the Slovak Republic also displays a peak which is very close to this threshold. We will focus our attention on (iii) and (iv). We will also study the Czech crisis given that the choice of the threshold is somewhat arbitrary, and given the relatively large size of the Czech economy.[21]

The easiest way of describing the relationship between the indices across countries is to report simple correlations. Tables 7 and 8 below show the correlation pairs for two subperiods, 1993:10-1995:1 and 1995:2-1998:11. The split into these two subperiods is dictated by data limitations for Russia, for which the series start in 1995:2. Note that in the first subperiod, there is no significant correlation across countries, except for two exceptions with negative sign. The picture looks different for the period 1995:2-1998:11. Of the 66 correlation pairs, 12 are significantly different from zero, with all of them being positive. Again, this observed increase in correlation may be the result of higher recent volatility in global financial markets.

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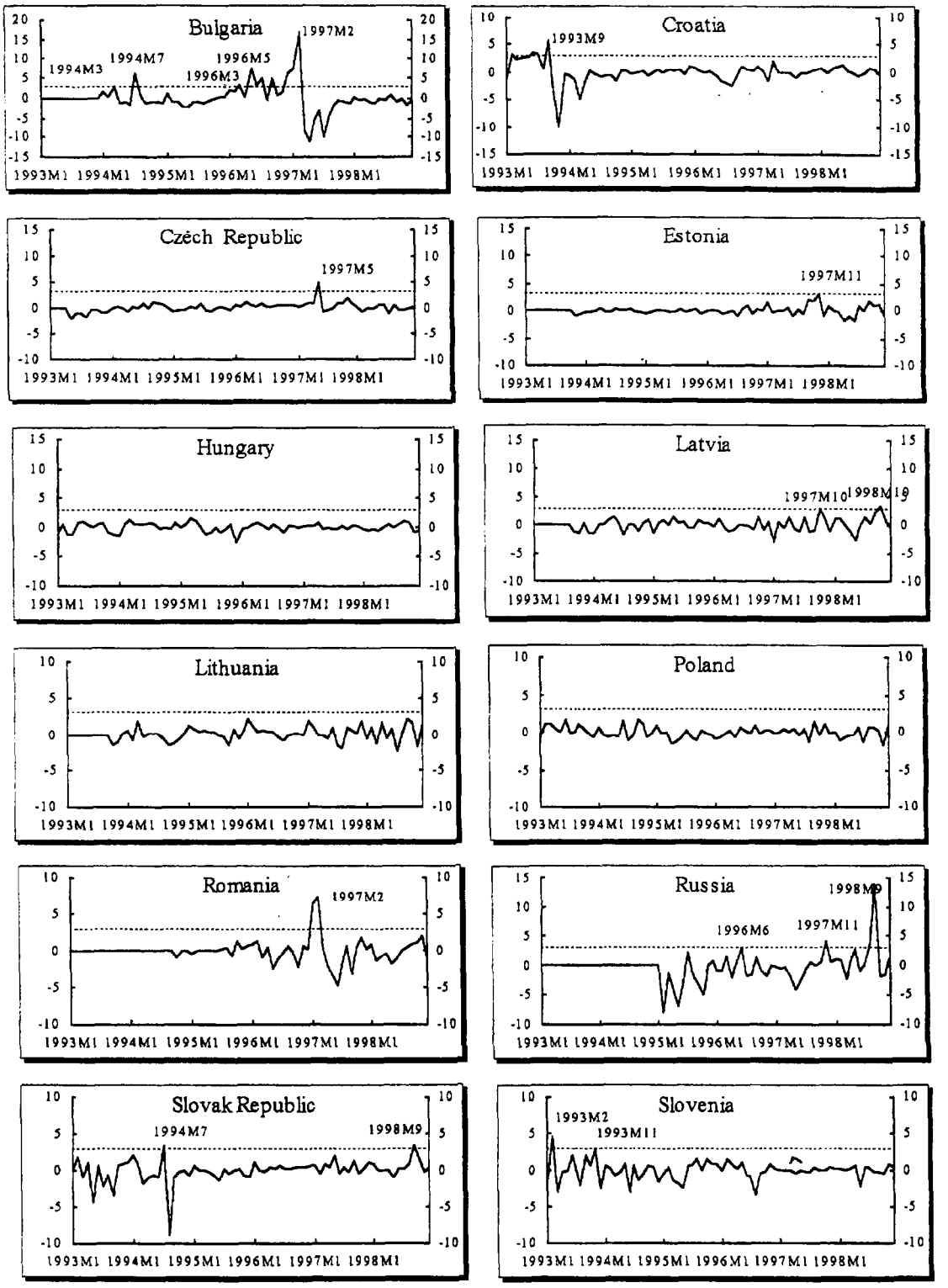
[21] The main reasons for excluding episodes (i) and (ii) from our analysis below are: the events appear to have been driven independently, the size of the economies is relatively small, and data on these countries are limited.

Figure 1. Selected Transition Countries: Index of Exchange Market Pressure, January 1993-December 1998



Sources: International Monetary Fund, International Financial Statistics; Bloomberg; Russian Economic Trends Database; and, Staff estimates.

Table 7. Cross-Country EMP-Index Correlations: 1993:10-1995:1

	BUL	CRO	CZK	EST	HUN	LAT	LTH	POL	SVK	SV
BUL	1									
CRO	-0.35	1								
CZK	0.12	0.42	1							
EST	0.16	0.23	0.48	1						
HUN	0.25	0.05	0.13	0.49	1					
LAT	**-0.62**	-0.07	-0.01	-0.07	0.25	1				
LTH	0.48	0.10	-0.28	-0.23	0.24	-0.08	1			
POL	-0.43	0.12	0.16	0.02	-0.20	-0.22	-0.20	1		
SVK	0.30	-0.08	0.00	-0.04	-0.26	-0.38	0.02	0.04	1	
SVN	0.30	**-0.56**	0.02	-0.01	-0.20	0.00	-0.30	-0.19	0.34	1

Source: Author's calculations based on IFC data. Note: Bold indicates significance at the 5 percent level.

Table 8. Cross-Country EMP-Index Correlations: 1995:2-1998:12

	BUL	CRO	CZK	EST	HUN	LAT	LTH	POL	ROM	RUS	SVK	SVN
BUL	1											
CRO	.0.069	1										
CZK	-0.043	-0.036	1									
EST	-0.005	-0.030	0.161	1								
HUN	-0.001	-0.095	0.008	0.118	1							
LAT	-0.152	0.071	-0.178	**0.390**	0.083	1						
LTH	0.273	0.216	0.042	-0.031	0.228	-0.023	1					
POL	0.035	-0.122	**0.370**	0.223	0.190	-0.003	0.283	1				
ROM	**0.534**	0.073	-0.152	0.260	0.037	0.060	0.173	-0.107	1			
RUS	0.129	-0.066	-0.031	**0.306**	0.061	0.102	0.175	**0.365**	0.086	1		
SVK	-0.104	-0.056	**0.302**	**0.390**	**0.357**	0.181	**0.306**	**0.485**	-0.052	**0.425**	1	
SVN	0.113	**0.299**	0.000	0.006	-0.242	0.041	0.092	0.044	0.124	0.067	-0.021	1

Source: Author's calculations based on IFC data. Note: Bold indicates significance at the 5 percent level.

Table 9. Explaining Correlations by Fundamentals

	Coefficient 1993:10-1995:1	Coefficient 1995:2-1998:12
Common creditor[1]	0.02	-0.05
Bilateral export shares[2]	0.001	0.01*
Capital account restrictions[3]	-	0.04

[1]Dummy.
[2]Maximum of observation pair.
[3]Minimum of observation pair.
** and * denote significance at the 1% and 5% levels, respectively.

To see whether exchange market pressures precede or follow specific countries, we conduct Granger causality tests. These tests indicate that movements in the Russian index tend to precede those in Hungary, Poland, Lithuania, and the Slovak Republic.[22] (Appendix I) In addition, speculative pressures in Slovenia generally preceded those in the Slovak Republic, while the latter Granger-caused those in Poland. Pressures in Romania preceded those in Bulgaria and Croatia. However, it is difficult to infer much about precise timing regularities due to the relatively low frequency of our data. We investigate this aspect in more detail in Section IV, where we examine the transmission of shocks during some of the episodes identified here.

B. Relating Comovements to Fundamentals

In this section, we examine to which extent the observed correlations can be traced to economic linkages. First, we regressed the reported correlations on bilateral export shares. Since we have two observations per country pair, the correlation used was the maximum of the two numbers (a small country's EMP index may comove with Russia if it is heavily dependent on Russia for its exports, even though Russia's export share to that country is negligible). For both subperiods, the sign of the trade-shares coefficient was positive, but it was only significant for the correlations of the second subperiod. The R^2 of that latter regression was 0.09, indicating that about ten percent of the variation in these comovements can be traced to direct trade links. Second, we regressed the correlation on the composite index average of capital flow restrictions (using the minimum of the capital flow variable pair as the right-hand side variable), without obtaining a significant coefficient.[23] Third, in an attempt to control for financial links based on the BIS data mentioned earlier, we create a dummy that equals one if two countries share the same major bank creditor country. Given that Germany is the major creditor country for most of the cases considered here, this variable takes the value of one in most cases. We find no significant relation between the EMP correlations and this dummy. The results are shown in Table.9

[22] When excluding the period of the Russian crisis, movements in the Russian index only Granger-cause those of the Slovak Republic.

[23] We obtain similar results when using the methodology proposed in Feldman et al. (1998) to construct capital account liberalization indices. We also ran a regression including all three variables. The coefficients were: –0.04 (t-statistic: -0.95) for the common creditor variable, 0.01 for the bilateral export shares (t-statistic: 2.45), and 0.03 (t-statistic: 0.69) for the capital restrictions variable. The R2 was 0.11.

In order to explore whether these comovements can be traced to other economic factors, we follow a similar approach to Wolf (1998) and rank countries according to a list of potential macroeconomic and structural fundamentals. If countries that are similar in these respects tend to be more prone to experiencing the same type of shocks, they should exhibit a higher correlation in the EMP index. Specifically, we looked at differences in a number of "performance variables" such as real GDP growth, "structural variables" such as GDP per capita, and "risk variables" such as the current account deficit.

Table 10 shows the results of regression of bilateral EMP correlations on the absolute rank difference between countries for each of these variables. If higher similarity is associated with higher comovements, one would expect a negative coefficient on the rank difference variable. The only variable for which the regression coefficient is significant is the Exports/GDP variable. The coefficient is positive, indicating that, beyond direct trade linkages, openness in general (possibly through the effects of indirect trade links) makes economies less prone to move with others. The lack of importance of the variables measuring economic similarity are in line with the results of Wolf (1998) which relates rank differences to stock market correlations. We also examined whether market pressures in countries with flexible exchange rate regimes tended to comove more with those in other economies than market pressures in countries with fixed exchange rate systems. We found no systematic evidence for the importance of the exchange rate regime.

Table10. Explaining Correlations by Fundamentals

Variable	**Coefficient on absolute rank difference 1993:10-1995:1**	**Coefficient on absolute rank difference 1995:2-1998:12**
Mean inflation	0.01	-0.01
Real GDP growth	-0.23	0.14
Mean Export growth	0.00	0.00
Investment/GDP	0.02	0.01
Real GDP per capita	-0.01	-0.01
Exports/GDP	-0.01	0.02*
Fiscal deficit/GDP	0.00	-0.01
Short term debt/GDP	0.02	0.00

** and * denote significance at the 1% and 5% levels, respectively.

A different way of relating the index to fundamentals is to focus on crisis periods and ask whether the strength of exchange market pressures experienced by a given country is related to vulnerability indicators. A problem with this approach is that for each crisis, we only have 12 observations, limiting the scope for formal statistical tests. Moreover, many macroeconomic variables deemed relevant in the literature on speculative attacks and financial market contagion are only available on an annual basis. Despite these difficulties, we inspected the relation between, on the one hand, EMP indices in October 1997 and August 1998, and, on the other hand, four vulnerability indicators.[24] These indicators were: the current account balance in the quarter prior to the two dates mentioned above, the ratio of international reserves to M1 in the previous month, the ratio of government short-term debt and fiscal deficit to GDP in the year prior to the event. While the two fiscal variables did not seem to predict the strength of the exchange market pressures well, the previous ratio of reserves to M1 appeared to influence the strength of these pressures. Interestingly, the current account deficit was negatively correlated with exchange market pressures during the Asian, but not the Russian crisis. This is shown in Figures 2 and 3.

IV. THE PROPAGATION OF SHOCKS-EVIDENCE FROM HIGH FREQUENCY DATA

A. Methodology

While the previous section provided a picture of the degree of correlations in exchange rate markets during tranquil and turbulent times, this section concentrates on a limited number of countries and explores higher frequency-data focusing on possible contagion effects during three crisis episodes. As stated in the introduction, it is nearly impossible to distinguish "contagion" from the effects of common shocks, and even more difficult to differentiate between spillovers that are due to financial market linkages, on the one hand, and herding behavior or changes in market sentiment (rational or irrational), on the other hand.[25] We carry out some tests which – while not constituting tests of contagion in a narrow sense– shed some light on the nature of financial market spillovers. In particular, we examine (i) whether there are systematic temporal patterns in the transmission of shocks to stock market returns, exchange rates and eurobond spreads in these episodes and (ii) whether daily correlations across stock markets increased significantly around these crisis periods.

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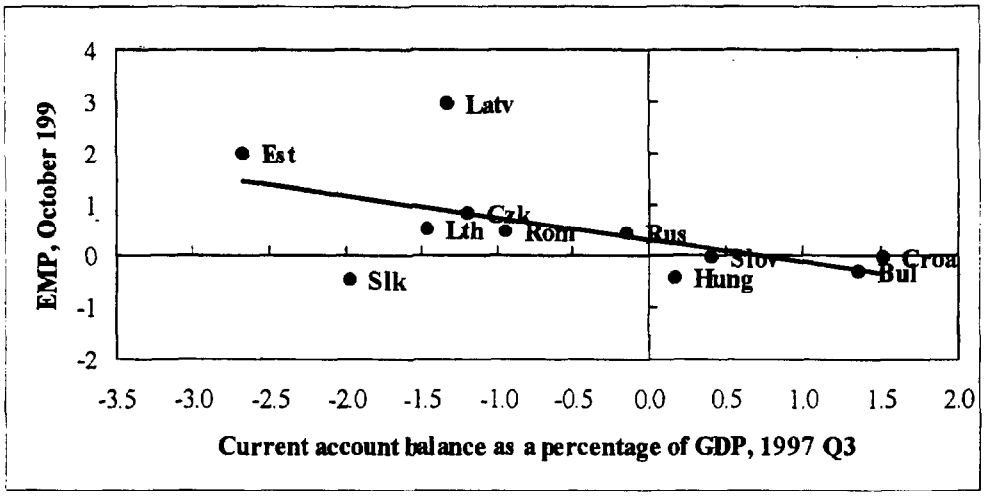
[24] We do not show all graphs and correlations are not shown; they are available upon request.

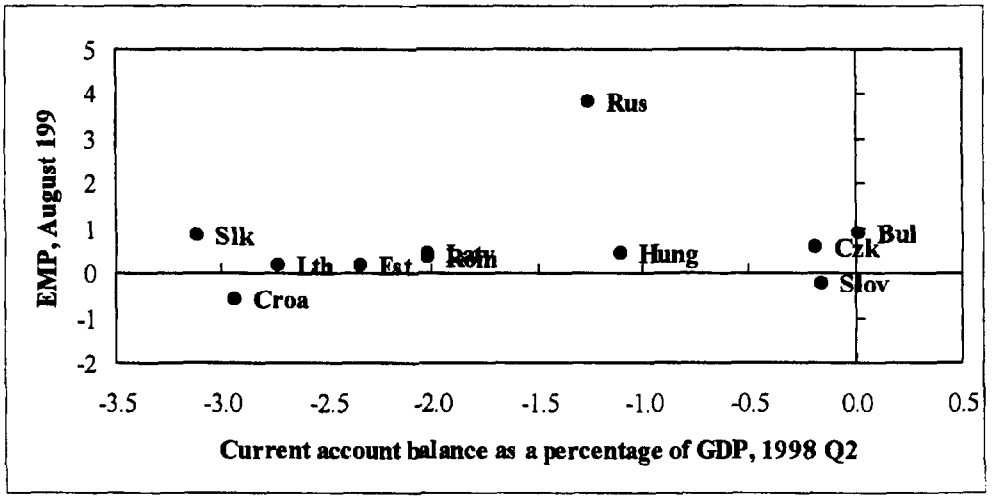
[25] For an examination of the behavior of emerging market funds around these crises, see Borensztein and Gelos (1999).

Figure 2. EMP Index and Current Account Balance during Asian Crisis



Source: Authors' calculation based on data from IFS.

Figure 3. EMP Index and Current Account Balance during Asian Crisis



Source: Authors' calculation based on data from IFS.

Concentrating on the crisis-cluster periods discussed earlier, namely the Czech, Asian, and the Russian crisis, we use two techniques to examine whether and how during these episodes, exchange-, stock- and sovereign spread movements in the country considered as the "origin country" were systematically transmitted to the other markets.[26]

First, we carry out VAR analyses with daily stock- and exchange market data to study dynamic interactions at a higher frequency. Due to data availability and comparability limitations, we restrict our stock-market analysis to the Czech, Hungarian, Polish, and Russian cases. In the case of exchange markets, we are able to expand the coverage, although data limitations again impeded including the full set of countries covered in Section III. Of course, this more restricted set of countries is not representative of "typical" transition countries, but is biased toward the most advanced economies. For mainly descriptive purposes, we show and discuss impulse response functions. These impulse response functions reveal, based on the VAR estimates, the dynamic effects of a standard deviation shock to one variable on the other variables in the system. In order to implement this exercise, one has to assume that innovations to certain variables do not contemporaneously affect the other variables, implying an *ordering of the variables*, in our case, stock and currency returns. We also carry out Granger causality tests, trying to assess whether stock returns in one country systematically affected returns in other markets with a lag, i.e. whether, for example today's stock market performance in Russia helps to explain tomorrow's performance on the Polish stock market. Such evidence would be difficult to explain by trade linkages, and would point at least to the presence of financial linkages and possibly to market inefficiencies.

Second, we pursue to examine whether correlations between the originating country's financial markets and other markets in the region increased markedly during crisis events. As argued earlier, a significant *increase* in correlation during turmoil periods may be interpreted as evidence in favor of a structural break during such events.[27] However, as pointed out by Forbes and Rigobon (1999), comparing correlations without controlling for changes in volatility can be misleading.[28] To see this, assume that x and y are stochastic variables, representing, for example, stock market returns. Following Forbes and Rigobon (1999) let:

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[26] See Baig and Goldfajn (1998), Tan (1998), and Mathur, Gleason, Dibooglu and Singh (1998) for similar exercises. Some authors, including Tan (1998) have estimated cointegrating relationships among stock markets. Problems associated with this approach are discussed insee Richards (1995).

[27] Often, such a structural break is considered evidence for "contagion". Given the conceptual and semantical problems mentioned earlier, we do not use this terminology.

[28] See also Ronn (1998).

$$y_t = \alpha + \beta x_t + \varepsilon_t \qquad (3)$$

where $E[\varepsilon_t]=0$, $E[\varepsilon_t^2]<\infty$, and $E[x_t\varepsilon_t]=0$, and $|\beta|<1$.

Suppose that there are two subperiods: one period with low variance σ_{xx}^l and another subperiod with high variance σ_{xx}^h (e.g. during a crisis), $\sigma_{xx}^l < \sigma_{xx}^h$. It can be shown that the estimated standard correlation between x and y, ρ, is higher in the period with higher variance of x_t, that is: $\rho^h > \rho^l$. The intuition is that the increase in the variance of x_t reduces the noise/signal ratio, independently of the distribution of the error term. In order to calculate the unconditional correlation, one needs to adjust for the increase in variance.

Defining $\delta_t = \frac{\sigma_{xx}^h}{\sigma_{xx}^l} - 1$, the unconditional correlation coefficient can be obtained by the following transformation of the unadjusted coefficient $\rho_t^{unadj.}$:

$$\rho_t = \frac{\rho_t^{unadj.}}{\sqrt{1+\delta_t\left[1-\left(\rho_t^{unadj.}\right)^2\right]}} \qquad (4)$$

After transforming the adjusted correlation coefficients with a Fisher transformation in order to ensure that they are normally distributed, standard tests can be used to examine whether during crisis periods, the adjusted correlations increased significantly. Note, however, that it is necessary to identify the originating country (which experienced a variance increase in its shocks) in order to carry out this adjustment. This is not a problem for our purposes, since the crisis origin country/region for the episode that we examine below have been identified a priori.

B. The Czech Crisis

Pressures on the Czech koruna in 1997 began in April 1997. Against the background of a widening trade deficit and an economic slowdown, on April 14, the koruna reached a ten-month low against the currency basket. After the publication of negative data on economic activity, the koruna weakened further, forcing the central bank to intervene. Despite a restrictive interest rate policy and the imposition of limits on foreigners' access to the money market, the koruna continued to be under pressure throughout May. On May 27 the target band was abandoned, and the Czech koruna depreciated almost immediately by around 10 percent.

On the same day, the Slovak crown, which also had been subject to a speculative attack, reached the bottom of its band. However, the Slovak central bank was able to maintain

the peg after choking off liquidity in the money market. In early June, the Czech government announced a stabilization package and the Czech central bank was able to lower its interest rate. On June 17, access of nonresidents to the Czech money market was resumed. Interestingly, market nervousness had manifested itself already earlier in the year on the stock market; in the beginning of February, stock market volatility increased, and the index started to decline. Volatility then abated somewhat and started to increase again in May. This is shown in Figure 2.

In view of the developments discussed above, the crisis window used for the stock market analysis is February 1 to June 15 1997, and April 2 to June 6 for the exchange rate. Granger causality tests for the stock markets do not indicate a clear pattern of transmission from the Czech Republic to the other countries (see Appendix for results).[29] The impulse response functions do not show signs of strong impacts in either direction; none of the response functions is significantly different from zero. However, depending on the exact data and lag estimation, a weak, but significant transmission from the Czech to the Hungarian and Russian markets could be detected.[30]

The graphical presentations of the impulse response functions for the exchange market do not suggest the presence of strong propagation mechanisms, either. However, the responses of the Estonian and Hungarian markets to movements originating in the Czech currency market are statistically significant. Granger causality tests, on the other hand, do not point to a lagged response of other countries to Czech shocks.[31]

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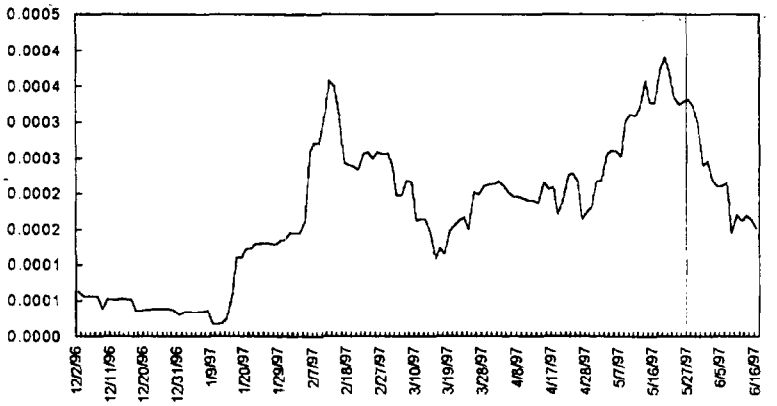
[29] In the appendix, we only show only the result of one specification of the test. However, here and in all cases discussed below, we experimented with various dates and lag specifications and report those cases were ambiguous results were obtained.

[30] Here and in the following, we used the Schwartz criterion to determine the optimal lag length in the VAR's. We will report the impulse response functions with the origin country listed first in the ordering. Due to space considerations, we only show the results corresponding to one of the remaining orderings, unless the results were substantially affected by different orderings. All variables are stationary. Note that we did not include the Slovak stock market due to data availability.

[31] However, even with daily observations, the frequency of the data may be too low to be able to detect the presence of spillovers from one market to the other.

Figure 4. Czech Republic: Variance of Stock Market Returns (Czech Crisis)



Source: IFC.
Note: The reported variance figures refer to the variance of daily stock market returns in four-week windows centered around the indicated dates.

Comparing correlations in daily stock market returns before and during the crisis period, the results reveal that there was a significant increase in correlation between the Hungarian and Czech stock markets during the crisis, but not between the Polish and the Czech markets.[32] Note however, that even during the crisis, the correlation of daily stock returns between the Czech and Hungarian markets is quite low. Similar tests for the exchange markets indicate that there have been structural breaks in the relation of the Czech with the Estonian, Hungarian, and Russian currency returns. These results, however, should be viewed with caution in light of the switch of the Czech exchange rate regime. Interestingly, however, there is no significant increase in the correlation between the Slovak and Czech currency returns

Summarizing, it can be said that there was little interaction between stock markets in the region during the Czech crisis, despite evidence for a structural break in the relation between the Czech and the Hungarian stock markets in form of a moderate increase in correlation. The impact on exchange markets was somewhat stronger, although changes are mainly reflected in contemporaneous, rather than lagged, correlations.

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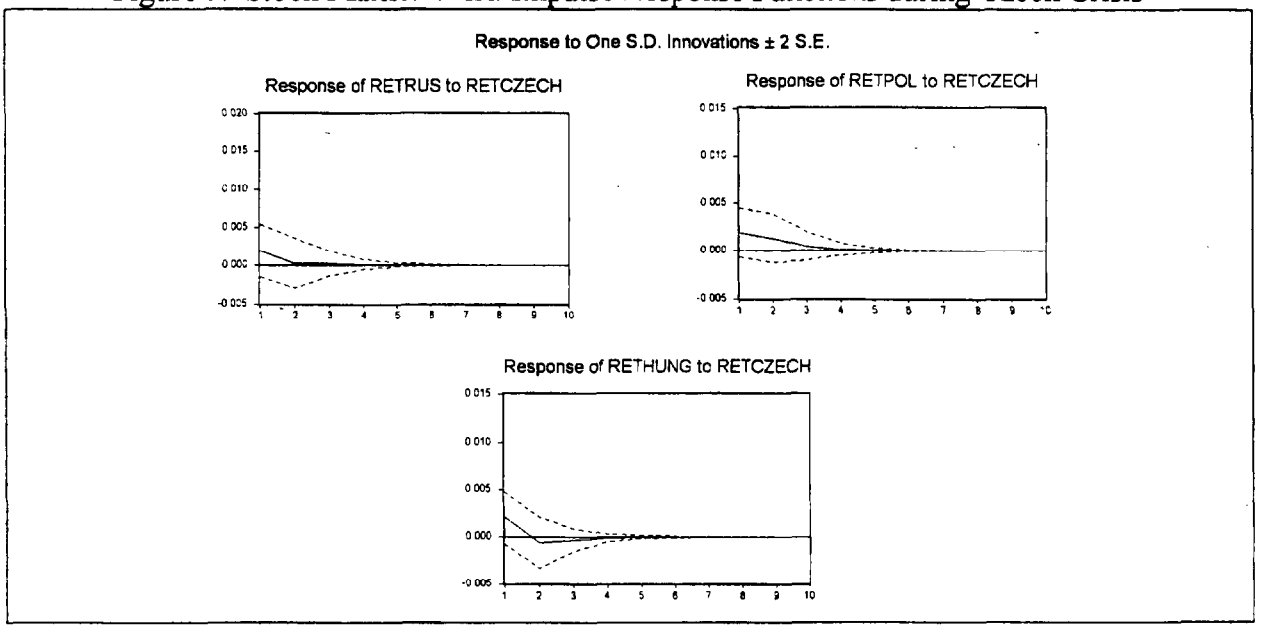
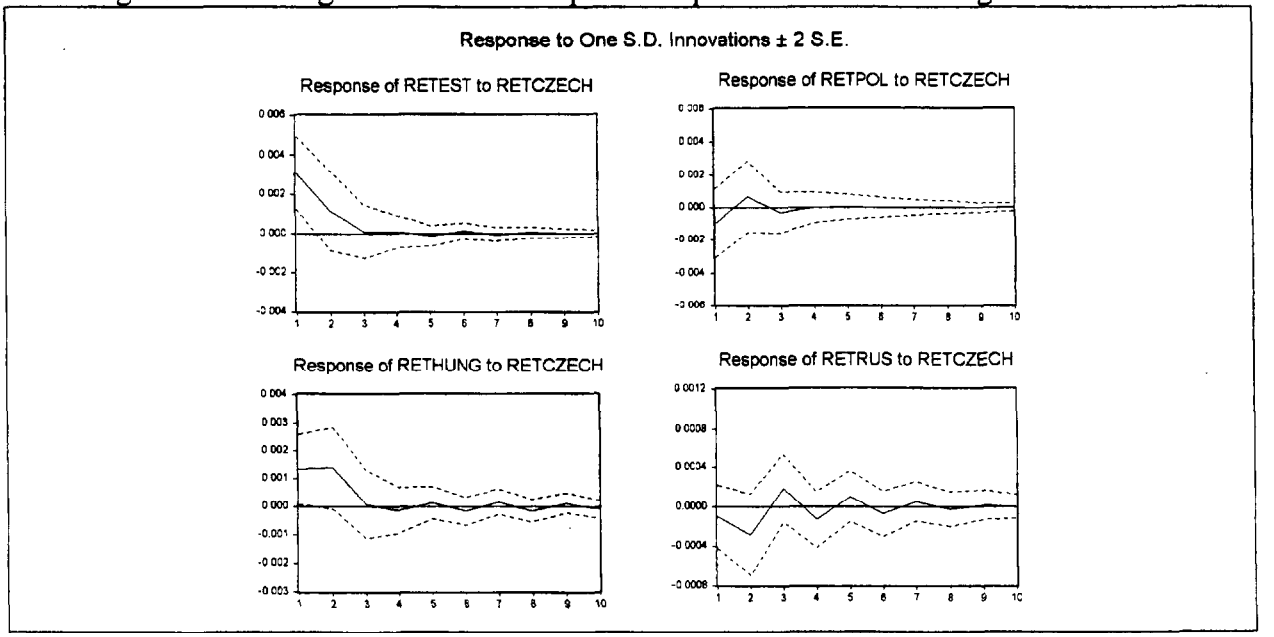
[32] The 5-percent critical value for a one-side test of the null hypothesis of no increase in correlation is –1.65. If the test statistic is below that value, the null hypothesis is rejected. In principle, these tests are sensitive to the precise choice of the tranquil and turbulent periods. This choice is necessarily somewhat arbitrary, but the results reported here and in the following are quite robust to the use of alternative time frames.

Figure 5. Stock Market VAR. Impulse Response Functions during Czech Crisis



Source: IFC Sample Period: 2/1/1997-6/15/1997. Ordering: Czech Rep.→Hungary→Poland→Russia; 1 Lag RETCZECH, RETHUNG, RETRUS denote stock returns in the Czech Republic, Hungary, and Russia, respectively.

Figure 6. Exchange Market VAR Impulse Response Functions during Czech Crisis



Source: Bloomberg. Sample Period: 4/2/1997-6/6/1997.Ordering: Czech Rep.→Hungary→Poland→Russia→Estonia;1 Lag. RETEST, RETCZECH, RETHUNG, RETPOL, and RETRUS stand for returns in Estonia, the Czech Republic, Hungary, Poland and Russia, respectively.

Table 11. Czech Crisis. Test for Significant Increases in Stock Return Correlations

Correlations	Tranquil	Crisis (unadj.)	Crisis (adjusted)	T-stat
Hungary-Czech	-0.001	0.143	0.093	**-7.65**
Poland-Czech	0.137	0.207	0.135	0.16

Note: Adjustment is given by equation (2). Tranquil period: 6/1/96-1/31/97. Crisis period: 2/1/97-6/15/97
Null hypothesis: no significant increase in correlation.

Table 12. Czech Crisis. Test for Significant Increases in Exchange Correlations

Correlations	Tranquil	Crisis (unadj.)	Crisis (adjusted)	T-stat
Estonia-Czech	0.117	0.390	0.207	**-4.24**
Hungary-Czech	0.281	0.704	0.443	**-8.65**
Poland-Czech	0.392	0.020	0.010	18.63
Russia-Czech	-0.095	0.164	0.083	**-8.23**
Slovak-Czech	0.181	0.107	0.053	5.97

Note: Differences in natural logarithms of exchange rates were used. Adjustment is given by equation (2).
Tranquil period: 6/1/96-4/1/97. Crisis period: 4/2/97-6/15/97 Null hypothesis: no significant increase in correlation.

C. The Asian Crisis

The Asian crisis erupted with the abandonment of the exchange rate peg by the Thai authorities on July 2, 1997. The collapse of the baht had widespread repercussions in the region. On July 11, the Philippine peso floated, followed by the Malaysian ringgit and the Indonesian rupiah on July 14 and August 14, respectively. In October, the crisis even spread to countries with large reserve holdings, namely Taiwan and Hong Kong. In the week of October 20, the Hong Kong stock market index lost approximately one fourth of its value. On November 17, South Korea was forced to abandon the peg of the won. While negotiations with the IMF started soon after, it was not until late January 1998 that the first comprehensive re-financing agreement was signed.[33] The following three and a half months were calmer, until around mid-May, when a political crisis in Indonesia led to a renewed wave of financial market turbulences.

The window used for our stock market analysis comprises the period July 2, 1997 (the day on which the Thai baht floated) until Jan 29, 1998 (the date of a successful resolution of the Korean debt negotiation) for the exchange market exercises and the period October 1, 1997 until Jan 29, 1998 for the stock-market analysis. We use the IFC composite investable index for emerging markets in Asia to investigate whether shocks from that region affected stock markets in the transition economies.[34] In order to reduce problems stemming from nonsynchronuous trading, we work with two-day returns. We do not examine effects on the exchange markets, since it was difficult to select among the Asian exchange rates and the corresponding time windows.

The stock-market-impulse response functions show a strong response of all four markets to shocks to the IFC Asia composite index. In addition, there is substantial shock transmission from Russia to Poland and Hungary. However, Granger causality tests do not provide evidence for the presence of lagged effects in stock markets.[35] While the results were somewhat dependent on the ordering adopted in the calculation, the effect of the Asian stock market remains even if placing it after the Russian stock return in the ordering. Adjusted correlation tests, shown in Table 15, indicate a significant increase in the correlation between the returns on the Asian composite index and the returns on the Russian index, but none in the other three cases considered here.

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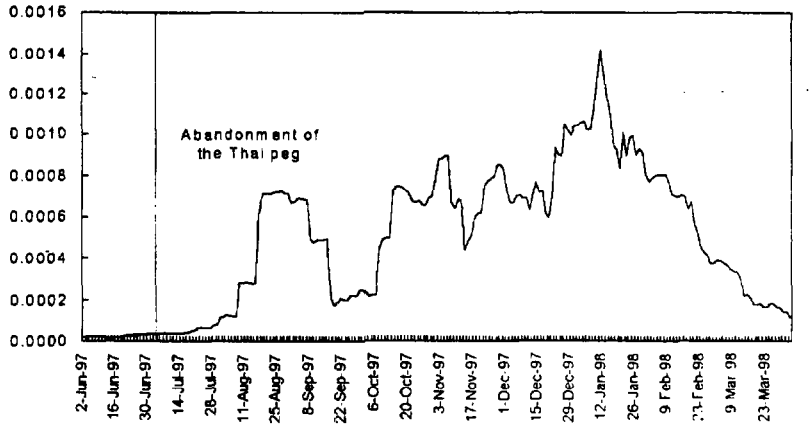
[33] See Fries, Raiser and Stern (1998). The authors also attempt to relate the degree of macroeconomic weaknesses in a number of transition economies to the strength of the impact of the Asian crisis on their financial markets.

[34] We also experimented instead with the Thai stock index, without altering the qualitative results reported below.

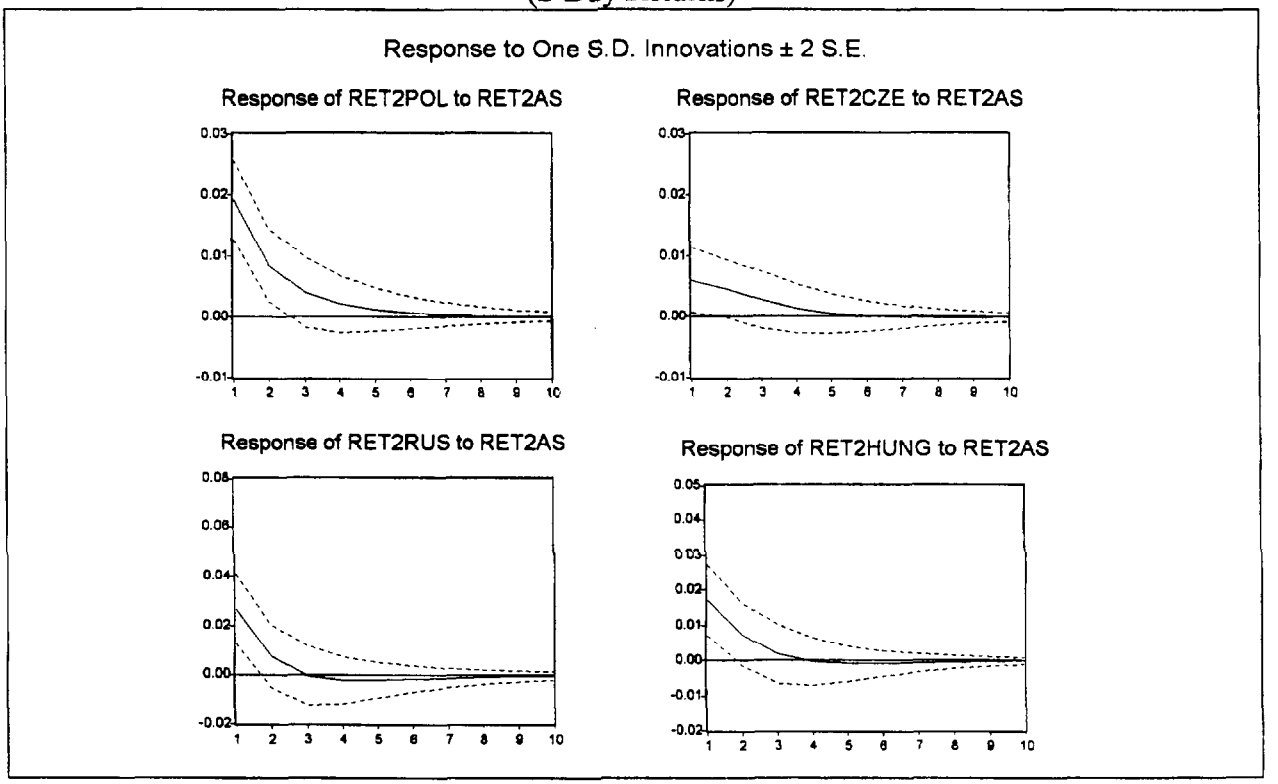
[35] This is in line with findings by Pesonen (1998).

Figure 7. Variance of IFC Asia Composite Stock Market Returns (Asian Crisis)



Source: IFC. The reported variance figures refer to the variance of daily returns in four-week windows around the indicated dates.

Figure 8. Stock Markets VAR. Impulse Response Function during Asian Crisis (2-Day Returns)



Source: IFC. Sample Period: 10/1/1997-1/29/1998 Ordering: Asia→Russia→Czech Republic→Hungary→Poland. 1 Lag. RET2AS, RET2HUNG, RET2POL, and RET2RUS denote to two-day stock returns in Asia, Hungary, Poland, and Russia, respectively.

Table 13. Asian Crisis. Test for Significant Increases in Stock Return Correlations

Correlations	Tranquil	Crisis (unadj.)	Crisis (adjusted)	T-stat
Asia-Czech	0.079	0.217	0.059	1.69
Asia-Hungary	0.210	0.304	0.082	11.14
Asia-Poland	0.313	0.389	0.101	18.51
Asia-Russia	0.038	0.297	0.081	**-3.66**

Note: Adjustment is given by equation (2). Tranquil period: 2/4/97-7/1/97. Crisis period: 7/2/97-1/29/98. Null hypothesis: No significant increase in correlation.

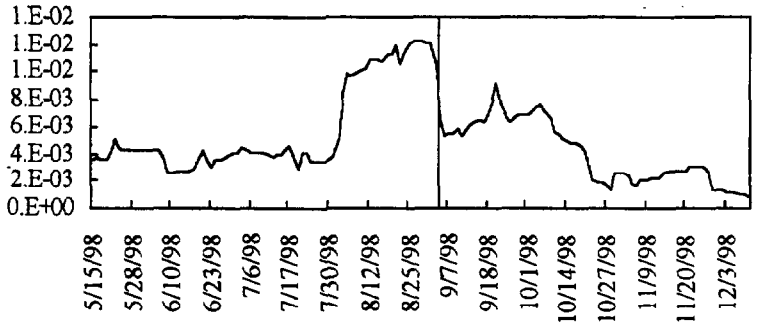
D. The Russian Crisis

The beginning of the 1998 Russian crisis can be dated at around mid-May 1998. There was a sudden large outflow of capital, and pressures intensified in late June. By July 10, average yields on treasury bills had reached 192 percent, owing to widespread devaluation concerns. After the announcement of an agreement with the IMF and of a plan for a voluntary restructuring of short term treasury bills in mid-July, pressures abated initially, the stock market recovered, and interest rates fell substantially. However, in August, capital outflows increased again, resulting in a sharp rise in interest rates (to almost 300 percent treasury bill yields) and a marked loss of reserves. On August 17, the exchange rate band was changed from 5.3-7.1 rubles per dollar to 6.0-9.5. However, this did not calm the markets, and on September 2, the ruble was allowed to float. As seen in Figure 9, stock market volatility increased sharply at the end of July and remained at high levels until October. For the stock market analysis, we therefore use the window 7/15/98-10/15/98.

The VAR results for the stock market indicate a strong shock transmission. As can be appreciated in Figure 10, the effect on the Hungarian market is particularly strong.[36] Again, the impact of such innovations is transitory and dies out after at most five days. Granger causality show that Russian stock performance clearly affected returns in the Czech Republic, Hungary and Poland with a lag (see Appendix III). This is consistent with perceptions about

[36] Krzak (1998) argues that the Budapest stock exchange was the most severely affected in the region because of the strong participation of foreigners.

Figure 9. Russia. Variance of Stock Market Returns
(Russian Crisis)



Source: IFC. The reported variance figures refer to the variance of daily returns in four-week windows around the indicated dates.

contagion during the summer of 1998.[37] Note that this pattern of Granger causality is special to the period around the crisis and not characteristic of the year preceding the event, reinforcing the notion that they may not be a mere reflection of market inefficiencies. Another piece of evidence supporting this view is that *negative* shocks to returns in the Russian stock market had a much stronger effect on the other countries' stock markets than positive shocks. While this is true for tranquil and crisis periods, around the Russian crisis the difference between the impact of positive and negative shocks is larger,[38] and there is no significant effect of positive Russian stock returns on the other markets. This asymmetric response is difficult to reconcile with the view that the reaction of these other markets was merely due to traditionally considered fundamental linkages.

However, impulse-response functions for the exchange market show much weaker responses. Granger causality tests for these markets do not reveal a lagged response of other markets to changes in the Russian exchange rate. With regard to Eurobonds, the evidence indicates Granger causality from Russia to Poland to Hungary, and also from Russia to Slovenia. Impulse responses for eurobond spread changes (not shown) do not show any

[37] See, for example, Krzak (1998).

[38] During the Russian crisis, the coefficients of lagged positive values of Russian stock returns are –0.1, -0.07, and 0.1 for Hungary, Poland, and the Czech Republic, respectively, with t-statistics of –0.78,-0.65, and 0.98. The corresponding coefficients for negative lagged returns are 0.31, 0.22, and 0.18, with associated t-statistics of 2.82, 2.32, and 2.08. For evidence of asymmetric GARCH effects of good and bad news in transition economies' stock markets, see Rockinger and Urga (1999).

significant impact, except for the case of Slovenia, where an innovation in the Russian spread had a lasting effect. In contrast to the stock market results, we find no evidence for asymmetric effects.

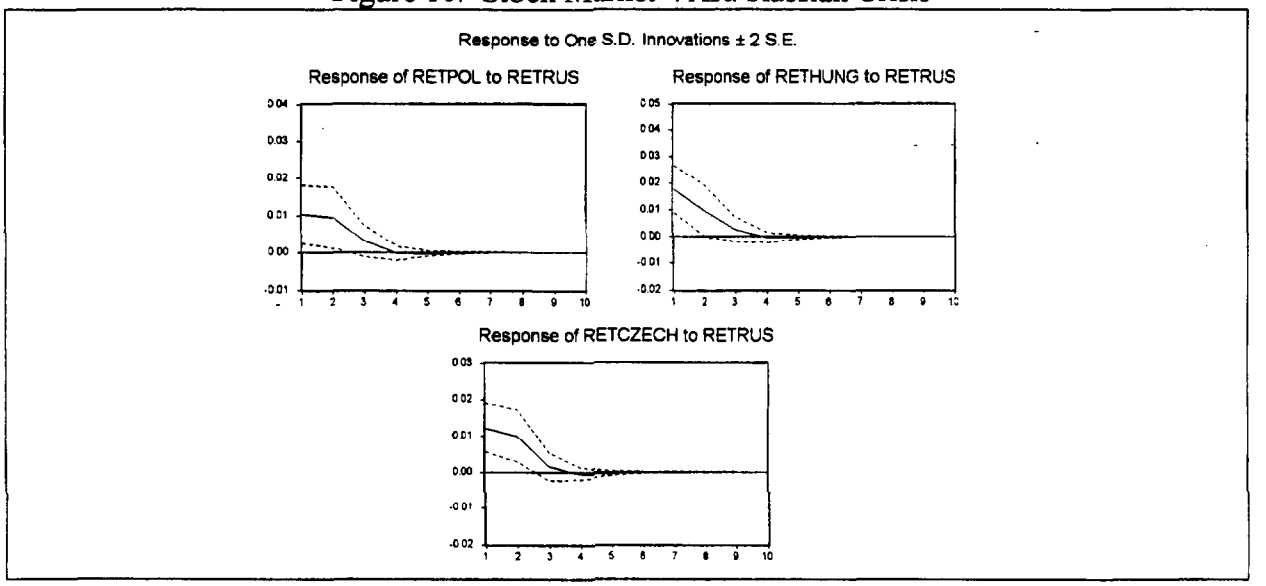
Tests for significant increases in stock return correlations show no evidence for a structural break. While unadjusted correlations increased, after correcting for the large increase in Russia's stock return variance, adjusted correlation coefficients were actually significantly lower during the crisis. This is not true, however, for the exchange market. With the notable exception of Poland, exchange rate correlations with Russia increased substantially. The adjusted correlations during the crisis period are approximately zero due to the extremely increase in the variance of the ruble which makes the denominator in equation (2) very large. Even more than in the Czech case, however, one should be cautious in interpreting the increase in exchange rate correlations given the stark regime change for the Russian ruble and the fact that the ruble was essentially only moving in one direction before the crisis.

For this episode, we have sufficient data to also inspect eurobond spread comovements between Hungary, Poland, and Slovenia. We cannot observe significant increases in the covariance of spread changes. Similarly to the stock market, we actually observe significant decreases for Hungary and Slovenia.

Table 17 summarizes the high-frequency results for the three crises discussed above. Overall, the data confirm the perception that for the transition economies, propagation effects during the Russian crisis were stronger than during the Czech and Asian crises. However, the effects on the exchange market, while noticeable, were not extremely strong. This is in line with the assessment by the IMF's Interim Capital Markets Assessment,[39] where the relatively muted effects of the Russian crisis on regional markets is attributed to limited exposure to portfolio flows, limited external financial needs, and prospects of EU accession. Nevertheless, it is difficult to assess the relative magnitude of our results in a global context. We briefly address this issue in the next section.

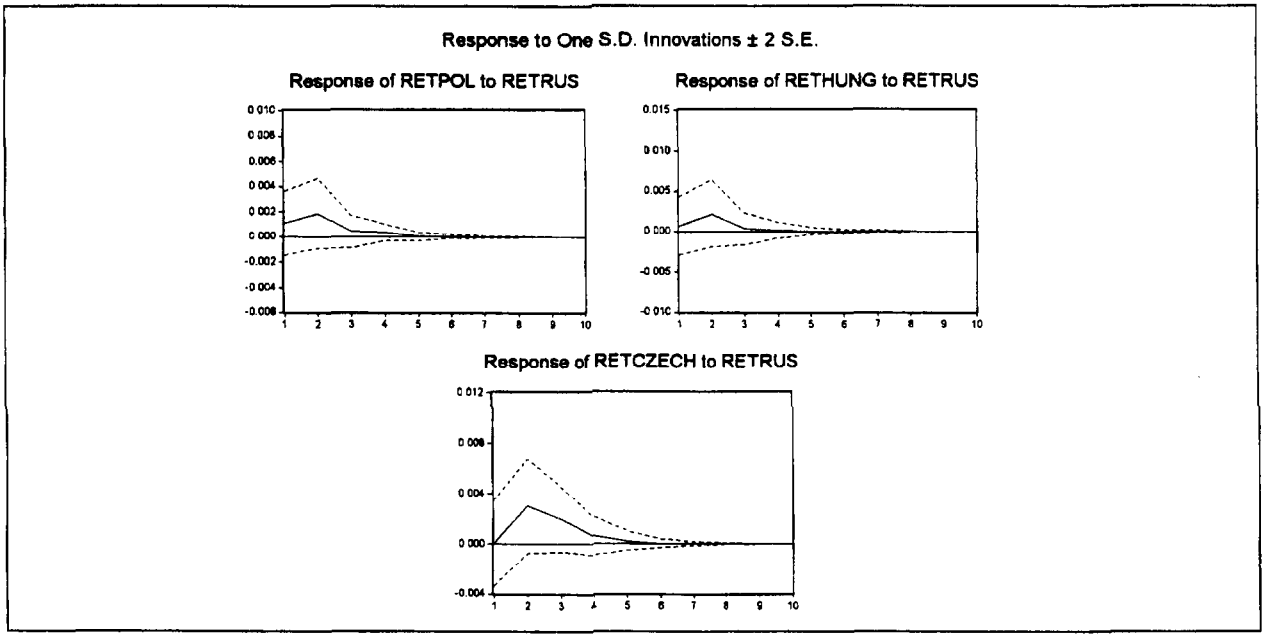
[39] See IMF (1998), p. 32.

Figure 10. Stock Market VAR. Russian Crisis



Source: IFC. Sample Period: 7/16/98-10/15/98 Ordering: Russia→Hungary→Poland→Czech Rep. 1 Lag. RETCZECH, RETHUNG, RETPOL, and RETRUS denote stock returns in the Czech Republic, Hungary, Poland, and Russia, respectively.

Figure 11. Exchange rate VAR. Russian Crisis



Source: Bloomberg. Sample 7/16/98-10/15/98. Ordering: Russia→Poland→Hungary→Czech Rep. 1 Lag. RETCZECH, RETHUNG, RETPOL, RETRUS denote stock returns in the Czech Republic, Hungary, Poland, and Russia, respectively.

Table 14. Russian Crisis. Test for Significant Increases in Stock Return Correlations

Correlations	Tranquil	Crisis (unadj.)	Crisis (adjusted)	T-stat
Czech-Russia	0.370	0.481	0.261	17.14
Hungary-Russia	0.318	0.490	0.267	9.99
Poland-Russia	0.302	0.344	0.178	10.19

Note: Adjustment is given by equation (2).Tranquil period: 1/31/98-7/15/98. Crisis period: 7/16/98-10/15/98. Null hypothesis: no significant increase in correlation. Correlations were calculated with log differences of the total return indices.

Table 15. Russian Crisis. Test for Significant Increases in Exchange Rate Correlations

Correlations	Tranquil	Crisis (unadj.)	Crisis (adjusted)	T-stat
Czech-Russia	-0.219	0.060	0.000	**-11.67**
Estonia-Russia	-0.355	0.259	0.000	**-7.39**
Hungary-Russia	-0.270	0.162	0.000	**-14.47**
Poland-Russia	0.141	0.050	0.000	7.42

Note: Adjustment is given by equation (2).Tranquil period: 1/31/-7/15/98. Crisis period: 7/16/98-10/15/98. Null hypothesis: no significant increase in correlation. Correlations were calculated with log differences of exchange rates.

Table 16. Russian Crisis. Test for Significant Increases in Sovereign Spread Correlations

Correlations	Tranquil	Crisis (unadj.)	Crisis (adjusted)	T-stat
Hungary-Russia	0.092	-0.086	-0.011	5.04
Poland-Russia	0.027	0.027	0.003	1.11
Slovenia-Russia	0.271	-0.017	-0.002	13.58

Note: Adjustment is given by equation (2).Tranquil period: 1/31/-7/15/98 Crisis period: 7/16/98-10/15/98. Null hypothesis: no significant increase in correlation. Correlations were calculated with first differences of spreads.

E. Comparison with Other Experiences: Asia and Latin America

How do these results compare to other countries' experiences? In other words, given the magnitude of the Russian shock, was the observed reaction in the region's financial markets comparatively weaker or stronger than in other countries during this or other crises? Do the observed correlations represent more general patterns of financial market spillovers?

In an attempt to answer these questions, we make three comparisons. First, we take a look at the effects of the Russian crisis on Latin America. Second, we carry out the same exercise as in the previous subsections for the case of another severe regional crisis, the Mexican currency collapse 1994/95, and inspect the reaction of three Latin American markets at the time. Third, we compare our intra-regional results to the ones obtained by Baig and Goldfajn (1998), who examine five Asian markets during the Asian crisis.

During the *Russian crisis*, Latin American stock markets experienced sizeable losses, and in fact, often appeared to move in tandem with the Russian stock market. As in the transition economies' case, we examine dynamic relationships and ask whether there was a structural break in the relationship between the Latin American and the Russian stock markets. Impulse response functions for stock market returns in Argentina, Brazil, and Mexico show a similar pattern to those for the transition economies; however, the magnitude of the impact of innovations in the Russian markets on Latin America is overall somewhat stronger, comparable to the Hungarian response function. Granger causality tests show that stock returns in Russia Granger caused those in Argentina and Brazil. While correlations in returns were high during the crisis, they had been so earlier, so that no significant increases in correlations are noteworthy. A look at the currency markets(results not shown here), on the

other hand, does not reveal Granger causality patterns from Russia to the Latin American currencies, and no significant increase in correlations.

In order to compare our intra-regional results with the those in another region, we use the same methodology to assess the impact of the *Mexican crisis* on Argentina's, Brazil's, and Chile's currency and stock markets. [40] The "Tequila effect" had been felt throughout Latin America in 1995. Figure 13 shows stock-return impulse response functions. They again show a pattern akin to the ones observed for the transition economies during the Russian crisis.

Similarly to the impact of the Russian crisis on other transition economies, Mexican stock return movements Granger-caused returns in Argentina, Brazil and Chile (see Appendix IV). With regard to the exchange markets, there is a significant increase in correlation between movements in the Brazilian Real and the Mexican peso during the crisis; this, however, is not the case for Chile.[41]

Interestingly, however, the correlation results for stock markets do not indicate the presence of a structural break in this case, either. Only Brazil shows a sizeable increase in comovement with the Mexican stock market, but controlling for the increase in variance in the Mexican market, this correlation increase fails to be significant at the five percent level. These results are in line with those reported by Forbes and Rigobon (1999) for a different set of countries.

Baig and Goldfajn (1998) take a closer look at exchange-, bond-, and stock markets in Thailand, Malaysia, Indonesia, Korea, and the Philippines during the *Asian crisis*. For the stock markets, impulse response functions for these Asian countries are very similar to those in transition economies after the Russian crisis. In contrast, impulse responses of the exchange rates are much stronger in Asia than in transition economies. While not carrying out the correlation adjustment that we apply here, the authors compare unadjusted correlations and find that, whereas the correlations across exchange markets increased substantially with the crisis, this was not the case for stock markets. In fact, similarly to our case, they find sizeable positive correlations prior to the crisis, with no marked change afterwards. Contrary to our findings, they report substantial increases in sovereign spread correlations.

It therefore appears that, while spillover effects of the Czech and Asian crisis on transition economies were moderate, those during the Russian crisis share many similarities with the experience of other regions. A characteristic of stock markets seems to be that they

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[40] To carry out a similar exercise as before, we again use daily data. However, since the daily IFC series starts only in July of 1995, we rely on the national indices as reported by Bloomberg (Bovespa, Bcbagnrl, Igpa, Mexbol.)

[41] We did not include Argentina in the analysis, since it maintained a currency board throughout the period.

do not show a marked increase in correlation during crises, whereas they are somewhat more common for the exchange markets.

V. Summary and Conclusions

This paper proceeded in four steps. First, we identified potential channels for financial market spillovers in twelve transition economies. Second, we constructed a composite exchange market pressure index and examined patterns in the movements of the index across countries for tranquil as well as for crisis periods. Third, we conducted a closer examination of the propagation of financial market shocks during crises using high frequency (daily) data for a more limited group of countries. Finally, we compared the results for transition economies to the "contagion" experience of Asia and Latin America.

When identifying potential shock transmission channels for spillovers, cross country data revealed that bilateral trade shares among the transition economies were low; on the other hand, indirect trade linkages appeared more important. Financial market linkages were more difficult to assess. A visible increase in stock market correlations during the 1994-99 period, while consistent with other explanations, points to increased financial market integration. Data on bank lending by third countries showed that Germany was the major bank creditor nation for most of the economies in the region, suggesting a potentially important financial link.

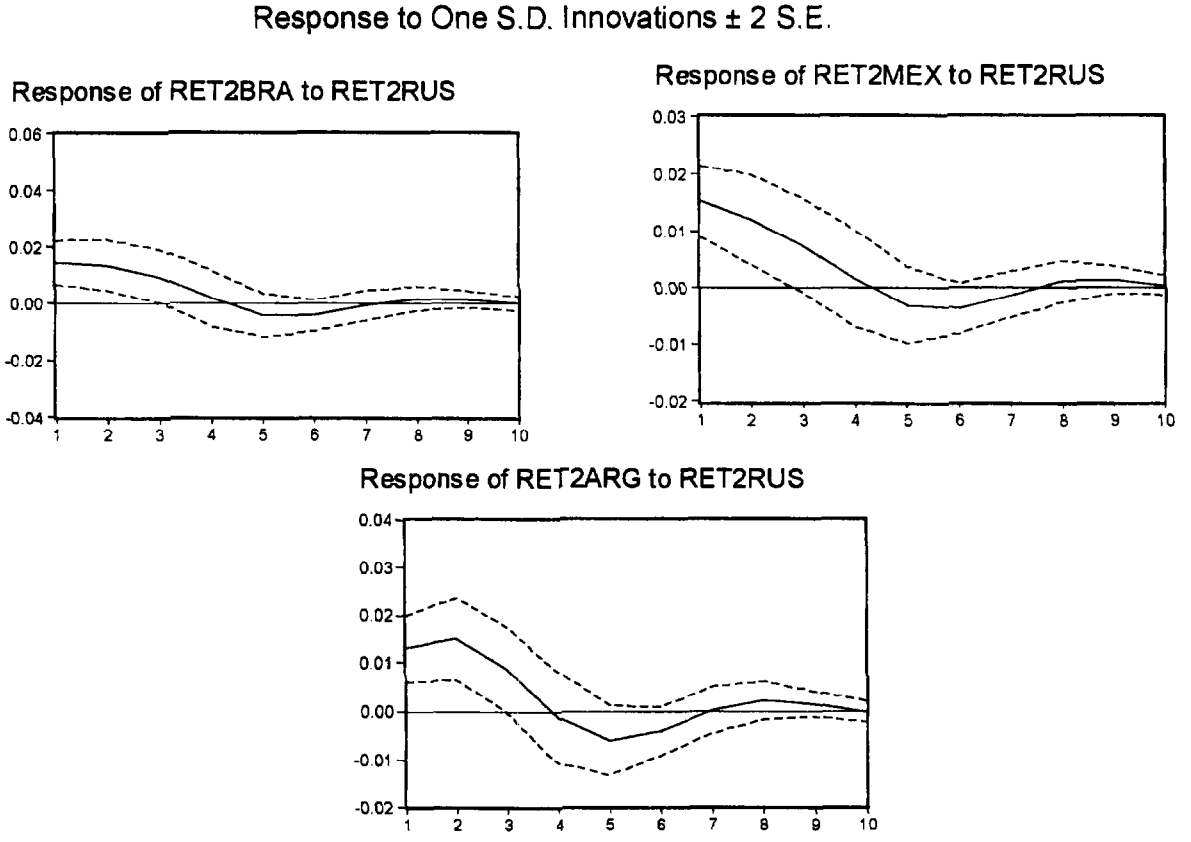
The examination of an exchange-market pressure index showed that pairwise correlations were moderate, positive and rising over time, and difficult to explain by fundamental variables other than trade linkages. Correlations did not appear to be systematically associated with differences in capital account restrictions, the existence of a common creditor country, or similarities in macroeconomic fundamentals. Despite the fact that bilateral trade shares among the transition economies were low, they appeared to matter, explaining about ten percent in the variation of exchange-pressure comovements. Granger causality tests indicated that movements in the Russian index tended to precede those in other countries.

A look at individual country experiences with exchange market pressures indicated that early market-oriented reformers (Czech Republic, Estonia, Hungary, and Poland) appeared to have been less vulnerable to exchange market pressures than late reformers (Bulgaria, Romania, and Russia) during the entire sample period. On the other hand, countries with the most liberal capital account regimes as of 1996-98 (the Baltics) witnessed the largest pressures around the Asian crisis. In all, during 1993-98, a total of 18 episodes of strong exchange market pressures were found in the 12 countries in the sample. Of these countries,

Table 17. Summary of High Frequency Correlation Results

	Czech Crisis	Asian Crisis	Russian Crisis
Exchange Rates			
Impulse response	Weak		Weak
Granger causality	None	-	None
Increase in correlation	**Yes, with Estonia, Hungary, and Russia**	-	**Yes**, except with Poland
Asymmetric response To pos. and neg. shocks	No	-	Weak
Stock Markets			
Impulse response	Weak	**Strong**	**Strong**
Granger causality	No		**Russia => Poland** **Russia => Czech** **Russia => Hungary** Czech => Poland
Increase in correlation	Hungary only	Russia only	No
Asymmetric response To pos. and neg.shocks	No	No	**Yes**
Eurobond Spreads			
Impulse response	-	-	Only sign. for Slovak R.
	-	-	**Russia => Poland** **Russia => Slovenia** **Poland => Hungary**
Increase in correlation	-	-	No
Asymmetric response To pos. and neg. shocks	-	-	No

Figure 12. Stock Market VAR. Russian Crisis – Response of Latin American Stock Markets



Source: IFC.
Sample Period: 5/15/98-10/15/98 Ordering: Russia=>Brazil=>Mexico=>Argentina
2-day returns, 2 lags. RET2ARG, RET2BRA, RET2MEX, and RET2RUS stand for two-day returns in Argentina, Brazil, Mexico, and Russia, respectively.

Table 18. Russian Crisis. Test for Significant Increases in Stock-Return Correlations between the Russian and Latin American Stock Markets

Correlations	Tranquil	Crisis (unadj.)	Crisis (adjusted)	T-stat
Argentina-Russia	0.418	0.401	0.133	18.95
Brazil-Russia	0.314	0.382	0.126	12.07
Mexico-Russia	0.187	0.354	0.115	4.50

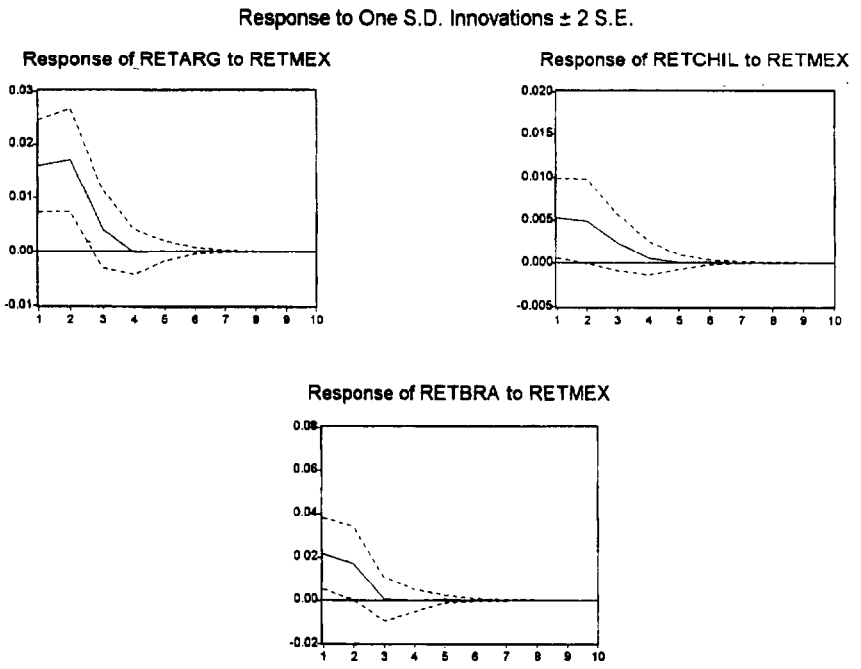
Note: Adjustment is given by equation (2).Tranquil period: 1/31/98-7/15/98. Crisis period: 7/16/98-10/15/98. Null hypothesis: no significant increase in correlation. Correlations were calculated with log 2-day differences of the total return indices.

Table 19. Mexican Crisis. Test for Significant Increases in Stock Return Correlations between the Mexican and other Latin American Stock Markets

Correlations	Tranquil	Crisis (unadj.)	Crisis (adjusted)	T-stat
Argentina-Mexico	0.400	0.445	0.253	9.34
Brazil-Mexico	0.186	0.381	0.212	-1.57
Chile-Mexico	0.249	0.257	0.139	6.51

Note: Adjustment is given by equation (2).Tranquil period: 1/31/98-7/15/98. Crisis period: 7/16/98-10/15/98. Null hypothesis: no significant increase in correlation. Correlations were calculated with log 2-day differences of the total return indices.

Figure 13. Stock Market VAR. Mexican Crisis



Source: Bloomberg. Sample Period: 1/3/1995-3/30/1995 Ordering: Mexico=>Brazil=>Argentina=> Chile. 1 Lag. RETARG, RETBRA, and RETMEX refer to returns in Argentina, Brazil, and Mexico, respectively.

Bulgaria and Russia experienced the maximum number of crisis. Crisis clusters could be identified following the Russian and the Asian crises. The intensity of exchange market pressures experience by a given country during these episodes appeared to be negatively related to the ratio of international reserves to M1, and, in the Asian episode, to the current account deficit prevailing before the crisis. We could not find a relation between the exchange rate regime and the strength of exchange-market pressures.

Focusing on three widely-cited crisis episodes (the Asian, Czech, and Russian) and on a subset of countries for which high frequency data was available, we conducted an analysis of the propagation of shocks. In particular, we explored whether there were systematic patterns in shock transmission to stock market returns, currency returns, and eurobond spreads during these episodes. In a VAR framework, we looked at impulse response functions, carrying out Granger causality tests, and asking whether the response to positive and negative shocks had been asymmetric. We also examined whether correlations between financial variables increased markedly during crises, pointing to contagion effects.

While spillovers during the Czech crisis were mild, they were stronger during the Asian crisis, and quite pronounced around the Russian ruble collapse. During the Russian ruble crisis, Russian stock returns clearly "Granger caused" those in European transition economies' stock market returns, while this was usually not the case during tranquil times. Moreover, unlike in previous cases, there was a marked asymmetry in the response to positive and negative shocks – drops in the Russian stock market resulted in drops in the other countries the day following day, but the effect of gains in the Russian market was less marked. However, there was no evidence for a structural break between these stock markets, while this was generally the case for the exchange markets. In general, shock propagation seemed different on exchange- and stock markets.

Finally, we compared our results with the experience in other regions, namely those of Latin American markets during the Asian and Russian crises and those of Asian economies during the Asian crisis. Broadly speaking, these episodes looked surprisingly similar to the experience of transition economies around the Russian crisis.

In sum, we find that during crisis events, shocks were propagated across financial markets in Central and Eastern Europe in ways that are difficult to explain based solely on traditionally considered linkages. While spillover effects were relatively weak during the Czech and Asian crises, the reaction of the more advanced financial markets in the region around the time of the Russian ruble collapse indicates that further financial market liberalization, deepening, and integration may result in increased future financial market comovements.

Granger Causality Tests for the EMP Index

Pairwise Granger Causality Tests
Sample: 1993:01 1998:12
Lags: 2

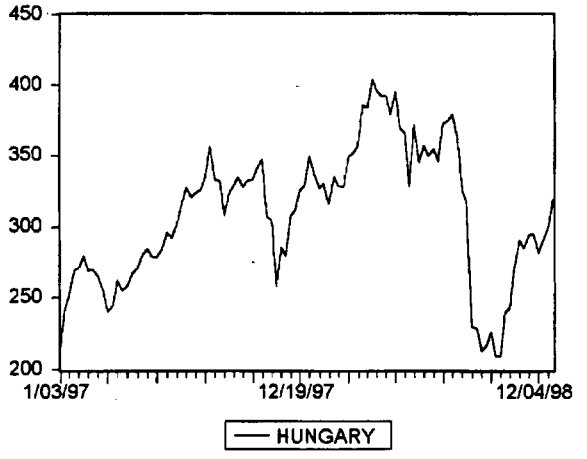
Null Hypothesis:	Obs	F-Statistic	Probability
EMPSVK does not Granger Cause EMPSVN	69	2.47	0.09
EMPSVN does not Granger Cause EMPSVK		**4.05**	**0.02**
EMPRUS does not Granger Cause EMPSVN	45	0.63	0.54
EMPSVN does not Granger Cause EMPRUS		1.07	0.35
EMPROM does not Granger Cause EMPSVN	40	0.15	0.86
EMPSVN does not Granger Cause EMPROM		1.91	0.16
EMPPOL does not Granger Cause EMPSVN	70	1.40	0.25
EMPSVN does not Granger Cause EMPPOL		0.08	0.92
EMPLTH does not Granger Cause EMPSVN	61	1.25	0.29
EMPSVN does not Granger Cause EMPLTH		2.27	0.11
EMPLAT does not Granger Cause EMPSVN	62	0.14	0.87
EMPSVN does not Granger Cause EMPLAT		1.39	0.26
EMPHUN does not Granger Cause EMPSVN	70	1.71	0.19
EMPSVN does not Granger Cause EMPHUN		1.34	0.27
EMPEST does not Granger Cause EMPSVN	61	0.85	0.43
EMPSVN does not Granger Cause EMPEST		0.16	0.85
EMPCZK does not Granger Cause EMPSVN	66	0.01	0.99
EMPSVN does not Granger Cause EMPCZK		0.81	0.45
EMPCRO does not Granger Cause EMPSVN	70	2.88	0.06
EMPSVN does not Granger Cause EMPCRO		0.16	0.85
EMPBUL does not Granger Cause EMPSVN	58	0.23	0.79
EMPSVN does not Granger Cause EMPBUL		1.42	0.25
EMPRUS does not Granger Cause EMPSVK	**45**	**5.27**	**0.01**
EMPSVK does not Granger Cause EMPRUS		0.44	0.64
EMPROM does not Granger Cause EMPSVK	40	0.20	0.82
EMPSVK does not Granger Cause EMPROM		0.37	0.69
EMPPOL does not Granger Cause EMPSVK	69	4.07	0.02
EMPSVK does not Granger Cause EMPPOL		**7.10**	**0.002**
EMPLTH does not Granger Cause EMPSVK	61	0.67	0.52
EMPSVK does not Granger Cause EMPLTH		1.68	0.19
EMPLAT does not Granger Cause EMPSVK	62	0.74	0.48
EMPSVK does not Granger Cause EMPLAT		0.82	0.45
EMPHUN does not Granger Cause EMPSVK	69	0.44	0.65
EMPSVK does not Granger Cause EMPHUN		0.24	0.79
EMPEST does not Granger Cause EMPSVK	61	0.27	0.77
EMPSVK does not Granger Cause EMPEST		0.23	0.80
EMPCZK does not Granger Cause EMPSVK	66	0.13	0.88
EMPSVK does not Granger Cause EMPCZK		0.68	0.51
EMPCRO does not Granger Cause EMPSVK	69	0.82	0.44
EMPSVK does not Granger Cause EMPCRO		0.14	0.87
EMPBUL does not Granger Cause EMPSVK	58	1.01	0.37
EMPSVK does not Granger Cause EMPBUL		0.32	0.73
EMPROM does not Granger Cause EMPRUS	40	1.05	0.36

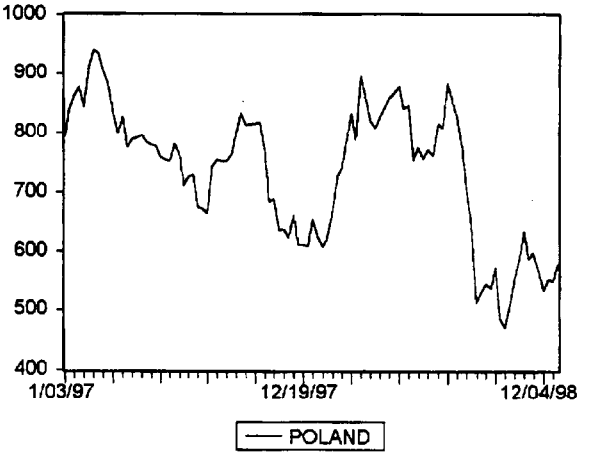
EMPRUS does not Granger Cause EMPROM		0.60	0.55
EMPPOL does not Granger Cause EMPRUS	45	0.50	0.61
EMPRUS does not Granger Cause EMPPOL		**3.58**	**0.04**
EMPLTH does not Granger Cause EMPRUS	45	1.03	0.36
EMPRUS does not Granger Cause EMPLTH		**3.93**	**0.03**
EMPLAT does not Granger Cause EMPRUS	45	0.09	0.91
EMPRUS does not Granger Cause EMPLAT		1.69	0.20
EMPHUN does not Granger Cause EMPRUS	45	0.50	0.61
EMPRUS does not Granger Cause EMPHUN		**3.73**	**0.03**
EMPEST does not Granger Cause EMPRUS	45	0.30	0.74
EMPRUS does not Granger Cause EMPEST		0.52	0.60
EMPCZK does not Granger Cause EMPRUS	45	0.09	0.91
EMPRUS does not Granger Cause EMPCZK		0.09	0.91
EMPCRO does not Granger Cause EMPRUS	45	0.20	0.82
EMPRUS does not Granger Cause EMPCRO		0.72	0.49
EMPBUL does not Granger Cause EMPRUS	45	0.46	0.66
EMPRUS does not Granger Cause EMPBUL		0.07	0.93
EMPPOL does not Granger Cause EMPROM	40	0.57	0.57
EMPROM does not Granger Cause EMPPOL		0.03	0.97
EMPLTH does not Granger Cause EMPROM	40	1.35	0.27
EMPROM does not Granger Cause EMPLTH		1.99	0.15
EMPLAT does not Granger Cause EMPROM	40	0.35	0.71
EMPROM does not Granger Cause EMPLAT		0.38	0.69
EMPHUN does not Granger Cause EMPROM	40	0.30	0.74
EMPROM does not Granger Cause EMPHUN		0.07	0.93
EMPEST does not Granger Cause EMPROM	40	0.56	0.58
EMPROM does not Granger Cause EMPEST		0.29	0.75
EMPCZK does not Granger Cause EMPROM	40	0.81	0.45
EMPROM does not Granger Cause EMPCZK		0.46	0.63
EMPCRO does not Granger Cause EMPROM	40	0.21	0.81
EMPROM does not Granger Cause EMPCRO		**3.36**	**0.05**
EMPBUL does not Granger Cause EMPROM	40	2.83	0.07
EMPROM does not Granger Cause EMPBUL		**5.94**	**0.01**
EMPLTH does not Granger Cause EMPPOL	61	2.87	0.07
EMPPOL does not Granger Cause EMPLTH		0.68	0.51
EMPLAT does not Granger Cause EMPPOL	62	0.43	0.65
EMPPOL does not Granger Cause EMPLAT		0.25	0.78
EMPHUN does not Granger Cause EMPPOL	70	0.37	0.70
EMPPOL does not Granger Cause EMPHUN		0.40	0.67
EMPEST does not Granger Cause EMPPOL	61	0.29	0.75
EMPPOL does not Granger Cause EMPEST		1.55	0.22
EMPCZK does not Granger Cause EMPPOL	66	0.17	0.84
EMPPOL does not Granger Cause EMPCZK		0.39	0.68
EMPCRO does not Granger Cause EMPPOL	70	1.09	0.34
EMPPOL does not Granger Cause EMPCRO		0.13	0.88
EMPBUL does not Granger Cause EMPPOL	58	0.24	0.79
EMPPOL does not Granger Cause EMPBUL		0.04	0.96
EMPLAT does not Granger Cause EMPLTH	61	2.48	0.09
EMPLTH does not Granger Cause EMPLAT		3.47	0.04

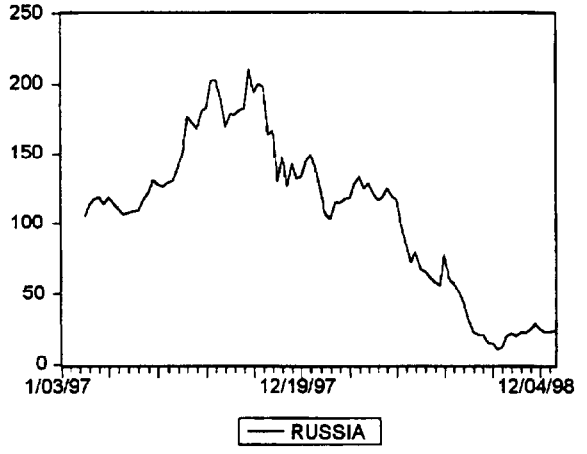
EMPHUN does not Granger Cause EMPLTH	61	0.55	0.58
EMPLTH does not Granger Cause EMPHUN		0.08	0.92
EMPEST does not Granger Cause EMPLTH	61	2.58	0.08
EMPLTH does not Granger Cause EMPEST		3.19	0.05
EMPCZK does not Granger Cause EMPLTH	61	2.15	0.13
EMPLTH does not Granger Cause EMPCZK		0.66	0.52
EMPCRO does not Granger Cause EMPLTH	61	0.34	0.71
EMPLTH does not Granger Cause EMPCRO		0.77	0.47
EMPBUL does not Granger Cause EMPLTH	58	1.12	0.33
EMPLTH does not Granger Cause EMPBUL		0.40	0.67
EMPHUN does not Granger Cause EMPLAT	62	1.77	0.18
EMPLAT does not Granger Cause EMPHUN		0.40	0.67
EMPEST does not Granger Cause EMPLAT	61	3.91	0.03
EMPLAT does not Granger Cause EMPEST		2.95	0.06
EMPCZK does not Granger Cause EMPLAT	62	0.52	0.60
EMPLAT does not Granger Cause EMPCZK		0.80	0.45
EMPCRO does not Granger Cause EMPLAT	62	0.15	0.86
EMPLAT does not Granger Cause EMPCRO		2.44	0.10
EMPBUL does not Granger Cause EMPLAT	58	0.14	0.87
EMPLAT does not Granger Cause EMPBUL		1.83	0.17
EMPEST does not Granger Cause EMPHUN	61	0.11	0.89
EMPHUN does not Granger Cause EMPEST		0.85	0.43
EMPCZK does not Granger Cause EMPHUN	66	0.53	0.59
EMPHUN does not Granger Cause EMPCZK		0.19	0.83
EMPCRO does not Granger Cause EMPHUN	70	0.56	0.57
EMPHUN does not Granger Cause EMPCRO		1.22	0.30
EMPBUL does not Granger Cause EMPHUN	58	0.78	0.47
EMPHUN does not Granger Cause EMPBUL		0.07	0.93
EMPCZK does not Granger Cause EMPEST	61	0.37	0.69
EMPEST does not Granger Cause EMPCZK		0.79	0.46
EMPCRO does not Granger Cause EMPEST	61	0.05	0.95
EMPEST does not Granger Cause EMPCRO		0.93	0.40
EMPBUL does not Granger Cause EMPEST	58	0.46	0.63
EMPEST does not Granger Cause EMPBUL		2.32	0.11
EMPCRO does not Granger Cause EMPCZK	66	3.42	0.04
EMPCZK does not Granger Cause EMPCRO		0.25	0.78
EMPBUL does not Granger Cause EMPCZK	58	0.86	0.43
EMPCZK does not Granger Cause EMPBUL		0.55	0.58
EMPBUL does not Granger Cause EMPCRO	58	2.15	0.13
EMPCRO does not Granger Cause EMPBUL		0.73	0.49

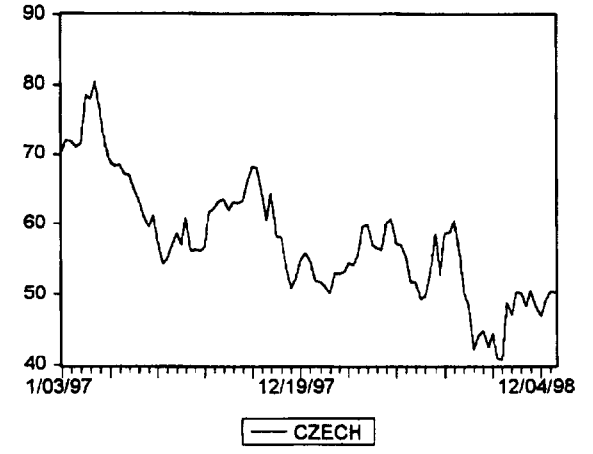
APPENDIX II

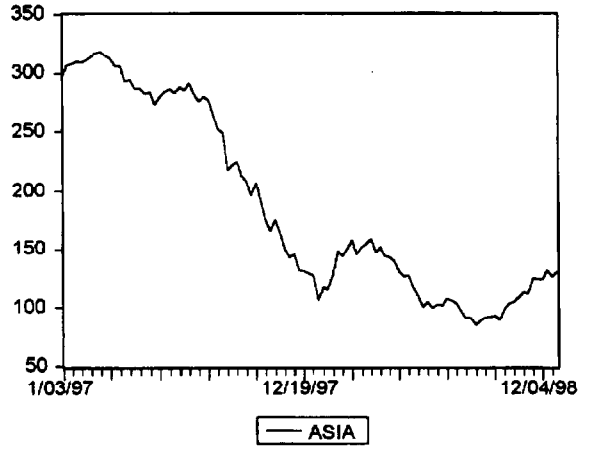
IFC Total Return Investable Stock Market Indices





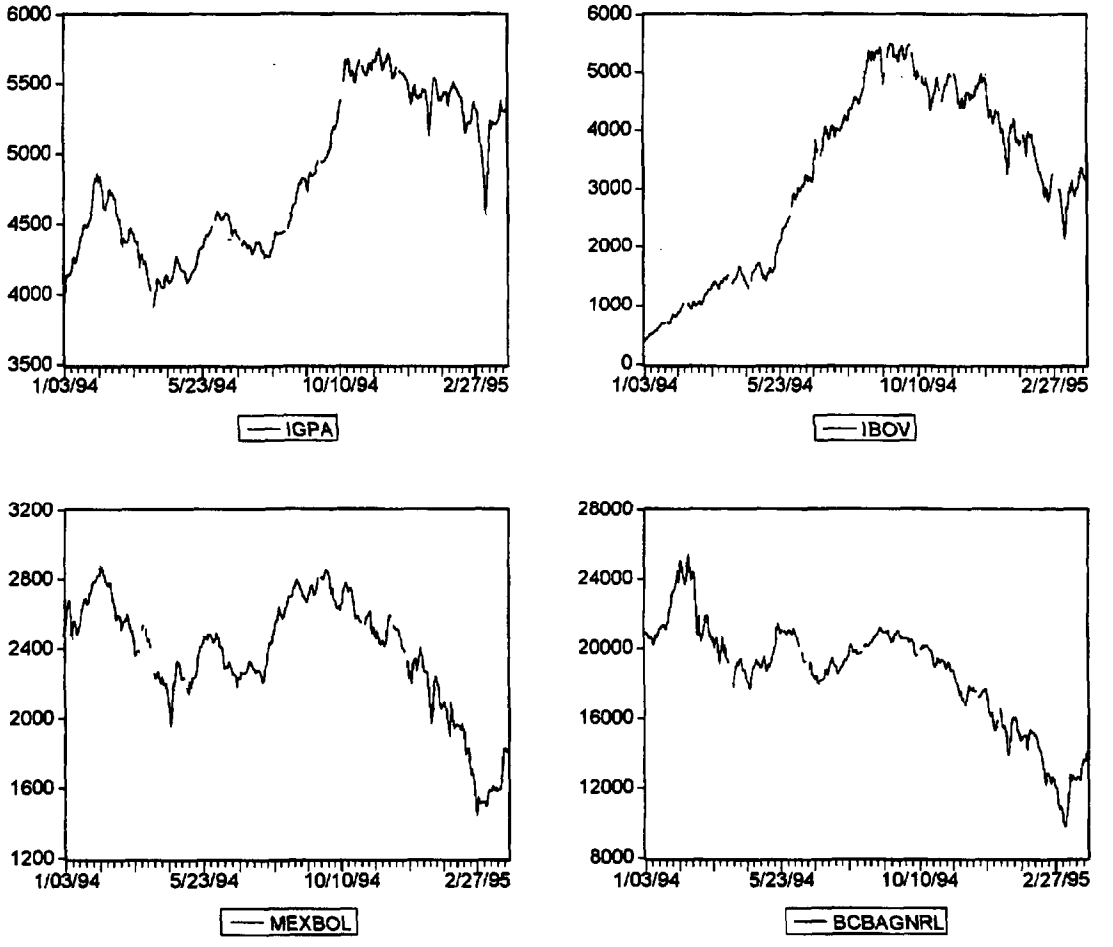






Source: IFC

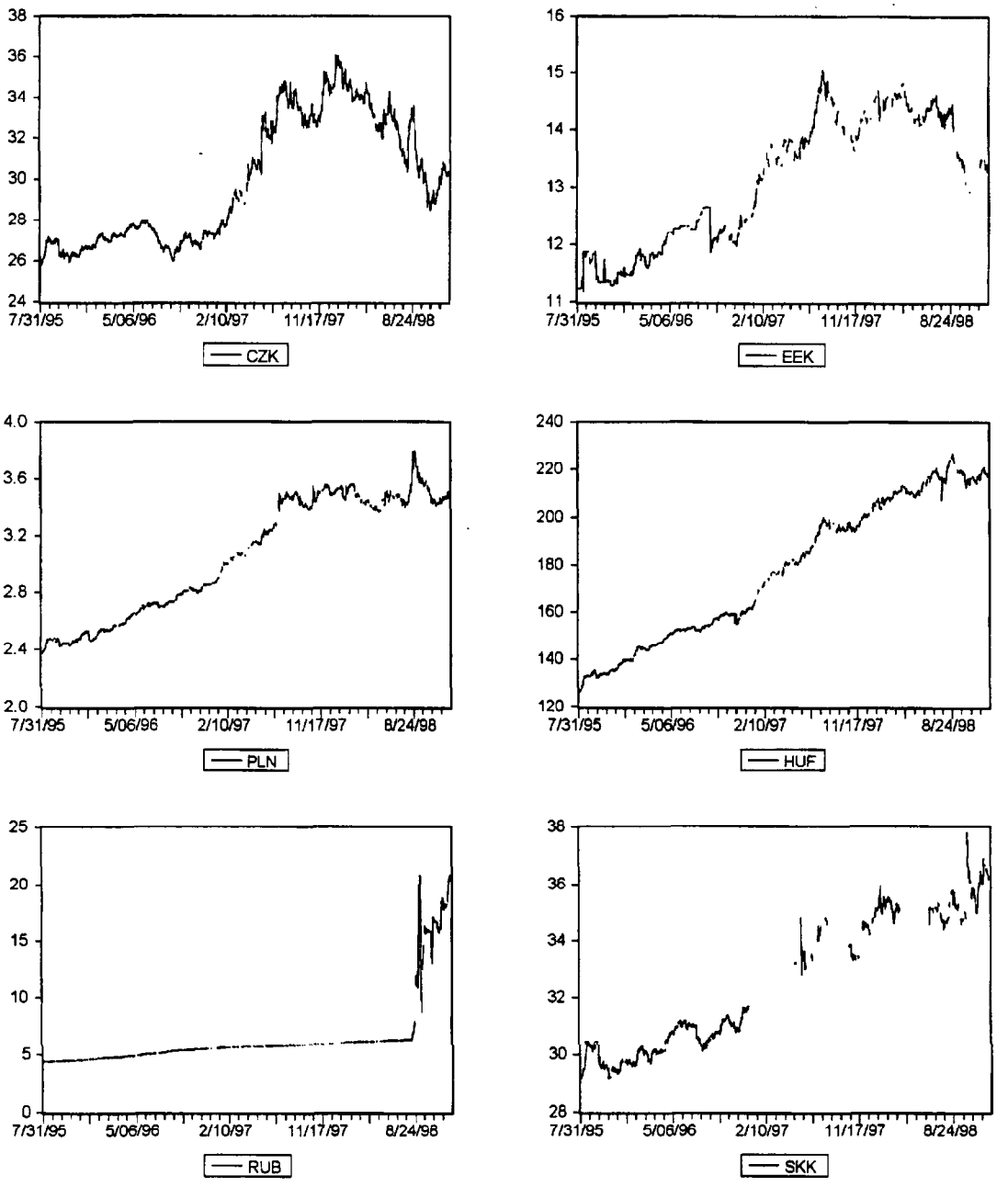
Latin American Stock Market Indices



Source: Bloomberg

APPENDIX II

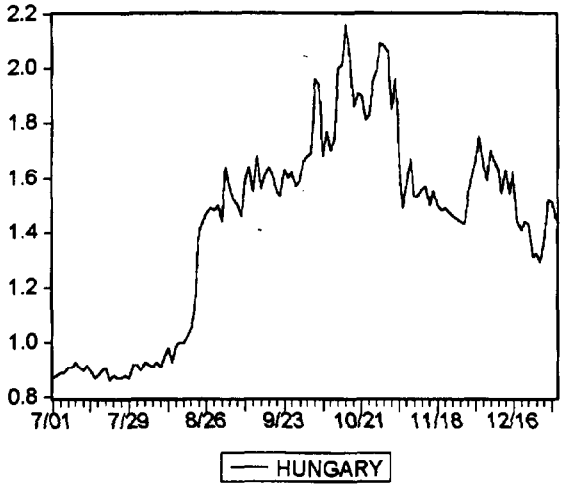
Exchange Rates

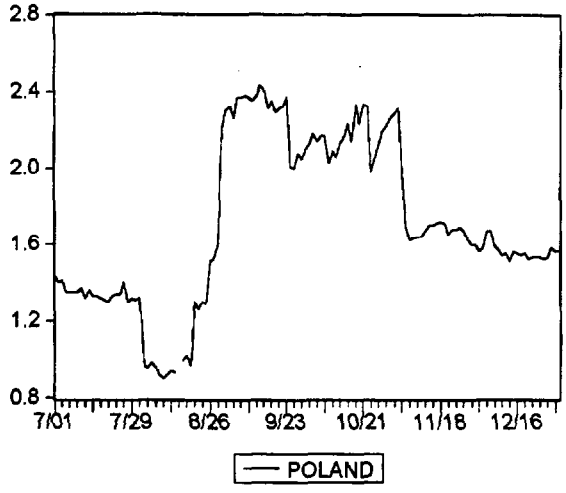


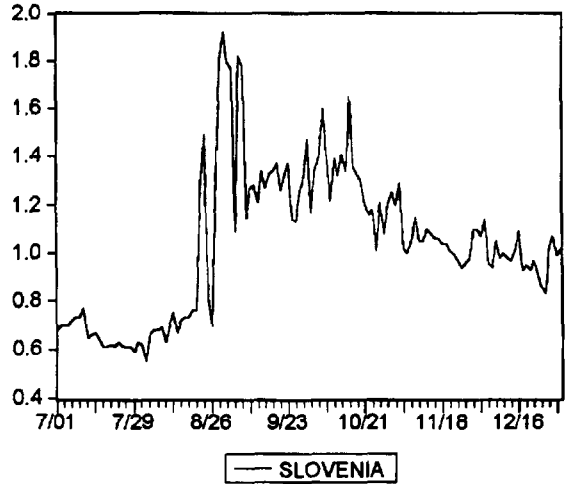
Source: Bloomberg.

APPENDIX II

Eurobond Spreads 1997/98







APPENDIX III

Granger Causality Tests using Daily Data

Czech Crisis

Pairwise Granger Causality Tests for Stock Markets
Sample: 1/31/1997 6/13/1997
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Probability
RETCZECH does not Granger Cause RETHUNG	96	0.43	0.51
RETHUNG does not Granger Cause RETCZECH		2.03	0.16
RETPOL does not Granger Cause RETHUNG	96	0.82	0.37
RETHUNG does not Granger Cause RETPOL		0.81	0.37
RETRUS does not Granger Cause RETHUNG	93	1.39	0.24
RETHUNG does not Granger Cause RETRUS		0.07	0.79
RETPOL does not Granger Cause RETCZECH	96	0.62	0.43
RETCZECH does not Granger Cause RETPOL		0.37	0.54
RETRUS does not Granger Cause RETCZECH	93	2.38	0.13
RETCZECH does not Granger Cause RETRUS		7.9E-05	0.99
RETRUS does not Granger Cause RETPOL	93	0.06	0.81
RETPOL does not Granger Cause RETRUS		1.04	0.31

Pairwise Granger Causality Tests for Exchange Markets
Sample: 4/02/1997 6/06/1997
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Probability
RETEST does not Granger Cause RETCZECH	31	2.78	0.11
RETCZECH does not Granger Cause RETEST		1.19	0.28
RETHUNG does not Granger Cause RETCZECH	29	0.97	0.33
RETCZECH does not Granger Cause RETHUNG		1.10	0.30
RETPOL does not Granger Cause RETCZECH	27	0.37	0.55
RETCZECH does not Granger Cause RETPOL		0.22	0.64
RETRUS does not Granger Cause RETCZECH	25	1.50	0.23
RETCZECH does not Granger Cause RETRUS		0.81	0.38
RETHUNG does not Granger Cause RETEST	27	0.26	0.61
RETEST does not Granger Cause RETHUNG		**4.40**	**0.05**
RETPOL does not Granger Cause RETEST	25	3.09	0.09
RETEST does not Granger Cause RETPOL		0.99	0.33
RETRUS does not Granger Cause RETEST	25	0.41	0.53
RETEST does not Granger Cause RETRUS		0.55	0.46
RETPOL does not Granger Cause RETHUNG	23	0.02	0.88
RETHUNG does not Granger Cause RETPOL		1.14	0.30
RETRUS does not Granger Cause RETHUNG	21	1.09	0.31
RETHUNG does not Granger Cause RETRUS		0.05	0.82
RETRUS does not Granger Cause RETPOL	24	0.10	0.76
RETPOL does not Granger Cause RETRUS		0.52	0.48

Asian Crisis

Pairwise Granger Causality Tests for Stock Markets
Sample: 10/01/1997 1/29/1998
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Probability
RET2RUS does not Granger Cause RET2POL	79	0.16	0.69
RET2POL does not Granger Cause RET2RUS		0.00	0.99
RET2HUNG does not Granger Cause RET2POL	79	0.01	0.98
RET2POL does not Granger Cause RET2HUNG		0.24	0.63
RET2CZE does not Granger Cause RET2POL	79	0.06	0.80
RET2POL does not Granger Cause RET2CZE		1.15	0.29
RET2AS does not Granger Cause RET2POL	79	0.07	0.79
RET2POL does not Granger Cause RET2AS		0.12	0.73
RET2HUNG does not Granger Cause RET2RUS	79	0.81	0.37
RET2RUS does not Granger Cause RET2HUNG		2.82	0.10
RET2CZE does not Granger Cause RET2RUS	79	0.45	0.50
RET2RUS does not Granger Cause RET2CZE		3.00	0.09
RET2AS does not Granger Cause RET2RUS	79	0.82	0.37
RET2RUS does not Granger Cause RET2AS		0.04	0.83
RET2CZE does not Granger Cause RET2HUNG	79	0.04	0.85
RET2HUNG does not Granger Cause RET2CZE		2.42	0.12
RET2AS does not Granger Cause RET2HUNG	79	0.07	0.79
RET2HUNG does not Granger Cause RET2AS		0.27	0.61
RET2AS does not Granger Cause RET2CZE	79	0.29	0.60
RET2CZE does not Granger Cause RET2AS		0.62	0.43

Russian Crisis

Daily Stock Returns - Pairwise Granger Causality Tests
Sample: 7/16/1998 10/15/1998
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
RETRUS does not Granger Cause RETPOL	**66**	**3.52**	**0.04**
RETPOL does not Granger Cause RETRUS		1.45	0.24
RETCZECH does not Granger Cause RETPOL	**66**	**3.36**	**0.04**
RETPOL does not Granger Cause RETCZECH		0.73	0.49
RETHUNG does not Granger Cause RETPOL	66	0.59	0.56
RETPOL does not Granger Cause RETHUNG		0.08	0.92
RETCZECH does not Granger Cause RETRUS	66	2.02	0.14
RETRUS does not Granger Cause RETCZECH		**5.71**	**0.01**
RETHUNG does not Granger Cause RETRUS	66	1.45	0.24
RETRUS does not Granger Cause RETHUNG		**3.20**	**0.05**
RETHUNG does not Granger Cause RETCZECH	66	0.12	0.89
RETCZECH does not Granger Cause RETHUNG		2.81	0.07

Daily Exchange rate Returns - Pairwise Granger Causality Tests
Sample: 7/16/1998 10/15/1998
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
RETPOL does not Granger Cause RETHUNG	38	0.62	0.55
RETHUNG does not Granger Cause RETPOL		1.20	0.31
RETRUS does not Granger Cause RETHUNG	36	0.77	0.47
RETHUNG does not Granger Cause RETRUS		0.22	0.80
RETCZECH does not Granger Cause RETHUNG	47	1.07	0.35
RETHUNG does not Granger Cause RETCZECH		0.27	0.77
RETRUS does not Granger Cause RETPOL	41	0.57	0.57
RETPOL does not Granger Cause RETRUS		0.14	0.87
RETCZECH does not Granger Cause RETPOL	54	0.43	0.65
RETPOL does not Granger Cause RETCZECH		0.06	0.94
RETCZECH does not Granger Cause RETRUS	48	1.02	0.37
RETRUS does not Granger Cause RETCZECH		0.12	0.88

Eurobond Spreads - Pairwise Granger Causality Tests
Sample: 7/16/1998 10/15/1998
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
DPOL does not Granger Cause DHUNG	**62**	**4.47**	**0.02**
DHUNG does not Granger Cause DPOL		0.24	0.79
DRUS does not Granger Cause DHUNG	66	1.13	0.33
DHUNG does not Granger Cause DRUS		0.20	0.82
DSLOVEN does not Granger Cause DHUNG	66	0.04	0.96
DHUNG does not Granger Cause DSLOVEN		2.37	0.10
DRUS does not Granger Cause DPOL	**62**	**8.34**	**0.00**
DPOL does not Granger Cause DRUS		0.47	0.63
DSLOVEN does not Granger Cause DPOL	62	1.80	0.18
DPOL does not Granger Cause DSLOVEN		0.84	0.44
DSLOVEN does not Granger Cause DRUS	66	1.91	0.16
DRUS does not Granger Cause DSLOVEN		**11.88**	**4.4E-05**

Comparison to other experiences: Asia and Latin America

Stock Markets in Latin America during Russian Crisis.

Pairwise Granger Causality Tests
Sample: 5/15/1998 10/15/1998
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Probability
RET2BRA does not Granger Cause RET2ARG	110	1.20	0.28
RET2ARG does not Granger Cause RET2BRA		2.97	0.09
RET2MEX does not Granger Cause RET2ARG	**110**	**6.93**	**0.01**
RET2ARG does not Granger Cause RET2MEX		**15.60**	**0.00**
RET2RUS does not Granger Cause RET2ARG	**110**	**5.81**	**0.02**
RET2ARG does not Granger Cause RET2RUS		3.28	0.07
RET2MEX does not Granger Cause RET2BRA	110	2.40	0.12
RET2BRA does not Granger Cause RET2MEX		4.08	0.05
RET2RUS does not Granger Cause RET2BRA	**110**	**5.30**	**0.02**
RET2BRA does not Granger Cause RET2RUS		3.59	0.06
RET2RUS does not Granger Cause RET2MEX	110	3.12	0.08
RET2MEX does not Granger Cause RET2RUS		3.38	0.07

Stock Markets in Latin America during Mexican Crisis

Pairwise Granger Causality Tests
Sample: 1/03/1994 3/30/1995
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Probability
RETBRA does not Granger Cause RETARG	259	0.13	0.72
RETARG does not Granger Cause RETBRA		0.95	0.33
RETCHIL does not Granger Cause RETARG	283	0.05	0.82
RETARG does not Granger Cause RETCHIL		**4.60**	**0.03**
RETMEX does not Granger Cause RETARG	**272**	**19.92**	**1.2E-05**
RETARG does not Granger Cause RETMEX		1.72	0.19
RETCHIL does not Granger Cause RETBRA	264	0.01	0.94
RETBRA does not Granger Cause RETCHIL		0.45	0.50
RETMEX does not Granger Cause RETBRA	**254**	**12.41**	**0.00**
RETBRA does not Granger Cause RETMEX		0.12	0.73
RETMEX does not Granger Cause RETCHIL	**277**	**14.12**	**0.00**
RETCHIL does not Granger Cause RETMEX		0.00	0.97

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