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The determinants of vulnerability to crisis:
Country-specific factors versus regional factors

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Abstract:

We investigate the determinants of exchange market pressures (EMP) for some new EU member states in two dimensions of national and regional levels, where macroeconomic and financial variables are considered as potential sources. The regional common factors are extracted from national levels of these variables by using the dynamic factor analysis. In a dynamic linear model, we find the statistically significant impact of the regional factor only in stock prices on the EMP for most of these economies. Overall, it highlights the importance of country-specific factors to defend against vulnerability in their external sector.

Key words: Exchange market pressure; dynamic factor analysis; New EU member states;

JEL Classification: F3, 016

1. Introduction

The financial crises, which occurred in Latin America, Central Europe and Asia in the 1990s had a large impact on the real economy, including a substantial loss of value of the domestic currency and a fall in output and employment, and it has brought much attention in literature to their causes, consequences, and recommended responses. Much of the empirical literature on financial crises focuses on country-specific macroeconomic factors, in an attempt at signalling future currency crises. In this vein, Eichengreen et al. (1996) make an early effort to identify currency crisis episodes by taking changes in exchange rates, international reserves and interest rates, which are combined into an index of speculative pressure known as the Exchange Market Pressure Index (EMPI). Since then, a substantial body of literature has followed by modifying the so-called 'earning warning system', for example, Kaminsky et al. (1998), Berg et al. (2000) and Edison (2003), among others. More recently, Kamin et al. (2007), based on several probit models of currency crises, suggest that domestic factors have tended to contribute to much of the underlying vulnerability of emerging market countries, whereas adverse swings in external factors may have been important in pushing economies 'over the edge' and into currency crisis. Lin et al. (2008) apply the neuro fuzzy method, a hybrid of neural network and fuzzy logic, to construct an early warning system to predict a currency crisis and claim that their approach can provide better forecasting performance than those of signal approach, logit and neural network models. These empirical studies are based on the *ad hoc* threshold, which is defined in terms of a number of standard deviations above the mean to identify currency crises. Lestano and Jacobs (2007) employ the extreme value theory as an alternative in dating currency crises. A regime switching type of model has also been used in the literature to identify periods between tranquil and speculative attacks. In all, identifying currency crisis episodes plays a crucial role in these empirical studies.

It is important to emphasise that one of the main features of financial crises is the spill-over effect to neighbouring countries. Hence, many other studies have stressed the contagion effect, as seen from many crises of the 1990s, which tended to cluster within regions and affect a broad range of countries almost simultaneously. There have been a number of attempts to examine empirically the channels through which the disturbances are transmitted. Glick and Rose (1999) assert that the international trade linkage is related to the contagion, whereas macroeconomic and financial influences are not closely associated with the cross-country incidence of speculative attacks. Kaminsky and Reinhart (2000) find that the contagion channels come from both trade links and the financial sector links. Fratzscher (2003) examines the role of contagion in the currency crises by employing a nonlinear Markov-switching model to conduct a systematic comparison and evaluation of three distinct causes of currency crises: contagion, weak economic fundamentals, and 'sunspots' - unobservable shifts in agents' beliefs. It is revealed that in the work of Fratzscher (2003), a high degree of real integration and financial interdependence among countries is a core explanation for recent emerging market crises. Mody and Taylor (2007) take an alternative look at the contagion effect by investigating regional vulnerability and several potential determinants. In the study of Mody and Taylor (2007), the common components of macroeconomic and financial factors are extracted from a group of Asian countries, and they find that the common factors have significant impacts on a country-specific EMP.

In this paper, we investigate the determinants of both the national and regional vulnerabilities in terms of EMP for a group of Central Eastern European countries (CEE), including the Czech Republic, Hungary, Poland, Slovakia and Slovenia over the sample period 1994 to 2006.[1] Since the transition process from command to market regimes took place in the early 1990s, these economies have experienced varying exchange rate regimes. In the earlier period, they suffered from the surge of price increases following market liberalisation, and the fixed regime was an initial step in an anti-inflation strategy. As the transition process progressed, managed flexible exchange rates or widening the bands were commonly introduced.[2] The unsettling exchange rate regimes along with the economic structural reforms including the massive privatisation and market opening policy have exposed these economies to vulnerability to external shocks. It is, therefore, imperative to investigate the forces driving the pressure on their foreign exchange markets, yet the empirical literature on EMP applied to the CEE countries is very limited, except for the work of Stavárek (2007).[3] The central focus in this study is to investigate to what extent the country-specific factors and regional common factors, respectively, contribute to the vulnerability. Such an analysis, we believe, would make a valuable contribution to delivering clear policy options concerning the course of action to defend their external sector.

The methodology adopted in this paper is systematic. Firstly, we derive the exchange market pressure (EMP) for individual countries, which represents the local vulnerability. Secondly, we extract the common component of the EMP from this group of countries by using dynamic factor analysis. The extracted common factor is treated as a regional stress index, referred to as regional vulnerability. Thirdly, we explore the potential determinants of national and regional EMPs, where we consider macroeconomic and financial variables. From the domestic potential determinants (i.e. domestic factors), we extract the common

[1] We focus on the 'first' wave of new EU member states in the CEE region, which are geographically close to each other.
[2] Hungary and Poland went from a fixed exchange rate regime with varying bands to a managed or full floating rate system. In the case of the Czech Republic and Slovakia, the currency crises forced them to introduce floating exchange rates. The Maastricht exchange rate criterion implies a participation in the ERM II for new EU countries as a prerequisite to joining the single currency. Slovenia opted for the ERM II in 2004 from the managed floating system, and joined the euro in 2007.
[3] Note that Stavárek (2007) focuses on the model comparison of deriving EMP, which is different from our objective in this paper.

components (i.e. common factors) by the same dynamic analysis as used for deriving the regional EMP. Finally, a dynamic linear regression analysis is conducted to investigate the driving forces behind the national vulnerability (i.e. national EMP) in two alternative models: one model is specified with the country-specific factors as regressors, and the other is with the common factors as potential determinants. In this way, we are able to identify the main determinants of EMP for each country in two dimensions at national or regional levels. The common factors are also used to measure the determinants of the regional stress index. To check the robustness of our results, we further estimate the EMP in a panel framework.

We find the statistically significant impact of the common component in stock prices on the EMP for most of these economies, indicating that there is a contagion effect observed through the conduit of stock market integration across these countries. However, it tends to highlight the importance of country-specific factors to guard against the vulnerability of their external sector.

The rest of the paper is organised as follows. Section 2 outlines the derivation of EMP and the specification of dynamic factor analysis, which is used in extracting the regional stress index and the common factors of determinants of vulnerability. Section 3 reports the data used in this study. Empirical study, together with the discussion of the results is presented in Section 4. Section 5 deals with the conclusion.

2. Exchange market pressure and dynamic factor analysis

The concept of exchange market pressure (EMP) is originally proposed by Girton and Roper (1977) in order to capture the idea of devaluation probability and financial stress. EMP is a weighted average of percentage changes in the exchange rate and (the negative of) percentage changes in international reserves. Eichengreen et al. (1996) modify EMP by including the level of domestic interest rates in the construction of the index, because policy makers could also resort to raising interest rates to defend their currency[4]. Thus, an increase in the value of a country's EMP indicates that the net demand for that country's currency is weakening and that the currency may be susceptible to a speculative attack, or that such an attack is already under way (Mody and Taylor 2007).

The exchange market pressure for a country *i* at time *t*, denoted E_{it}, can be constructed as:

$$E_{it} = \alpha \frac{\Delta e_{it}}{e_{it}} - \beta \frac{\Delta r_{it}}{r_{it}} + \gamma \Delta i_{it} \tag{1}$$

where e_{it}, r_{it} and i_{it} denote, respectively, the nominal exchange rate (domestic price of foreign currency), level of foreign exchange reserves and short-term interest rates. Δ denotes the first-difference operator. The weights α, β and γ are chosen such that each of the three components on the right-hand side of equation (1) has a standard deviation of unity, which prevents any one of them from dominating the index.

The common component of EMP (the regional stress index) is extracted from the individual EMPs of five countries by using the dynamic factor model. The same method is applied to derive the common component of the potential determinants of the EMP.

Suppose that E_{it} is the EMP at time *t* for *i* country. It can be modelled as consisting of two stochastic autoregressive (AR) processes: a single unobserved component, which corresponds to the common factor, and an idiosyncratic component, representing a country-specific factor. The model can be written as follows,

$$E_{it} = \lambda_i \kappa_t + z_{it}, \qquad i = 1, \ldots, n, \tag{2}$$

$$\phi(L)\kappa_t = v_t, \qquad v_t \sim i.i.d.\ N(0,1), \tag{3}$$

[4] Kaminsky et al. (1998) follow the concept of Eichengreen et al., though without including interest rate differentials in their index. Edison (2003) extends the country coverage and adds several explanatory variables to develop this monitor system.

$$\psi_i(L) z_{it} = \varepsilon_{it}, \qquad \varepsilon_{it} \sim i.i.d.\ N(0, \sigma_i^2) \tag{4}$$

where κ_t is the common factor of EMP to all of the countries under examination and it enters into each of the *n* equations with a different weight λ_i, which measures the sensitivity of the *i*th country to the regional stress index. The variables z_{it} are idiosyncratic terms having an AR representation. Their innovations ε_{it} can be thought of as measurement errors and v_t is the innovation to the common factor. The functions $\psi_i(L)$ and $\phi(L)$ are polynomials in the lag operator, where *L* is the lag operator.

To facilitate estimation, the model can be expressed in state-space representation. With the AR(2) process for both the common factor and idiosyncratic term, and with $n = 5$, the model can be expressed as the measurement and transition equations

$$\begin{bmatrix} E_{1t} \\ E_{2t} \\ E_{3t} \\ E_{4t} \\ E_{5t} \end{bmatrix} = \begin{bmatrix} \lambda_1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \lambda_2 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \lambda_3 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ \lambda_4 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ \lambda_5 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} \kappa_t \\ \kappa_{t-1} \\ e_{1t} \\ e_{1,t-1} \\ e_{2t} \\ e_{2,t-1} \\ e_{3t} \\ e_{3,t-1} \\ e_{4t} \\ e_{4,t-1} \\ e_{5t} \\ e_{5,t-1} \end{bmatrix} \tag{5}$$

$$\begin{bmatrix} \kappa_t \\ \kappa_{t-1} \\ z_{1t} \\ z_{1,t-1} \\ z_{2t} \\ z_{2,t-1} \\ z_{3t} \\ z_{3,t-1} \\ z_{4t} \\ z_{4,t-1} \\ z_{5t} \\ z_{5,t-1} \end{bmatrix} = \begin{bmatrix} \phi_1 & \phi_2 & 0 & 0 & \dots & 0 & 0 \\ 1 & 0 & 0 & 0 & \dots & 0 & 0 \\ 0 & 0 & \psi_{11} & \psi_{12} & \dots & 0 & 0 \\ 0 & 0 & 1 & 0 & \dots & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & 0 & 0 & \dots & \psi_{51} & \psi_{52} \\ 0 & 0 & 0 & 0 & \dots & 1 & 0 \end{bmatrix} \begin{bmatrix} \kappa_{t-1} \\ \kappa_{t-2} \\ z_{1,t-1} \\ z_{1,t-2} \\ z_{2,t-1} \\ z_{2,t-2} \\ z_{3,t-1} \\ z_{3,t-2} \\ z_{4,t-1} \\ z_{4,t-2} \\ z_{5,t-1} \\ z_{5,t-2} \end{bmatrix} + \begin{bmatrix} v_t \\ 0 \\ \varepsilon_{1t} \\ 0 \\ \varepsilon_{2t} \\ 0 \\ \varepsilon_{3t} \\ 0 \\ \varepsilon_{4t} \\ 0 \\ \varepsilon_{5t} \\ 0 \end{bmatrix} \quad (6)$$

Using the Kalman filter technique and maximum likelihood estimation, the unobservable component, κ_t, together with the parameters can be derived.

3. Data

The datasets used in this study are the monthly data during the period from January 1994 to December 2006 with 156 observations for the Czech Republic, Hungary, Poland, Slovakia and Slovenia. The sample period ends in December 2006, since Slovenia joined the euro in January, 2007. The detailed description of all data series and their sources (including the determinants of EMP as described below) can be found in Appendix 1. The nominal exchange rate is the number of domestic currency per US$ and per ECU/Euro.[5] These countries used to peg the DM and the US$ with a ratio of around 70-60% and 30-40% respectively till around 1999/2000. We, therefore, take weights in exchange rates with 65% of ECU/Euro and 35% of US$, and this reflects their concern relative to two major currencies over the sample period.

[5] Until the end of 1998, the exchange rate is against the ECU and after that, with the Euro.

4. Results

4.1 Exchange market pressure and the extracted common factor

[FIGURE 1 AROUND HERE]

The constructed EMP over the sample period for each country, based on equation (1), is shown at the top of each graph with the right-hand side scale in Figure 1 together with the extracted common component of EMP with the left-hand side scale, representing the regional stress index, at the bottom for comparison. A large positive value of EMP suggests that the country is under higher stress of depreciation, whereas a negative value indicates speculators' expectations of currency appreciation. Looking at the individual EMPs, it is evident that each country experienced a different degree of stress at different periods. During the early period Hungary, Poland, Slovakia and Slovenia experienced a high and/or volatile EMP, whilst for the Czech Republic and, again, Slovakia it showed a high pressure in 1997 and 1998. The former appears to reflect the transition process of these economies. The latter indicates a high tension before the actual currency crises occurred in the Czech Republic and Slovakia, where the fixed exchange rate became unsustainable. Since 2000, the EMPs have been shown to be less volatile except for Hungary during the period around 2003.

From the plotted regional stress index, we can see that the highest tension occurred during the period 1997-98, which echoes the depreciation pressure throughout these emerging markets and coincides with the financial crises in Asia and Russia. The Russian economy had a predominant role in these economies, thus, the Russian crisis should have had a significant impact on the region. It is also notable that since 2000 there is a downward trend till around 2003, and the regional stress index mostly falls into negative. The negative value is an indication of regional optimism from the point of view of international investors (Mody and Taylor, 2007). After these economies joined the EU in 2004, the common EMP appears to depict a similar pattern of fluctuations with the individual EMPs, and this is intuitively plausible.

[TABLE 1 AROUND HERE]

Table 1 reports the estimates of the parameters of the state space models (2) - (4). It is shown that the estimated λ_i parameters, which measure the degree of influence of the regional stress index on the national EMP, are all statistically significant above the 5 percent level. This implies that the regional stress index plays an important role in driving the EMP for each of the countries under examination. In order to investigate the extent of the variation in each country's EMP explained by the regional stress index, we further regress the individual EMPs onto the extracted regional EMP. The goodness of fit, R^2 statistics in the last column of Table 1, indicates that there is, relatively, a large variation amongst these economies. The Czech Republic is shown to have at the highest with an R^2 of 65 percent, whereas Hungary has the lowest with only 6 percent.

4.2 The determinants of exchange market pressure

To investigate the driving force behind both the country specific EMP and the regional stress index, we consider a number of macroeconomic and financial variables as potential determinants.

Theory suggests that a financial crisis is the interaction of high interest rates and capital flight caused by the combination of currency collapse and banking failure. Capital flight is likely to be translated into the collapse of currency value, which in turn implies that investors require a higher risk premium, giving rise to ever higher interest rates. With a rising cost of capital, and foreign currency denominated debt obligations doubled or tripled in terms of local currency, banks are framed with ever increasing nonperforming assets and default of loans, whilst bearing huge foreign debt burdens. One of the common preconditions for such a crisis is, *inter alia*, massive capital inflows: a high level of foreign borrowing in the short-term tends to lead to a financial crisis, and the crisis is a sudden withdrawal of foreign capital creating a liquidity crisis (e.g. Obstfeld 1986 and 1996 and Radelet and Sachs 1998). It is often the case that financial crises tend to occur following privatization, deregulation and financial liberalisation, since such structural reforms attract foreign capital. It is, therefore, conceivable that the effect of foreign liabilities on EMP is not trivial for these transition economies.

The capital outflows correspond to currency depreciation pressure, yet during the fixed or managed exchange rate regimes, central banks would intervene to maintain the level of exchange rates by buying domestic currency in exchange for foreign reserves. The effect of the intervention would be a decline in domestic money supply (though if there aren't enough reserves, the value of the currency falls), and a fall in money supply corresponds to a rise in interest rates, hence a rise of EMP. This mechanism predicts a negative sign on money.

We also consider stock prices as one of the determinants of EMP. Stock markets are not new in these transition economies, though all stock markets were closed during the Communist period. Stock exchanges re-emerged with mass privatization programmes in the early 1990s. The earlier stage of these stock markets was characterised by the lack of an adequate regulatory framework, and the requirement of disclosure and the high cost of raising funds through the market deterred the development of stock market (Wang and Moore, forthcoming). These emerging markets experienced a surge of stock market growth over the sample period, though not necessarily driven by fundamentals, and during the Asian and Russian financial crises, these stock markets experienced high volatility.[6] Note that it is empirically found that the volatile movement of stock markets can be a cause of currency

[6] See Moore and Wang (2007) and Wang and Moore (forthcoming).

crisis (Kaminsky et al. 1998 and Sarno and Taylor 1999), especially when the market plummets, hence asset prices could be a strong candidate to explain the EMP[7].

It is generally expected that monetary policy affects the EMP, and Tanner (2001) theoretically and empirically finds that the monetary policy stance is best measured by domestic credit growth. For these transition economies, credit growth may be a cause of vulnerability for the following reason. The credit markets in transition economies were, in general, characterised by soft budget constraints (SBCs). SBCs imply that governments or financial institutions are willing to provide additional resources to firms, especially, to former state-owned enterprises, or to bail them out (Kornai, 1992 and Lízal and Svejnar, 2002). Evidence indicates that soft budget constraints remained during the later stages of transition, since subsidies through banks continued to exist on a large scale (Lízal and Svejnar 2002 and Konings et al. 2003). The transition countries are, therefore, prone to excessive government deficits, building up high levels of public debt. It is also a cause of financial bubbles (Kornai 2001 and Brücker et al. 2005), and a growth of domestic credit is a concern in potentially increasing exchange market pressure (Kaminsky and Reinhard 1999).

Finally, import prices are also deemed as one of the determinants of the EMP. For small open economies, import prices may act as a conduit for inflationary pressures, which are then transmitted into the EMP. Oil prices are included as a proxy of import prices.

To summarise, the linear equation takes the following form with the predicted sign:

$$EMP = f(sp, dc, m, fl, oil) \qquad f_{sp} < 0, f_{dc} > 0, f_m < 0, f_{fl} > 0, f_{oil} > 0 \qquad (7)$$

where *sp* is the log of real stock market index adjusted by consumer price index; *dc* is the log of real domestic credit deflated by consumer price index; *m* is the log ratio of M2 to GDP, *fl* is the log ratio of total foreign liability to GDP and *oil* is the log of oil prices. The data are all

[7] Mody and Taylor (2007) attribute this to the moral hazard problem existing where financial institutions provide loans to finance risky financial assets, causing asset inflation beyond the level of fundamentals. When the bubble bursts, the consequence is capital flight triggering a currency crisis.

first-differenced to ensure stationarity.[8] We extracted the common factors of these variables apart from oil prices using the Kalman filter technique, and the results are found in Appendix 2. They are, then, used to investigate the predicative components of regional and national vulnerabilities.

The estimation of equation (7) is two-fold: firstly each country's EMP is regressed on country-specific variables, and secondly it is regressed on common variables. We also estimate the regional stress index by regressing the common EMP on common factors. The model is specified with the current and two lagged regressors with the general to specific method, where the explanatory variables that fail to reach around the 20 percent significant level are deleted. The parsimonious models for the EMPs are shown in Tables 2, which specifies national factors, and Table 3, which specifies common factors.

[TABLE 2 AND 3 AROUND HERE]

Diagnostic tests for serial correlation by the Breusch-Godfrey test indicate the absence of serial correlation at the conventional significance level. Where the heteroskedasticity test by the Breusch-Pagan-Grodrey method rejects the null of homoskedasticity, we use robust estimation with White's heteroskedastic consistent t-ratio. The Ramsey RESET test, which specifies a squared fitted value as an additional regressor detects specification errors including omitted variables, functional form and correlation between explanatory variables and residuals. The test statistics are mostly in favour of the null with only three out of eleven cases being significant at the 5% level. The Hausman exogeneity test with two lagged values of all variables in (7) as the instrument sets is satisfactory to prove that the regressors are likely to be exogenous.

[TABLE 4 AROUND HERE]

[8] We have checked the variables by the Augmented Dickey Fuller unit root test.

These transition economies have undergone substantial structural changes in their economies in the estimation period. We, therefore, carried out a series of Chow forecast tests to check slope coefficients for structural breaks (Bai 1996). We chose five potential breakpoints (one every two years) making five tests in each equation. The results are shown in Table 4. It appears to suggest that there is no structural break in the estimates over the sample period. This may be due to the fact that possible breaks are likely to be embedded in the explanatory variables. Overall, these diagnostics tests suggest that the underlying parameter estimates are remarkably robust for us to draw inferences from the estimates.

Start with the country-specific determinants in Table 2. The significant effect of real growth in the stock price index is observed in all cases, except for the Czech Republic, and it proves that the development of a stock market has a way of affecting exchange market pressure. There seems to be a discernible impact of credit growth on the EMP, since statistically and numerically significant positive coefficients of the credit growth are found for all, except Hungary. This result can be explained with reference to the SBCs. The operation of SBCs is said to be weak in Hungary, whereas it is strong in other transition countries under the current study. It is argued that for Hungarian firms hard budget constraints were in place. Bonin and Schaffer (2002) and Shaffer (1998) demonstrated that Hungarian banks were not providing net financing to firms that were unprofitable, and as a consequence large numbers of bankruptcies were observed. Thus, credit growth is less likely to be a concern in driving the EMP in Hungary. The possible supporting evidence can be found by looking at the banks' nonperforming loans as a percentage of the total in 2000s: the Czech Republic and Poland exhibit a relatively high level of an average of 12.5% and 18.8% respectively, with Slovakia and Slovenia at around 7%, whilst Hungary has the smallest at

2.6% (World Development Indicators).[9] If the non-performing assets in the banking sector are closely associated with the SBCs, and the operation of SBCs is linked to a financial bubble, our result is plausible.

It is interesting to find that only Hungary has shown the significance of foreign liability in Table 2. There is the ease of availability of external funds in Hungary compared with the other four countries: the rights of foreign shareholders under Hungarian law in Hungarian firms created a strong connection between privatization and foreign direct investment (FDI), making it easy to obtain external funds from abroad. This would create vulnerability to external borrowing. The impact of monetary growth is significant, except for Slovakia. The negative sign is possibly due to the intervention by the central banks in an attempt to maintain exchange rates in the foreign exchange market. Poland and Slovakia respond to the oil price, and high import prices are likely to be a cause of stress for their external sector. It is noteworthy that for Poland the vulnerability can be driven by all these potential variables, except for *fl*, since the coefficients are statistically significant, at least, at the 5 percent level.[10]

We now turn to the common factor model in Table 3. One can see that the regional EMP is largely explained by stock prices and money. In particular, lagged stock prices seem to be the main driving force of the regional stress index. For the five national EMP regressions, overall the goodness of fit is lower compared with those of country-specific determinants in Table 2, and the magnitudes of the coefficients of common factors are smaller than those of national factors. The evidence seems to reveal that national factors are more important than regional ones in explaining the individual EMPs. Note, though, that amongst other determinants, the stock prices are well-determined with a statistical

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[9] It is also noted that the enforcement of bankruptcy is strong in Hungary, whereas bankruptcy laws are looser in the Czech Republic, which should have played a role as a prerequisite for easing the practice of the SBCs in the latter.

[10] This is also true in the common factor model in Table 3.

significance of at least a 5 percent level (except for the Czech Republic). It may be a sign of the increased integration in their stock markets, and that the regional component of the stock prices needs to be taken into account in monitoring the individual EMPs.

[TABLE 5 AROUND HERE]

Finally, as a robustness check, we have conducted a panel estimation by pooling the data of the five countries. The country-specific EMP is regressed on both common factors (denoted with a prefix of *cf*) and national factors. Similar to the single estimation, we estimated from general to specific model by deleting the insignificant coefficients. The fixed effect is found to be statistically significant, thus a country shift dummy is specified. The estimates are shown in Table 5. The national factors of *sp*, *dc* and *m* are statistically significant at the 5 percent level, and in the case of common factors, there is only one variable, i.e. the stock price index (*cfstock*), which is found to be significant, though at the 10% level. The result is supportive to that found for single equations, where the country-specific factors are influencing predominantly the national EMPs.

5. Conclusion

We have investigated the determinants of exchange market pressure for the transition economies in two ways: one with country specific factors and the other with regional common factors. In the existing literature, most researchers focus on internal factors in the belief that certain fundamental domestic factors affect a country's external sector, at the same time many other observers stress the importance of contagious elements in global markets as being responsible for external vulnerability. In our study, the sensitivity of national EMPs to the regional EMP is found to be statistically significant, implying that the regional stress induces an increase in national vulnerability. We also find a relatively strong impact of the regional stock price index on driving the regional and the national EMPs (except for the Czech Republic). In this respect, we can not ignore the contagion effect on national vulnerability, however, the linear empirical analysis, in general, highlights that the country-specific determinants are more crucial in explaining the vulnerability in foreign exchange markets for these five new EU countries.

In light of the findings in this study, the key policy implications for individual countries may be drawn up as follows: The movements of growth in stock prices at both regional and national levels are to be closely monitored for Hungary, Poland, Slovakia and Slovenia. For the Czech Republic, domestic credit growth appears to be one of the main concerns. Poland needs to be alert for most of these potential national and regional factor variables in monitoring its vulnerability.

These transition economies have each gone through a similar phase of structural changes in their economies. Yet the complexity of their external sectors attached to individual countries combined with a naïve and heterogeneous economic structure may lead to a lack of integration among these countries so as to be satisfactorily explained by regional factors. This is contrasted with the Asian region by the work of Mody and Taylor (2007), who find that common factors were more of a concern, and the Asian countries may have to demonstrate some harmony in the operation of foreign exchange markets.[11]

[11] It can be argued that the selection of countries by Mody and Taylor (2007) may be biased, as the selected six Asian countries were most severely affected by the financial crisis, and it is not surprising to find that common factors played a major role during the Asian crisis period. As suggested, further research would be useful by extending the country coverage and also the sample period.

Appendix 1

Description of the data

Data are collected from International Financial Statistics (code) and Datastream (DS):

National currency per US$ (rf, IFS). Nominal exchange rate with ecu/euro (DS). Foreign exchange reserves (id.d, IFS). Foreign liabilities (16c, IFS). Domestic credit (32, IFS). Consumer price index (64, IFS). Money plus quasi money (35L, IFS) for the Czech, Poland and Slovakia and M2 (DS) for Hungary and Base money (DS) for Slovenia. Industrial production (66, IFS) is used for GDP. Crude oil-Brent FOB US$ per Barrel (DS). Short term interest rates (DS). Share prices index (62) for Poland and DS market for the Czech republic and Hungary, SAX 16 for Slovakia and Slovenian Exchange Stock for Slovenia.

Some parts of data are calibrated as follows:

Monthly data for Financial liabilities (16c) and Domestic credit (32) in Hungary are not available during 1994:01 to 1999:12. The monthly data are interpolated from the corresponding quarterly series applying a linear technique. Monthly data of Domestic credit (32) are not available during 2005:1 to 2005:12. The missing data are calibrated proportionately with the same rate of growth as the data for Domestic credit to private sector (32d).

Appendix 2 Estimation of the common factors: Determinants of exchange market pressure

Ratio of M2 to GDP (*m*)

ϕ_1	-0.2192 (0.0940)	ϕ_2	-0.0120 (0.0103)						
ψ_{11}	-0.3697 (0.1421)	ψ_{21}	0.0345 (0.1279)	σ_1^2	0.1201 0.0265	λ_1	0.8808 (0.0594)	R_1^2	0.93
ψ_{21}	-0.5022 (0.0937)	ψ_{22}	-0.0631 (0.0235)	σ_2^2	0.2843 0.0390	λ_2	0.7850 (0.0626)	R_2^2	0.69
ψ_{31}	-0.5490 (0.0902)	ψ_{32}	-0.0753 (0.0247)	σ_3^2	0.3711 0.0469	λ_3	0.7286 (0.0643)	R_3^2	0.56
ψ_{41}	-0.3169 (0.1252)	ψ_{42}	-0.0251 (0.0198)	σ_4^2	0.1749 0.0315	λ_4	0.9041 (0.0633)	R_4^2	0.87
ψ_{51}	-0.6043 (0.0798)	ψ_{52}	-0.0494 (0.0803)	σ_5^2	0.6531 0.0742	λ_5	0.0396 (0.0634)	R_5^2	0.03

Ratio of Foreign liability to GDP (*fl*)

ϕ_1	-0.7211 (0.1659)	ϕ_2	-0.1300 (0.0598)						
ψ_{11}	-0.3946 (0.0974)	ψ_{21}	-0.0389 (0.0192)	σ_1^2	0.6726 0.1139	λ_1	-0.3894 (0.1264)	R_1^2	0.43
ψ_{21}	-0.2367 (0.0871)	ψ_{22}	-0.0140 (0.0103)	σ_2^2	0.9396 0.1071	λ_2	-0.0467 (0.1058)	R_2^2	0.02
ψ_{31}	-0.3681 (0.1182)	ψ_{32}	-0.0339 (0.0218)	σ_3^2	0.5331 0.1273	λ_3	0.4835 (0.1306)	R_3^2	0.72
ψ_{41}	-0.4312 (0.0907)	ψ_{42}	-0.0465 (0.0196)	σ_4^2	0.7399 0.0959	λ_4	-0.2237 (0.1138)	R_4^2	0.21
ψ_{51}	-0.2717 (0.0875)	ψ_{52}	-0.0185 (0.0119)	σ_5^2	0.8514 0.1051	λ_5	0.1959 (0.1054)	R_5^2	0.14

Real domestic credit *(dc)*

ϕ_1	-0.0584 (0.1759)	ϕ_2	-0.0009 (0.0051)						
ψ_{11}	-0.0322 (0.0841)	ψ_{21}	-0.0003 (0.0014)	σ_1^2	0.9328 (0.1147)	λ_1	0.2439 (0.1191)	R_1^2	0.08
ψ_{21}	0.1702 (0.0801)	ψ_{22}	0.2066 (0.0804)	σ_2^2	0.8649 (0.1087)	λ_2	0.2128 (0.1258)	R_2^2	0.06
ψ_{31}	-0.3004 (0.4529)	ψ_{32}	-0.0226 (0.0680)	σ_3^2	0.2155 (0.5729)	λ_3	0.8695 (0.3385)	R_3^2	0.98
ψ_{41}	0.0465 (0.0869)	ψ_{42}	-0.0005 (0.0020)	σ_4^2	0.9864 (0.1124)	λ_4	0.0655 (0.1036)	R_4^2	0.01
ψ_{51}	-0.0612 (0.0812)	ψ_{52}	0.0299 (0.0789)	σ_5^2	0.9753 (0.1112)	λ_5	0.1078 (0.0920)	R_5^2	0.21

Real stock market *(sp)*

ϕ_1	0.2831 (0.1112)	ϕ_2	-0.0200 (0.0157)						
ψ_{11}	0.0956 (0.1275)	ψ_{21}	-0.0023 (0.0061)	σ_1^2	0.3128 (0.0628)	λ_1	0.7970 (0.0715)	R_1^2	0.81
ψ_{21}	-0.0635 (0.1106)	ψ_{22}	-0.0010 (0.0035)	σ_2^2	0.3829 (0.0660)	λ_2	0.7508 (0.0737)	R_2^2	0.73
ψ_{31}	-0.1401 (0.1045)	ψ_{32}	0.0822 (0.1003)	σ_3^2	0.4581 (0.0711)	λ_3	0.7197 (0.0731)	R_3^2	0.62
ψ_{41}	0.1079 (0.1176)	ψ_{42}	-0.0029 (0.0063)	σ_4^2	0.7566 (0.0917)	λ_4	0.4660 (0.0809)	R_4^2	0.27
ψ_{51}	0.0114 (0.0839)	ψ_{52}	0.0548 (0.0834)	σ_5^2	0.9434 (0.1086)	λ_5	0.2162 (0.0886)	R_5^2	0.06

Standard errors are in bracket. The order of the idiosyncratic component is Czeck Republic, Hungary, Poland, Slovkia and Slovenia.

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Table 1 Estimation of the common factors: Exchange market pressure

ϕ_1	0.1259 (0.1601)	ϕ_2	-0.0040 (0.0101)						
ψ_{11}	0.1691 (0.1158)	ψ_{21}	-0.0072 (0.0098)	σ_1^2	0.5765 (0.1261)	λ_1	0.6168 (0.1143)	R_1^2	0.65
ψ_{21}	0.0814 (0.0811)	ψ_{22}	0.0981 (0.0843)	σ_2^2	0.9401 (0.1104)	λ_2	0.2055 (0.1062)	R_2^2	0.06
ψ_{31}	0.0436 (0.0902)	ψ_{32}	-0.0005 (0.0020)	σ_3^2	0.8643 (0.1097)	λ_3	0.3494 (0.1044)	R_3^2	0.20
ψ_{41}	-0.0141 (0.0692)	ψ_{42}	0.0000 (0.0005)	σ_4^2	0.6637 (0.1259)	λ_4	0.5684 (0.1183)	R_4^2	0.54
ψ_{51}	0.1294 (0.0930)	ψ_{52}	0.0577 (0.0945)	σ_5^2	0.7673 (0.1067)	λ_5	0.4492 (0.1049)	R_5^2	0.35

Log likelihood -350.7574
Standard errors are in bracket.
The order of the idiosyncratic component is Czeck Republic, Hungary, Poland, Slovkia and Slovenia.

Table 2 Country specific determinants: dependent variable *EMP*

	Hungary	Czech Rep.	Poland	Slovakia	Slovenia
constant	0.148	-0.343*	-0.587***	-0.257*	-0.243
	(0.145)	(0.183)	(0.130)	(0.157)	(0.169)
sp_t			-4.296***		3.835*
			(1.491)		(2.104)
sp_{t-1}	-5.915***		-3.489**	-3.071*	-4.711**
	(1.586)		(1.518)	(1.867)	(2.104)
sp_{t-2}			3.078**		
			(1.483)		
dc_t		20.518***	22.466***	5.368**	25.839***
		(7.513)	(6.503)	(2.651)	(7.433)
m_t	-3.454**	-2.668*	-6.208***		-6.512**
	(1.627)	(1.458)	(2.007)		(2.558)
m_{t-1}					-4.141*
					(2.569)
fl_t	2.243***				
	(0.519)				
oil_t			2.426**		
			(1.163)		
oil_{t-1}				2.412*	
				(1.335)	
EMP_{t-1}		0.208			0.152**
		(0.152)			(0.077)
R^2	0.205	0.113	0.254	0.060	0.164
Breusch-Godfrey χ^2 (1)	0.046	0.080	0.101	0.005	2.787
	[0.830]	[0.777]	[0.751]	[0.943]	[0.095]
χ^2 (2)	1.536	0.834	4.768	2.665	4.423
	[0.464]	[0.659]	[0.092]	[0.264]	[0.110]
Breusch-Pagan-Godfrey	2.339	15.800	5.230	2.846	7.537
	[0.505]	[0.001]	[0.515]	[0.416]	[0.274]
Ramsey RESET F-test	0.057	6.702	1.505	5.213	2.065
	[0.812]	[0.011]	[0.222]	[0.024]	[0.073]
Exogeneity test Prob. value	0.834	0.632	0.072	0.596	0.750

***, ** and *: significant at the 1%, 5% and 10% .Sample period: 1994m1 to 2006m12.

Breusch-Pagan-Godfrey heteroskedasticity test, χ^2 (df=no. of regressors). White Heteroskedasticity-Consistent Standard Errors are estimated where there is presence of heteroskedasticity. Breusch-Godfrey: Serial correlation LM test, distributed as χ^2 (1) and χ^2 (2). Figures in parentheses are standard errors ( ) for coefficients, and probability values [ ] for diagnostic tests.

Table 3 Common factor determinants: dependent variable *EMP*

	Regional *EMP*	Hungary	Czech Rep.	Poland	Slovakia	Slovenia
constant	0.002	0.044	-0.344*	-0.429***	-0.236	-0.061
	(0.063)	(0.150)	(0.189)	(0.130)	(0.148)	(0.154)
sp_t		-0.371**		-0.451***		0.374**
		(0.178)		(0.144)		(0.177)
sp_{t-1}	-0.179**	-0.376**			-0.703***	
	(0.075)	(0.164)			(0.158)	
sp_{t-2}	0.149**			0.407***		0.329**
	(0.068)			(0.132)		(0.162)
dc_t	0.106			0.529***		
	(0.072)			(0.143)		
dc_{t-1}					0.431***	
					(0.170)	
m_t	-0.106*	-0.233	-0.197	-0.330***	-0.177	
	(0.065)	(0.153)	(0.148)	(0.128)	(0.155)	
m_{t-1}					-0.252*	
					(0.156)	
EMP_{t-1}			0.196	0.131**		0.085
			(0.168)	(0.072)		(0.080)
R^2	0.074	0.091	0.048	0.240	0.175	0.063
Breusch-Godfrey	2.060	0.095	0.000	3.393	0.009	2.356
χ^2 (1)	[0.151]	[0.757]	[0.987]	[0.066]	[0.926]	[0.125]
χ^2 (2)	3.720	0.626	0.887	3.642	0.737	4.088
	[0.156]	[0.731]	[0.642]	[0.162]	[0.692]	[0.130]
Breusch-Pagan-Godfrey	5.755	1.241	15.149	6.452	8.748	26.445
	[0.218]	[0.743]	[0.001]	[0.265]	[0.068]	[0.000]
Ramsey RESET F-test	0.013	0.351	0.102	1.294	11.920	3.749
	[0.910]	[0.554]	[0.749]	[0.270]	[0.001]	[0.055]
Exogeneity test Prob. Value	0.211	0.592	0.641	0.568	0.706	0.185

***, ** and *: significant at the 1%, 5% and 10%. Sample period: 1994.1 to 2006.12.

Breusch-Pagan-Godfrey heteroskedasticity test, χ^2 (df=no. of regressors). White Heteroskedasticity-Consistent Standard Errors are estimated where there is presence of heteroskedasticity. Breusch-Godfrey: Serial correlation LM test, distributed as χ^2(1) and χ^2(2). Figures in parentheses are standard errors ( ) for coefficients, and probability values [ ] for diagnostic tests.

Table 4 Chow forecast F-test:

Country specific factors

Forecast period	1996.1 – 2006.12	1998.1 – 2006.12	2000.1 – 2006.12	2002.1 – 2006.12	2004.1 - 2006.12
	0.327	0.665	0.741	1.137	0.996
Hungary	(1.000)	(0.951)	(0.901)	(0.289)	(0.487)
	1.751	0.382	0.327	0.416	0.249
Czech	(0.085)	(1.000)	(1.000)	(1.000)	(1.000)
	1.069	0.746	0.443	0.475	0.616
Poland	(0.477)	(0.877)	(1.000)	(0.999)	(0.951)
	0.585	0.514	0.291	0.373	0.377
Slovakia	(0.955)	(0.997)	(1.000)	(1.000)	(0.999)
	0.301	0.224	0.333	0.363	0.357
Slovenia	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)

Common factors

Forecast period	1996.1 – 2006.12	1998.1 – 2006.12	2000.1 – 2006.12	2002.1 – 2006.12	2004.1 - 2006.12
	0.875	0.428	0.485	0.629	0.520
Regional	(0.676)	(1.000)	(0.999)	(0.971)	(0.987)
	0.387	0.725	0.933	1.355	0.638
Hungary	(0.999)	(0.904)	(0.620)	(0.096)	(0.938)
	1.891	0.449	0.353	0.473	0.202
Czech	(0.066)	(1.000)	(1.000)	(0.999)	(1.000)
	1.000	0.821	0.496	0.503	0.673
Poland	(0.541)	(0.787)	(0.999)	(0.997)	(0.913)
	0.567	0.455	0.380	0.505	0.353
Slovakia	(0.960)	(0.999)	(1.000)	(0.997)	(1.000)
	0.252	0.286	0.311	0.340	0.273
Slovenia	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)

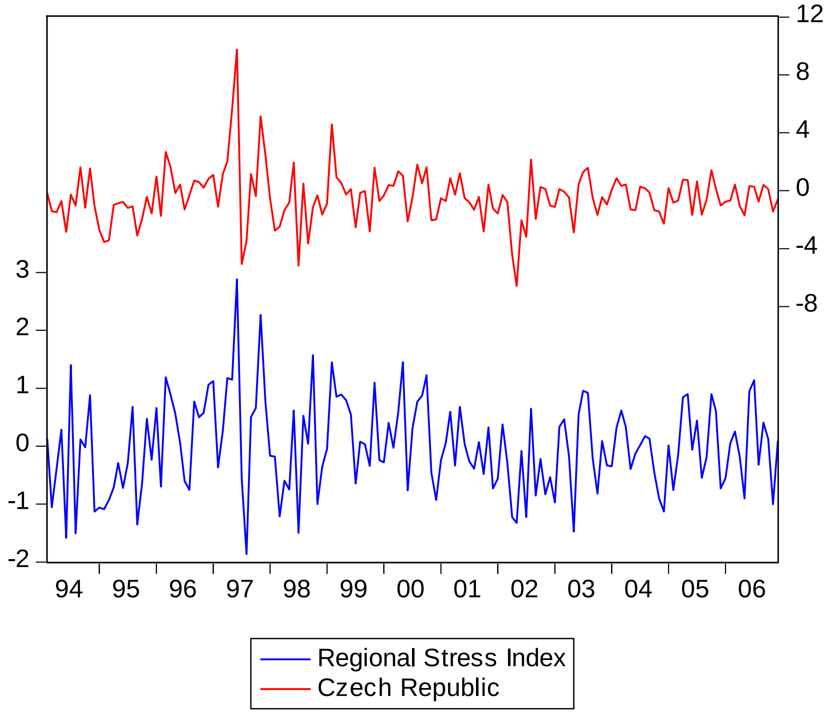
Notes: the numbers are the Chow forecast F-test for parameter stability, which requires estimation over a sub-sample Significance levels are based on $F = \frac{(RSS_T - RSS_{T_1})/T_2}{RSS_{T_1}/(T_1 - k)}$, where RSS_T is the residual sum of squares for the whole sample, RSS_{T_1} is the residual sum of squares for the first T_1 observations. The number in brackets is the probability of finding a value in excess of F.

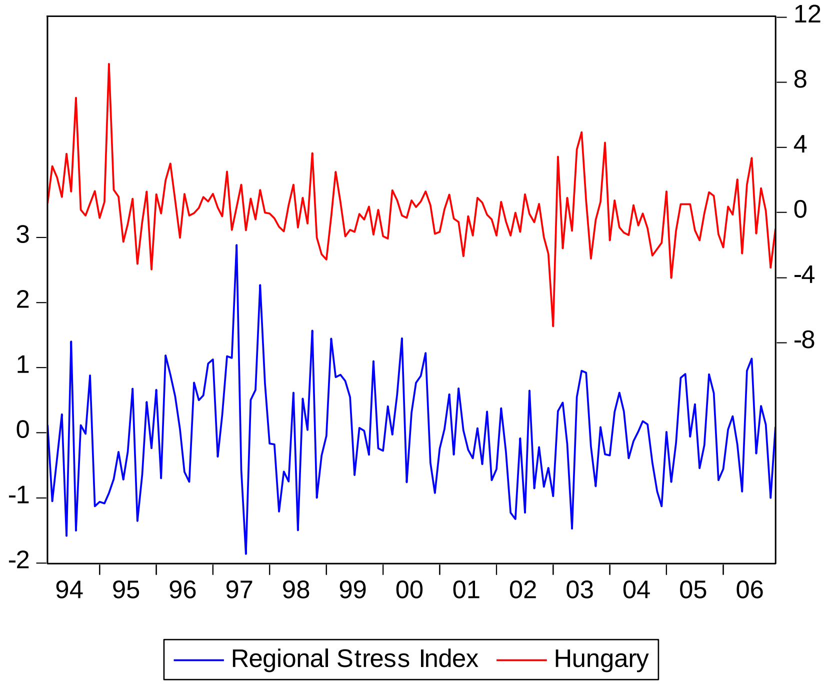
Table 5 Panel estimates

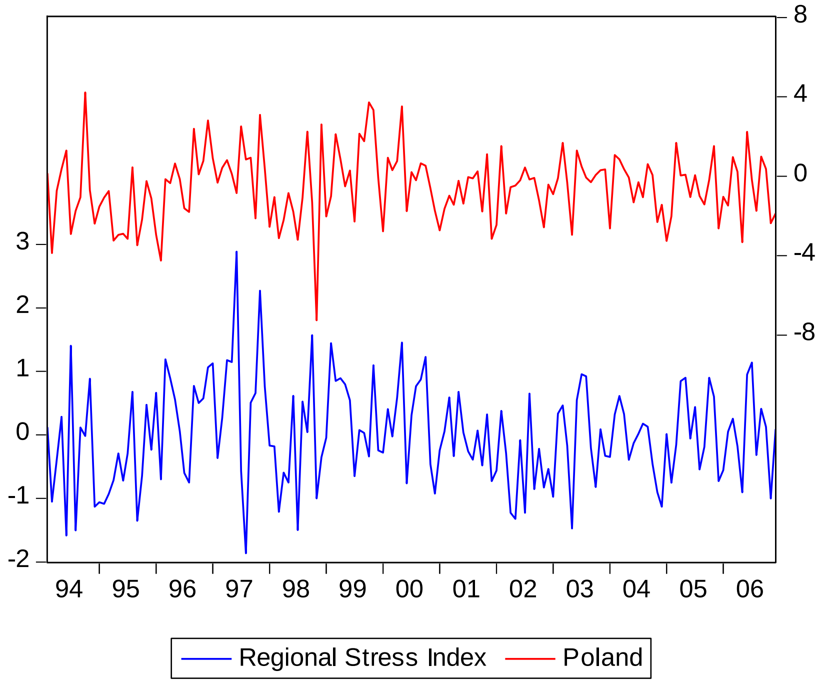
	constant	sp_{t-1}	*dc*	*m*	m_{t-1}	*cfstock*	EMP_{t-1}
Coef.	-0.236***	-3.260***	12.825***	-3.235***	-1.472*	-0.145*	0.098***
s.e.	0.068	0.748	2.656	0.860	0.878	0.077	0.035

***, *: significant at 1 and 10%. c*fstock*: common factor stock. *s.e.*: standard errors.
R^2 =0.094, Fixed test: F-test 2.68 [prob. 0.030] χ^2 (df = 4) test 10.80 [prob. 0.028]
Breusch-Godfrey serial correlation χ^2 (1): 0.6148, χ^2 (2): 2.4899 with critical value 3.84(1), 5.99(2) at 5% , 6.64(1) and 9.21(2) at 1% level.
Breusch-Pagan-Godfrey heleroskedasticity χ^2 (df=6): 15.436 with critical value 12.59 at 5%, 16.81 at 1%.

Figure 1 Exchange market pressure







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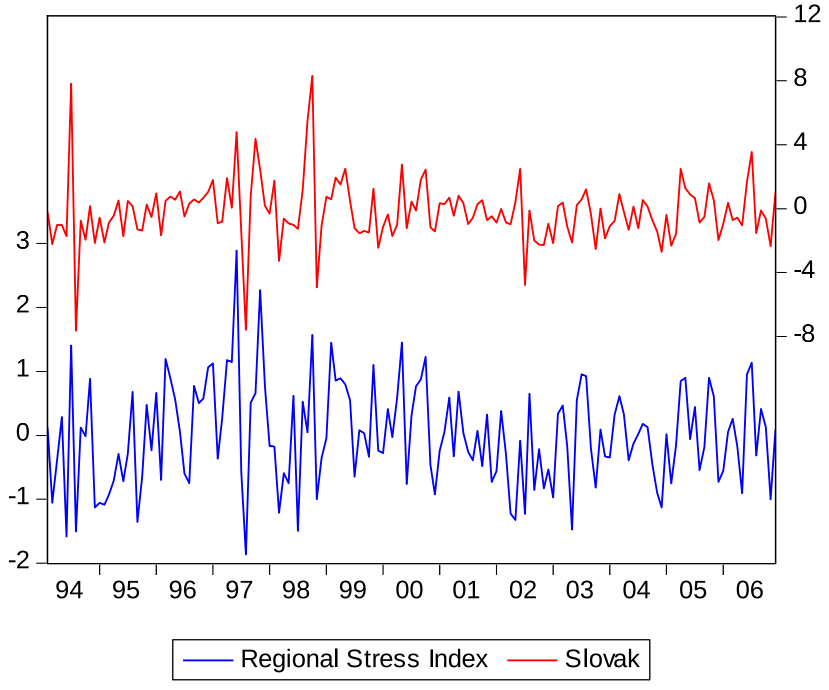

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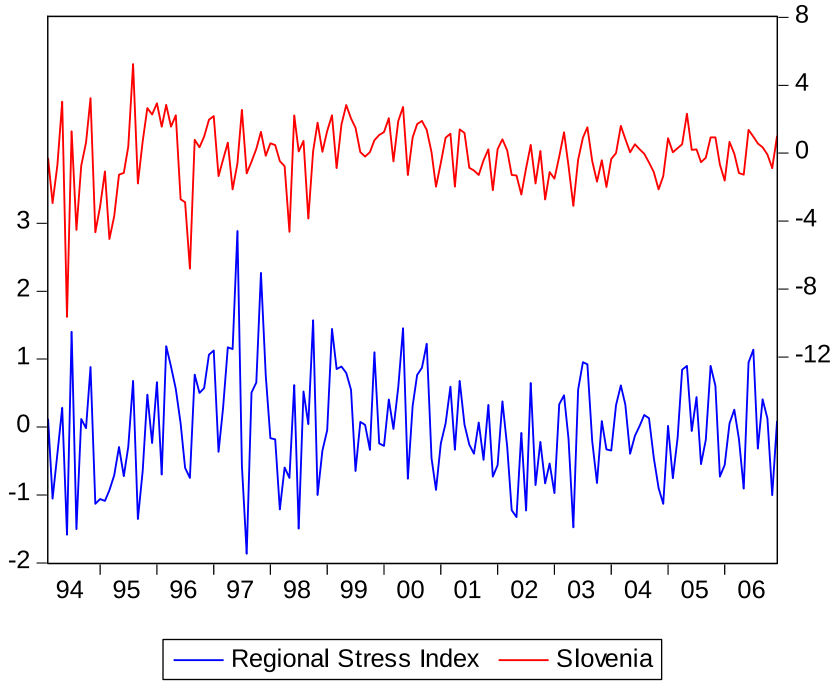
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