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SHORT RUN *LATS* RATE MOVEMENTS : IMPACT OF FOREIGN CURRENCY SHOCKS VIA TRADE AND FINANCIAL MARKETS [1]

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ABSTRACT

This paper investigates the short-run dynamic impact of foreign currency shocks on the deviations of Latvian *lats* vis-à-vis US *dollar* market spot rate from the parity set via *lats'* peg to SDR for the period from 1994 to 2000. The analysis is based on the standard theoretical model of dynamic cost adjustment, from which empirical models of the autoregressive distributed-lags form are derived. Reduction of several versions of such general models leads to a number of parsimonious and data congruent models. Our main findings from the modelling experiment are: Cross-currency shocks produce extensive impact on the net rate of *lats*, especially those shocks from the neighbouring transition economies, such as Estonia and Lithuania; These shocks may not be original, and may well act as transmission ports of other foreign currency shocks; The Russian crisis of August 1998 has exerted massive devaluation pressure on *lats*; The shocks are found to be transmittable via either trade and financial linkages, with the financial channel being the most contagious; Model configurations are found, however, neither unique nor definitely invariant, suggesting that it might be necessary to maintain several models in practice to fulfil different purposes in policy analyses and economic forecasting.

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1. Introduction

Stability management of Latvian *lats* (LVL) exchange rate forms one of the successes of the Latvian macro policy during the economic transition. Since February 1994, Latvian exchange rate has been implicitly pegged to the Special Drawing Rights (SDR) at the parity of 1SDR = 0.7997LVL with only a narrow fluctuation band of ±1%. Remarkably, this exchange rate arrangement has survived hitherto, withstanding the tremendous structural transformation, the growing economic openness[1], and a series of financial crises from both home and abroad including the severe banking crisis of 1995, the stock market fall of 1997 due to East Asian crisis, and the devastating Russian *rouble* crisis of 1998.

The sustainability of the exchange rate regime is reflected in the fact that the market spot rate of *lats vis-à-vis* US *dollar* has not deviated radically away from the parity rate (set via *lats'* peg to SDR) in terms of both magnitude and time span (see the upper panel of Graph 1).[2] This implies that the official (i.e. parity based) real rate must have been evolving in a close vicinity of the latent real exchange rate (i.e. the rate which moves in line with the fundamentals of the economy), because the parity would have been abandoned had there been persistent misalignments. Kazaks (2001) addresses this issue and carries out a carefully designed econometric investigation on the long-run relationship between the official real effective exchange rate of *lats* and the latent rate, which is constructed in accordance to various available theories. The hypothesis of no persistent misalignments is not rejected by the investigation over the period from 1994 to mid-2000.[3] Another way of testing the hypothesis is to examine the time-series properties of the deviations of the market spot rate from the official rate. Stationarity of the deviations implies that the parity must be in tune with the fundamentals by and large

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[1] Here are a few statistics as indicators of the growing openness. The total commodity trade as percentage of GDP increased from 61.1% in 1994 to 82.2% in 1998, but fell to approximately 70% in the aftermath of the Russian crisis. Latvia implemented liberal financial openness policies at the early stages of transition, e.g. free current account convertibility was implemented as early as April 1994. According to the index of restrictions on capital flows constructed by Garibaldi *et al* (1999), Latvia was ranked as one of the most open transition economies in Central and Eastern Europe by 1997.

[2] Notice that the central bank's ability to keep the market rate in line with the parity was not attained at the expense of continuous depletion of its reserves. On the contrary, the net foreign assets of the Bank of Latvia grew by 120% over the period from 1994 to mid-2000, although the foreign reserves were used extensively during the episodes of major speculative attacks set off by the domestic banking crisis of 1995 and the Russian crisis of 1998.

[3] However, Kazaks' (2001) result does not cover the present issue entirely because the real effective rate modelled there is based on the currencies of ten major Latvian trade partners rather than the US dollar alone.

so that the spot rate deviations from the parity are transitory. Results of such a test on the deviations are reported in section 3 and are corroboratory to Kazaks' (2001) result.

A common econometric representation of an exchange rate is the unobserved components model (e.g. see Pagan (1996)), where the exchange rate is decomposed into a permanent part, R_t^P, and a transitory part, R_t^T:

$$R_t = R_t^P + R_t^T \qquad (1)$$

The permanent part is then explained by what economic theory postulates, e.g. the latent real rate or the official rate in our case, whereas the transitory part is frequently regarded as resulting from various non-fundamental random shocks and falls into the realm of data-instigated trials of dynamic specification by applied modellers.

The focus of our present study is to model empirically such a transitory part, R_t^T. More precisely, we postulate that external currency shocks (i.e. foreign currency returns) constitute a significant driving force for the dynamics of the transitory part of the *lats vis-à-vis* US *dollar* market spot rate.[4] This hypothesis can be further decomposed into a number of questions. For instance, in what dynamic forms have external exchange rate shocks been propagated on to the *lats* nominal exchange rate? Which currencies have been the most important in transmitting such shocks? What are the principal channels of exchange rate shock propagation, e.g. foreign trade or international financial markets? We are aware of the fact that foreign currency shocks are not the only type of non-fundamental short-run shocks to prompt short-run deviations of the spot rate from the parity. However, foreign exchange rates are normally very sensitive to all sorts of major shocks, and therefore act as good and speedy indicators of various external shocks. Moreover, they may form a considerable source of short-run fluctuations in many of the domestic monetary variables (see section 2 below).[5] In view of the policy issue of designing of the future exchange rate regime in preparation for Latvia to join EU, it is crucial to identify if and how foreign currency shocks have been propagating onto the *lats* spot rate.

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[4] It is widely acknowledged in the exchange rate literature that the fundamentals commonly used in various exchange-rate models often have very low power in explaining short-run exchange-rate movements, especially for small open economies, see Frankel and Rose (1995) for a survey.

[5] Purely domestically originated non-fundamental shocks are not explicitly considered in this study. This is guided by our aim to focus on effects of external currency shocks. Empirically it is also due partly to the difficulty of finding right variables to represent local shocks exclusively, and partly to the limit of the number of explanatory variables that we are able to bring in the present models given the fixed sample size.

The method of the present investigation follows largely the empirical modelling approach experimented by Qin (2000), who investigates, by means of dynamic model specification, how much the 1997 Korean *won* crisis can be attributed to contagion from foreign currency crises via trade and financial channels. A key advantage of this approach lies in its power to identify factors, which propagate shocks onto the modelled variable in a statistically significant way and estimate their individual dynamic impact in a relatively robust manner. This is because that the method facilitates modellers to identify a data congruent and parsimonious ADL (Autoregressive, Distributed-Lags) model and then to reparameterise it into a structural model decomposing the modelled variable as the summation (i.e. moving averages) of a series of mutually independent random-shock variables, see Qin and Gilbert (2001) for more detailed methodological discussion. However, our current modelling experiment differs from that in Qin (2000) in the specification of the transitory part. While Qin uses simply the exchange rate returns, i.e. $R_t^T = \Delta \ln R_t$, we choose to use the difference between the market spot rate and the official rate (see the next section).

To the authors' knowledge, very little research has been done in the area of empirical determination of the short-run dynamics of exchange rates in transitional economies. A number of recent studies look at the contagious effects of currency and/ or financial crises on transition economies, e.g. Krzak (1998), Fries, Raiser and Stern (1998), Darvas and Szapary (1999), and Gelos and Sahay (2000). But none of these studies investigates fully the issue, which we are addressing here.[6] Target zones approach to exchange rates that similarly to this study examines deviations between market spot rate and parity rate, to our knowledge, has not been assumed for transition economies yet.[7] We do not employ this approach either because of our aim to focus on external currency shocks.

The rest of the paper is organised as follows. The next section sets up the modelling framework and gives a basic account of why and what input variables have been chosen for the investigation. Section 3 describes key data characteristics of main variables.

[6] Of these studies only Gelos and Sahay (2000) undertake econometric investigation, while the other employ graphical and anecdotal analysis of spillovers across a group of selected transition economies during the episodes of major financial crises of 1990s. Gelos and Sahay (2000) is also the only study that takes a brief look at the Latvian case. However, what they assess is an exchange market pressure index (composed of exchange rate, interest rate and international reserves' fluctuations) rather than spot rate fluctuations as we do here.

[7] For key inferences on target zones literature see a review by Garber and Svensson (1995).

Section 4 reports empirical results and compares various versions of the models. The final section draws the major conclusions.

2. Modelling framework

Primarily, we choose to use the LVL/US$ rate[8] and define the variable to be modelled as:

$$LATN = LVL/US\$ - P \times SDR/US\$ \qquad (2)$$

where P takes the peg value of 0.7997. In terms of the unobserved component model (1), the above equation amounts to defining *LATN* as the transitory part, R_t^T, and the parity as the permanent part, R_t^P. Accordingly, explanatory variables for *LATN* should also be of the transitory type. In this study, foreign currency shocks form the main source of these variables.

Since *LATN* depicts the market fluctuations of LVL/US$ rate net of parity variation due to fluctuations in SDR/US$ rate, we refer to *LATN* as the net rate of *lats*. Notice that we can regard *LATN* as a disequilibrium process representing a controlled target digressing from what market leads from time to time. Such a process has to be weakly stationary or transitory to be practically sustainable, i.e. to keep the controlled target dynamically stable, see e.g. Qin and Lu (1996). This interpretation enables us to apply the standard theory of intertemporal cost minimisation to depict the dynamic adjustment process of *LATN*. For instance, a simple cost function could be:

$$C_t = E\left[\sum_{i=0}^{\infty}\omega^i[(1-\lambda)(LATN_{t+i} - f(Z_{t+i}^e))^2 + \lambda(LATN_{t+i} - LATN_{t-1+i})^2]\right] \qquad (3)$$

where ω denotes a constant discount rate, λ the adjustment cost parameter, and $f(Z_{t+i}^e)$ a function of a set of expected forcing variables Z^e representing foreign currency shocks at period $t+i$. The term $(LATN_{t+i} - f(Z_{t+i}^e))^2$ reflects costs of the net rate of *lats* not moving exactly in line with the expected movement of the forcing variables, and the term $(LATN_{t+i} - LATN_{t-1+i})^2$ represents the cost of dynamic adjustment for the net rate.[9] Minimising C_t in (3), taking a linear form for the function $f(\bullet)$ and allowing for a more general dynamic cost adjustment structure, we should be able to link (3) with an

[8] We choose the US dollar rate here because of its reserve currency role.

[9] Notice that (3) can be augmented to take into consideration the dynamic adjustment cost of $LATN_{t+i}$ to lagged Z^e_{t+i}.

autoregressive and distributed-lag (ADL) model, see e.g. Nickell (1985) and Pagan (1985):

$$LATN_t = \mu + \alpha LATN_{t-1} + \sum_{i=0}^{k}\sum_{j=1}^{n}\beta_{ij}Z_{j,t-i} + u_t \qquad (4)$$

where parameters μ, α and β are functions of ω and λ. Henceforth, we adopt the ADL model as the generic econometric model form in our investigation.

Next, let us consider the choice of feasible variables in the set, Z_t. There are basically two ways of choosing the variables. The direct and obvious way is to choose a number of currencies from countries which hold relatively strong economic ties with Latvia. Denoting the exchange rate vis-à-vis US$ of the currency from country j by R_j, we define a currency shock variable simply as the exchange rate returns, i.e. $\Delta r_{jt} = \ln R_{jt} - \ln R_{jt-1}$. However, it is practically impossible to keep all the currencies of the world in the model and thus the choice of the currencies has to be sample dependent. Therefore, there is always the risk of omitting a foreign currency from an economy which might originate a future currency crisis and make direct and significant impact on *lats*. The alternative and indirect way is to identify certain domestic short-run variables, which would act as the first port of call, or the domestic initial indicators, of any major foreign currency shocks before they are reflected in *LATN*. This seems to be more desirable than the direct way, but can be extremely difficult to implement in practice for two key reasons. The first relates to the fact that the exchange rate itself is normally very responsive to various shocks, and increasingly so in view of the current trend of rising world integration of financial markets and currency markets, as well as growing international trade. It would thus be very difficult to find indicators, which possess faster reaction speed than that of the exchange rate. The second relates to non-experimental nature of economic statistics. Whatever economic statistics we choose, it is impossible to filter out the part of information which is not due solely to external currency shocks. Nevertheless, we endeavour to construct a number of such indicators and denote them as DOM_z.

Another question arising from the choice of the shock variables relates to what the possible channels are via which these shocks could be transmitted to the net rate of *lats*. The recent literature on crisis contagion highlights two major channels of currency shock transmission – trade and financial linkages.[10] It is thus desirable to further incorporate these two channels into the specification of shock variables.

During the modelling experiment, we look at the following four versions of model (4) depending on how Z_t is specified.

2.1. Cross-currency shocks model with domestic initial indicators

This version of (4) includes in Z_t both the direct foreign shock variables, Δr_{jt}, and the domestic indicators, DOM_{zt}:

$$LATN_t = \mu + \alpha LATN_{t-1} + \sum_{i=0}^{k}\sum_{j=1}^{7}\beta_{ij}^{r}\Delta r_{j,t-i} + \sum_{i=1}^{k+1}\sum_{z=1}^{4}\beta_{iz}^{z} dom_{z,t-i} + \varepsilon_t$$

j = GER, EST, LIT, POL, RUS, SWE, UK (5)

where dom_z=lnDOM_z and the subscript k denotes the minimum lag length, which brings about a white-noise residue ε_t. Seven Δr_j are included in (5) where GER stands for Germany, EST for Estonia, LIT for Lithuania, POL for Poland, RUS for Russia, SWE for Sweden and UK for Britain. These are chosen out of the following consideration. To accommodate the limited degrees of freedom and to avoid possibly high collinearity among Δr_j, we classify the foreign countries potentially important to the Latvian exchange rate into three groups and choose a couple of countries from each group as its representatives, in accordance with their relative importance in the group, their trade and financial openness, especially with respect to Latvia. Specifically, we define the first group as the neighbouring companion countries for their closely shared history and economic experience with Latvia. Lithuania and Estonia are chosen to be the representatives of this group on the ground that Latvia, Lithuania and Estonia are widely viewed as forming a single economic area, and thus currency shocks from one are likely to be highly transmittable to the other two. The second group is designated to cover a wider region of transition economies, i.e. those formerly centrally planned economies. Russia and Poland are selected to be the representatives. Russia is important not only as once the major trade partner with Latvia, but also as an external financial source, since Latvian financial system has benefited significantly from Russian capital inflows. Moreover, the recent *rouble* crisis forms a major currency shock to Latvian economy in 1990s. Poland is seen as a representative of the other transition economies of Central

[10] For discussions on contagion channels and the taxonomy of contagion, see Komoulainen (1999),

and Eastern Europe. The third group represents the Western/North European region. We choose Germany, Sweden and the UK on the ground of both their sizeable trade shares with Latvia and their roles as international financial centres and/or their strong presence in the Latvian financial system.

Four DOM_z variables are constructed as the possible domestic indicators: i) ratio of net foreign assets of the central bank to reserve money (DOM_1) as a measure of the central bank's ability to meet requests for foreign currencies in case of a run on *lats*, ii) ratio of the net foreign assets of the central bank to domestic money demand (DOM_2) as a measure of the relative size of the central bank to the banking system, and therefore of its capacity to calm down a fully fledged financial crisis,[11] iii) the share of foreign assets in the total assets of the banking system (DOM_3) as a measure of the vulnerability of the banking system to foreign shocks via its asset structure, and iv) the share of the foreign liabilities in the total liabilities of the banking system (DOM_4) as a proxy for the common lender effect.[12] For description of data sources, see Data Appendix.

Notice that the set of shock variables Δr_{jt} in (5) is not strictly contemporaneous to the explained variable $LATN_t$.[13] This is because empirically we choose to record $LATN_t$ at the beginning of period t (i.e. beginning-of-month exchange rate) whereas Δr_{jt} represents exchange rate changes of country j's over the past observation interval (a month), i.e. from $t-1$ to t. In other words, we are modelling the instantaneous market rate deviation from the parity rate of *lats* and assume the deviation being caused by the latest change of the external environment. Similarly, we cannot use contemporaneous dom_{zt} to

Forbes and Rigobon (1999), and Kaminsky and Reinhart (2000) among many others.

[11] Variables in similar definitions to DOM_1 and DOM_2 have been found to have the property of triggering speculative attacks, see e.g. Fratzscher (1998) and Gelos and Sahay (2000). Caramazza, Ricci and Salgado (2000) argue that empirically short-run debt may be a more crucial factor to trigger speculative attacks than reserves/ money ratios. We do not use short-run debt series because of their inherently high content of domestic information. Reserves/ money ratios are expected to be more external driven because of political independence of Latvian central bank and its sole responsibility for price stability.

[12] Unavailability of data prohibits us from identifying particular countries from an aggregate common lender effect. For further discussion and evidence on the common lender effect see e.g. Kaminsky and Reinhart (2000), Caramazza, Ricci and Salgado (2000), and Van Rijckeghem and Weder (2001).

[13] The following table gives the exact point of observations of various variables used in our models (for description of variables see sections 2.1. - 2.4.):

Time: month	Point of observation	Variables
t	*End-of-month*	DOM_{zt} ; wt_{jt} ; wkI_{jt} ; wkS_{jt}
	Beginning-of-month	$LATN_t$; R_{jt}
$t-1$	*End-of-month*	$DOM_{z,t-1}$; $wt_{j,t-1}$; $wkI_{j,t-1}$; $wkS_{j,t-1}$
	Beginning-of-month	$LATN_{t-1}$; $R_{j,t-1}$;

explain $LATN_t$ because monetary authorities report the series, from which dom_z are derived, at the end of the period (month here). $dom_{z,t-1}$ are actually the closest subsequent forcing variables to $LATN_t$ (there is only one-day lag in spite of the notation one-month gap from t to $t-1$). Since exact simultaneity is absent from our model, we are thus exempt from the problem of testing for weak exogeneity of Δr_{jt} variables, and we should be able to estimate the models by the ordinary least squares (OLS) method.

Obviously, we would expect $\beta_{ij}^{r} = 0$ if the set, dom_z, indeed takes in virtually all the initial currency reaction of *lats* to external currency shocks. On the other hand, we could have $\beta_{iz}^{z} = 0$ if the indicators fall short of the above expectation and *LATN* turns out to be reacting directly and almost immediately to the foreign currency fluctuations embodied by the seven exchange rate return variables. Since (5) describes short-run adjustment, it is difficult to designate *a priori* economic interpretation to β_{ij}^{r} and β_{iz}^{z}. This is because the short-run dynamic adjustment process to various external shocks, which may also be dynamically interdependent, is normally too specific and complicated to explain by economic theory alone, which is usually concerned with long-term causal effects. Nevertheless, we may form certain economic anticipation concerning the signs of some of these parameters, assuming a simple, non-oscillatory dynamic impact. For example, among the four domestic initial indicators, we would expect the coefficients of dom_1 and dom_2 to be negatively related to *LATN*. Increases in dom_1 indicate the strengthening of the *lats'* foreign exchange backing, reducing the feasibility of currency runs triggered by inadequate reserves. Correspondingly, excessive depletion of the central bank's net foreign assets would create uncertainty on the peg's sustainability and the central bank's ability/ willingness to defend it, increasing the probability of speculative attacks on the peg. Similarly, growing dom_2 indicates enhancing capacity of the central bank to calm down financial markets in times of turmoil. In sum, sufficiently large decreases in dom_1 and dom_2 are expected to trigger a speculative attack. We also expect negative coefficients for dom_3 because a fall in foreign assets owing to partner country's currency depreciation could increase the depreciation pressure on *LATN*. For dom_4, we would expect positive coefficients as long as it embodies potential risk of a common lender effect. Finally, since all the four indicators are designed to convey similar information, we should expect them to be highly substitutive between each other and hence only one or two would survive the model reduction process. As for the currency shocks, we normally expect positive coefficients for those countries whose currency depreciation/ appreciation would infect *lats* directly for whatever economic reasons. For example, we may expect positive coefficient if one "infective" country originates a major financial crisis, or if a country serves as a transmission port of currency shocks produced elsewhere. We may also expect positive coefficient if cross-currency shocks cause abrupt deterioration in trade competitiveness that can not be neutralised by gains in productivity. On the other hand, negative coefficients can be associated possibly with mutually competitive countries, whereby devaluation of one currency may boost the credibility of *lats* in the international money markets.[14]

2.2. Cross-currency shocks model without domestic indicators

Since we expect that the sets of dom_z and Δr_j in (5) might be substitutive of each other and that the shock transmission of Δr_j to *LATN* is likely to outrun that of dom_z, we define the second version of model (4) simply as:

$$LATN_t = \mu^{\#} + \alpha^{\#} LATN_{t-1} + \sum_{i=0}^{k}\sum_{j=1}^{7} \beta_{ij}^{r\#} \Delta r_{j,t-i} + \varepsilon_t^{\#} \qquad (6)$$

with identifier # denoting parameters under assumption that all $\beta_{iz}^{z} = 0$ in (5). As model (6) is nested in (5), we can use various tests to compare the empirical performance of the two models. These tests will help us to determine whether the seven chosen countries are adequate representatives of direct foreign currency shocks to *lats*, whether and how responsive *LATN* is to the world exchange rate markets, and whether domestic initial indicators dom_z are substitutive to cross-country currency shocks.

Since model (6) is a special case of (5), our previous analysis about the limited economic interpretability of the parameters βs remains unaffected here. Notice also that models (5) and (6) assume that *LATN* reacts to foreign exchange rate shocks in a simple and direct way. The assumption disregards the possibility that *LATN* may respond to exchange rate shocks more strongly from countries which have closer economic links than from countries less closely linked with Latvia. In other words, (6) treats all the

[14] Such competitive effect between countries of a single economic region is often due to the fact that large foreign investors tend to plan and coordinate their investment strategies on a regional basis, where individual countries of a region are treated by their comparative attractiveness. The effect can be particularly strong in a region where foreign exchange markets are thin and/ or investors' funds are

seven currencies as having equal impact on *LATN* regardless of their different strength and capacity of transmitting foreign currency shocks. The next two versions of (4) relax this assumption by introducing a set of weights to readjust Δr_j, see Qin (2000).

2.3. Cross-currency shocks model weighted by foreign trade

Foreign trade linkages form one of the most discussed channels of cross-country currency shock propagation. Two types of trade linkages have been identified in the literature: direct trade linkages and indirect linkages via third market competition, see e.g. Glick and Rose (1999), Van Rijckeghem and Weder (2001), and Gelos and Sahay (2000).[15] Measures for these linkages are commonly based on trade shares, where trade to a relevant foreign country is weighted by the total foreign trade of the home country. However, it is very difficult to distinguish the two types of linkages from the movement of such measures, since the movement can be caused by either changes in the specific trade volume to one country, or changes in the total trade volume of the home country, or both. Whereas indirect linkages are likely to induce the latter changes, direct linkages can induce both. Here, we construct a set of trade weights, wt_j, by taking the export share of country j in Latvia's total exports, so implicitly accounting for direct and indirect trade linkages. We then define a set of currency shock variables via the trade channel by:[16]

$$st_{jt} = wt_{jt-1} \times \Delta r_{jt} \qquad (7)$$

The cross-currency shocks model weighted by trade can be therefore written as:

$$LATN_t = \mu^T + \alpha^T LATN_{t-1} + \sum_{i=0}^{k}\sum_{j=1}^{7} \beta_{ij}^{rT} st_{j,t-i} + \varepsilon_t^T \qquad (8)$$

Since the trade weights in st_j have one period lag, the property of no strict simultaneity in (6) remains with (8). Notice that the signs of β_{ij}^{rT} should be the same as the

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especially large relative to the market size. Krzak (1998) and Darvas and Szapary (1999) discuss the role of big investors in generating market fluctuations in transition economies.

[15] Forbes (2001) provides a detailed account on how devaluation could result in possible welfare and production capacity improvement due to the effect of cheaper import prices. However, this is implicitly a medium-term effect and should not affect short-run dynamics of exchange rates.

[16] An alternative is to use the total trade as the base for calculating the share. Since the impact of currency shocks on export should be opposite of that on import, we expect that differences due to different choice of the base should be insubstantial. Notice that we use lagged trade weights in (7). This is because exchange rate series here are taken as the-beginning-of-month observations while the trade data are from the-end-of-month observations.

corresponding $\beta_{ij}^{r\#}$ in (6), since all wt_j are positive by definition and only modify the absolute magnitudes of the original external shocks.

2.4. Cross-currency shocks model weighted by capital market openness

Another key channel of transmitting foreign currency shocks is the international capital markets. We intend to design a set of financial weights, which account for the degree of capital mobility. Obviously, the higher the degree of a country's capital mobility, the stronger its exchange rate changes would impact on the currencies of other economies linked to each other via capital markets. In order to measure changing degrees of capital mobility, we exploit the principle of zero country premiums underlying the interest rate parity condition, namely that future cross-country currency price difference, i.e. the exchange rate return, is expected to match perfectly the cross-country capital price difference under the free market situation.[17] Mismatch of the prices should therefore reflect the degree of capital market segregation from the world markets. In other words, we should have the interest parity condition:

$$E_t[\Delta r_j] = Id_{jt} \qquad (9)$$

under the situation of perfect financial market integration ($E_t[\Delta r_j]$ is the expected exchange rate returns and Id_{jt} is the interest differential of country j *vis-à-vis* a benchmark economy measured at time t for exchange rate returns and interest rates of the same maturity). Imperfect capital mobility can thus be reflected by the non-zero premiums, $(Id_j - E[\Delta r_j])_t$.[18]

Hence, we construct the basic financial weights on the basis of the absolute deviations, i.e. $\left|Id_{jt} - \Delta r_{jt+1}\right|$, using the *ex post* uncovered interest parity (UIP) version of (9),[19] which entails an additional assumption of rational expectations to the basic interest parity condition, and thus could make the deviations a less accurate measure of capital

[17] There are two other methods of capital mobility measurement in the literature, i.e. savings-investment approach due to Feldstein and Horioka (1980) and consumption correlation approach due to Obstfeld (1986). We do not adopt those methods here because of their slowness in information transmission as well as the unavailability of monthly data.

[18] Notice that the interest parity condition also assumes perfect asset substitutability and risk neutrality. It therefore is more stringent than the perfect capital mobility condition, see e.g. Frankel (1991) and Lemmen (1998).

[19] Empirically, there are two versions of (9) with regard to the formulation of the expectation $E_t[\Delta r_j]$. The covered interest parity (CIP) defines the expectation by the difference between the forward rate and the spot rate, whereas the uncovered interest parity (UIP) simply use the difference between the present

mobility, see e.g. Frankel and MacArthur (1988) and Lemmen (1998). In fact, different empirical specifications of (9) are bound to compound the fundamental hypotheses contained in the interest parity condition with different auxiliary assumptions and thus weaken the interpretation of the deviations as solely due to capital immobility.

Apart from the difficulties in specifying $E[\Delta r_j]$, there are two other issues pertinent to our design of the financial weights. One relates to the concept of capital mobility. It should intrinsically depict a trend over a certain time period. To accommodate our data set to this, we choose to smooth the deviations from interest rate parity calculated from weekly data by means of 12 weeks' rolling averages. Series of the monthly deviations are then produced by selecting end-of-month observations from the smoothed weekly deviation series. The other issue concerns the accuracy of using money market rates as the measure of the aggregate price for capital, especially in view of the common fact that the short-term rates are often used as monetary policy targets. To circumvent this problem, Baig and Goldfajn (1999) propose to use the sovereign spreads of foreign currency denominated debt traded in offshore markets as a substitute for the interest rates differential Id_j. Such data for transition economies are unavailable until very recently. Here, we choose to use the stock market returns as an alternative price measure for capital and to construct another set of the financial weights by the differential of the realised aggregate stock market returns between the country concerned and a benchmark country, denoted as Sd_j.[20]

Specifically, we define the two sets of financial weights as:

$$\begin{cases} 0 \le wkI_{jt} = 0.95^{(RA_{12}|\Delta r_{j,w+m} - Id_{jw}|)_t} \le 1 \\ \\ 0 \le wkS_{jt} = 0.95^{(RA_{12}|\Delta r_{j,w+m} - Sd_{jw}|)_t} \le 1 \end{cases} \qquad (10)$$

where subscript w denotes weekly frequency, m denotes number of weeks over which interest rate and exchange rate returns are measured, and RA_{12} denotes 12 weeks rolling average, which is transferred to monthly frequency by taking its weekly frequency end-of-month observation. The particular exponential function is used in order to ensure that the weights are within the domain of [0,1] and that the higher values correspond to

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and the future spot rates. The choice of UIP here is due to unavailability of the forward exchange rate data for transition economies.

[20] We are aware of the fact that stock market returns may not be a very good price measure for capital unless the stock market is well functioned and well developed. Although that is yet to be realised in many

higher degrees of capital mobility. On the basis of (10), we specify a pair of foreign currency shocks transmitted via the channel of financial markets:[21]

$$\begin{cases} skI_{jt} = wkI_{jt-2} \times \Delta r_{jt} \\ skS_{jt} = wkS_{jt-2} \times \Delta r_{jt} \end{cases} \quad (11)$$

We then construct two versions of the currency shock model via financial linkages, in a similar manner to model (8):[22]

$$LATN_t = \mu^I + \alpha^I LATN_{t-1} + \sum_{i=0}^{k} \sum_{j=1}^{7} \beta_{ij}^{rI} skI_{j,t-i} + \varepsilon_t^I \quad (12a)$$

$$LATN_t = \mu^S + \alpha^S LATN_{t-1} + \sum_{i=0}^{k} \sum_{j=1}^{7} \beta_{ij}^{rS} skS_{j,t-i} + \varepsilon_t^S \quad (12b)$$

Again, the signs of β_{ij}^{rI} and β_{ij}^{rS} are dependent solely on Δr_{jt-i}, since all the financial weights are positive by design.

As models (8) and (12) form two alternative ways to (6), we would naturally want to make comparison of them. There are two issues in need of clarification before we can attempt the comparison. The first issue relates to the comparability between the least-squares estimates of $\beta_{ij}^{r\#}$ in (6), and β_{ij}^{rT} in (8), β_{ij}^{rI} in (12a) or β_{ij}^{rS} in (12b) respectively. Denoting all the explanatory variables in (6) by matrix *X*, all the weights by matrices *W*s and all the coefficients by vector *βs* in all the models concerned, we want effectively to make comparisons between the ordinary least squares (OLS) estimators of:

$$\beta^{r\#} = (X'X)^{-1} X' LATN \quad (6')$$

and $$\beta^{rT} = ([W^T \circ X]'[W^T \circ X])^{-1}[W^T \circ X]' LATN \quad (8')$$

or $$\beta^{rI} = ([W^I \circ X]'[W^I \circ X])^{-1}[W^I \circ X]' LATN \quad (12a')$$

or $$\beta^{rS} = ([W^S \circ X]'[W^S \circ X])^{-1}[W^S \circ X]' LATN \quad (12b')$$

where $\circ$ indicates Hadamard product.[23] Notice that we could regard (6') as a special case of (8'), (12a') or (12b'), in which there is an implicit weight matrix of unity in all its

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transition economies, the money market rate may not be a much better measure of the capital price due to the imperfectly developed banking system.

[21] Note that financial weights are lagged two periods, i.e. weights are observed just before the period over which exchange rate return is measured. This specification stresses inertia in capital mobility.

[22] It is unnecessary to introduce a separate measure for the changing degrees of openness of the home country, in this case Latvia, since it should be reflected in the significance of all the external shocks in our models.

[23] Hadamard product is an element by element product of two matrices of the same dimensions, see e.g. Styan (1973) and Visick (2000).

elements. Since all the coefficients are estimated by the LS method, their statistical properties should be comparable. Any difference in the estimates should result from differences in the weights.

Another issue relates to the relationship between the weighted models (8) and (12a) or (12b). Although β_{ij}^{rT} in (8) and β_{ij}^{rI} in (12a) or β_{ij}^{rS} in (12b) could be regarded as certain further decompositions of $\beta_{ij}^{r\#}$ in (6), it would be wrong to assume that model (6) is composed of (8) and (12). In other words, currency shock impacts via trade and via financial linkages do not add up to account for the unweighted model (6). This is partly due to the fact that trade and financial channels do not form the exhaustive set of channels of currency shock transmission, partly due to the non-additive nature of the trade weights and the financial weights because of their very different definitions. Moreover, we cannot rule out the possibility that trade weights and financial weights may convey overlapping information and hence may not embody the trade or financial market channels solely. In fact, difficulties in separating trade contagion effects from financial contagion effects have been acknowledged in other studies of currency or financial crises, see e.g. Van Rijckeghem and Weder (2001).

3. Key data characteristics of main variables

Econometric modelling is based on monthly time series, although we use weekly series to construct the financial weights. The sample length is primarily dependent on trade data, which goes back to 1994M4. Data series relating to the financial weights are shorter, with some of them going back only as far as 1996M9. Thus we define two sample lengths: one covering 1994M4 – 2000M5 and the other 1996M9 – 2000M5. We refer to the former as '*full sample*' and the latter as '*small sample*'. In order to enable more comparisons of the model results, we extrapolate those missing early observations of some financial series and construct a full sample of the financial weights, though such comparisons should be treated with care.

3.1. Deviations of LVL/US$ spot rate from the parity

As defined in equation (2), our explained variable is the net rate of *lats*, *LATN*, i.e. the market fluctuations of LVL/US$ rate net of the parity. The monthly series of

LVL/US$ rate, the parity and *LATN* are plotted in Graph 1.[24] The dotted lines in the lower panel of Graph 1 are the 1% bands around the parity. We can see from the graph that: i) the net rate shows no long-run mean diversion, ii) there are few instances where *LATN* has exceeded the bands allowed by the peg, and iii) its speed of mean reversion has slowed down significantly from the mid 1996 to 1997 onwards. These suggest that the parity has been sustained so far but periods of appreciation pressure (when *LATN* approaches the lower band of parity) and/or of depreciation pressure (when *LATN* approaches the upper band of parity) have become more persistent during the second half of the sample period. This is particularly prominent in the aftermath of the Russian crisis of 1998 and the Latvian budgetary hardships of late year 2000.

Formal statistical tests (DF (Dickey-Fuller) and ADF (Augmented DF) unit-root tests) of the weak stationarity hypothesis are carried out on *LATN* and the results are summarised in Table 1. We see that the unit-root, or non-stationarity, hypothesis is rejected by all of the test results at 1% significance level. Analysis of autocorrelations and partial autocorrelations (not reported here) suggests AR(1) process for LATN. If we run an autoregression estimation of *LATN* for the full sample period, we find that the first lag is significant at 5% with the estimated coefficient of 0.36 (standard error 0.11). However, the estimated coefficient becomes insignificant (0.24 with standard error 0.13) when the AR(1) is run for the sub-sample of 1994M4-1998M7, i.e. for the period prior to the Russian crisis, whereas it becomes highly significant (0.74 with standard error 0.16) for the post Russian-crisis period, i.e. 1998M8-2000M5. These estimates confirm the earlier observation of changing patterns in the dynamics of *LATN*.

The lack of constancy in the autoregression of *LATN* implies that simple AR models are inadequate in characterising the disequilibrium adjustments of *LATN*. Intuitively, it is easy to see that *lats* rates would become inevitably more receptive to an increasingly wide range of external shocks, as the Latvian economy grows opener and more market-oriented.

[24] Since Datastream provides LVL/US$ spot rate only from June 1997, we have constructed its earlier part as a cross rate from LVL/UK£ and UK£/US$ rates. This construction implies the assumption of no arbitrage possibilities. To verify the validity of this assumption, we have checked the cross rate against the actual spot rate for the period of 1997(6)-2000(5) and found that the two series are highly correlated in both their levels and returns with the correlation coefficients of 0.99 and 0.97, respectively.

3.2. Direct currency shocks and shocks domestic initial indicators

Graph 2 plots the nominal exchange rates *vis-à-vis* US$ and exchange rate returns (i.e. cross-currency shocks) of the seven countries defined in (5).[25] One of the most noticeable countries here is Russia in terms of both the depth and magnitude of its 1998 crisis. We expect that the Russian variables should play certain destabilising roles in our models. Table 2 reports the ADF test results of all the exchange rate series, where is confirmed that all the returns are stationary. Description of data sources is given in Data Appendix.

It should be noted here that it is inappropriate to include, into our models, exchange rate returns as individual shock variables when one of the currencies is rigidly pegged to the other. This is because the shocks from a country that pegs its currency are a mixture of shocks from both countries and thus do not embody country specific information. Estonian *kroon* falls into this situation, for *kroon* has been fixed to German *mark* at parity 8:1. In order to circumvent the problem, we redefine the Estonian shock variable as the difference between the exchange rate returns of Estonian *kroon* and German *mark*, both *vis-à-vis* US$. We find, from the plot of the Estonian shock variable, a pronounced regime shift, which is caused either by narrower fluctuation bands and/ or increased credibility of the peg.[26]

Graph 2 also plots the domestic indicators. We can see from the plots that there was a massive build-up of the central bank's net foreign reserves during mid 1995 to 1996. That reflects the bank's policy target then to fully back up its reserve money by hard currencies after the banking crisis of early 1995. Consequently, there was a drastic increase in the size of the central bank relative to the banking system, as shown from the rising dom_2. Since then, the net foreign reserves have been covering about 70-80% of the domestic money demand. The Bank of Latvia thus remains the biggest player in the *lats* market. The indices of banking system's exposure to foreign shocks via its asset and

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[25] Similarly to *LATN*, Datastream does not supply spot rates of Estonian, Lithuanian and Polish currencies vis-à-vis US$ for the early part of the full sample. Therefore we substitute spot rates by their cross rates via British *pound sterling* for the missing period (except for Lithuania). The feasibility of this is supported by correlation coefficients of 0.99 in both levels and returns of actual series and cross rates for their overlap period for both Estonian *kroon* and Polish *zloty*. Very thin *pound sterling* market in Lithuania produces too low correlation coefficients to be considered as appropriate (0.136 for levels and 0.152 for returns for the period of 1997M7-2000M5), as a result for Lithianian *litas* we use series of spot rate vis-à-vis US$ supplied by Reuters. Since these series go back only to 1995M6, we extrapolate its first observation to the beginning of the full sample.

[26] The possibility that the observed regime shift in Estonian series be caused by the merger of actual and cross series is rejected by data analysis.

liability structures, dom_3 and dom_4, followed surprisingly the similar growth pattern until 1998, when foreign assets first fell early in the year and dropped further following the Russian crisis. While the share of foreign assets subsequently recovered to a certain extent, dom_3 was still far from its pre-1998 level by 2000, indicating that domestic banks have been re-orienting their business towards the home market. The share of foreign liabilities, dom_4, has displayed a continuous growth, albeit being slowed down by the Russian crisis. However, we have to treat this index very cautiously because of a data definition problem. Only until very recently, the Bank of Latvia did not allow for a separate statistic entry on foreign investment in a bank's capital and reserves, and foreign loans and deposits. Hence, a ratio of more than 50% in year 2000 is very much a manifestation of the Nordic and German banks buying into the Latvian banking system rather than staggering dependency on short-run/ medium-run foreign financing. While non-stationarity is not rejected for majority of domestic initial indicators, various sub-sample results support weak stationarity of all these variables (see Table 2). The evidence suggests that all four series are stationary but have experienced regime shifts corresponding to stages of economic transition.

3.3. Trade and financial weights

Historical exposure to cross-currency shocks via trade linkages is well covered by the chosen seven partner countries, which jointly account for about 70% of total Latvian exports. Graph 3 shows that Germany and the UK had taken the largest share of approximately 15% each in Latvian export markets by year 2000. Sweden had a lower share of about 10% in 2000. While trade shares of these developed economies increased over the sample period, the Russian trade share has drastically decreased from 30% in 1994 to less than 10% in 2000. Apart from the Latvian efforts to reorient exports towards the European markets, the implementation in Russia of political sanctions on exports from Latvia at the end of 1997, and the Russian currency crisis of August 1998 have certainly added to the decrease. Export shares to Estonia and Lithuania have been relatively small in comparison (reaching around 5% and 7% respectively in 2000). But the actual export volumes may not be trivial when we take into consideration the small sizes of these two economies. Although Poland is the largest Latvian export market of transition economies in Central Europe, its export share has attained only about 2%.

Currency shocks from Poland via the trade channel should therefore have very limited effect on *lats*.

The US is used as the benchmark country in the construction of the two sets of financial weights. We use one month interbank market interest rates in the first set, and the *ex post* four weeks stock market returns in the second set, to form the capital price differential. All the raw data series are weekly in frequency when we calculate wkI_{jt} and wkS_{jt} using (10), with one month and four weeks realised exchange rate returns respectively. We then take the end-of-month observations of wkI_{jt} and wkS_{jt} from their 12 weeks' rolling averages to calculate skI_{jt} and skS_{jt} in (11). The two sets of capital mobility indices, wkI_{jt} and wkS_{jt}, are drawn in Graph 4.[27] We see from the graph that wkS_{jt} are normally smaller than wkI_{jt}. This can be explained by either relatively high macro policy content in the interest rates such that they may over represent openness, or by lower degree of stock market integration with international capital markets,[28] or both. On average, the developed countries, i.e. Germany, Sweden and the UK, exhibit, as one would expect, higher degrees of financial openness than those of the transition economies.

Table 3 shows that correlation between both types of financial weights, wkI_j and wkS_j, is low, reflecting significant disparity between the stock market differential and the interest rate differential in pricing aggregate capital.[29] But we can see that weighted shocks can have high correlation despite the dissimilarity in the weights, as shown from the correlation coefficients of st_{jt}, skI_{jt} and skS_{jt} in Table 4. This is due to the general dominance of exchange rate returns Δr_j over the weights in terms of their sample variances. Table 2 gives the ADF test results of all the weighted shock variables, which are confirmatory of their weak stationarity.

4. Empirical Results

We follow the general→simple dynamic specification and model reduction approach, see Hendry (1995), and endeavour to derive the most data-congruent and

[27] Due to shorter data samples, we have to extrapolate some early observations for Russia, Lithuania and Estonia in the full sample. In addition, Lithuanian weekly interest rates are interpolated largely from monthly data. Detailed description of these series is given in the Data Appendix.

[28] Traditional arguments for relatively low stock market integration include imperfect asset substitutability and home bias of investors, see Lemmen (1998).

[29] Russia is perhaps the only exception. However, its relatively high correlation coefficients (0.52 and 0.74 over full and small samples respectively) are mainly the result of Russian crisis.

parsimonious models (5), (6), (8), (12a), and (12b). The method of estimation is ordinary least-squares (OLS). Two sets of models are thus produced covering the full sample and the small sample respectively. Tables 10a and 10b give the summary regression results of the two sets. Graph 5 plots the relevant recursive regression results.[30] Considering the limited degrees of freedom available, we carry out the model reduction twice, once setting k=2, i.e. the maximum lag length, and the other k=4 in the general models.[31] Diagnostic tests of the residual autocorrelation on the parsimonious models suggest that our choice of k is appropriate in general. The two settings result in the same parsimonious models for the full-sample case; whereas for the small-sample case, model reduction sometimes fails to result in parsimonious models which pass all the diagnostic tests in the setting of k=4, due mainly to the very small degrees of freedom of the starting general models. Model progress or encompassing tests are used to help us to choose between alternative models from the two settings when the reduction has not led to the same parsimonious models.

As mentioned before, none of the explanatory variables forms strictly simultaneous relation with the explained variable, and thus OLS method is used in estimation. In order that the estimates of all the shock parameters are economically interpretable, we check the orthogonality among all the shock variables within a model. A simple check is the relevant sample correlation coefficients, which are given in Tables 5, 6, 7 and 8. We can see from the table that correlation coefficients are generally low between the foreign shock variables of the same model (e.g. across shocks via trade linkages), but that there is quite high correlation between the domestic indicators, although it appears to fade away in the small sample. We can thus anticipate that the parameters of the shock variables represent more individual shock effects than those of the domestic variables. To use single-equation models for forecasting, we also need to check the assumption of strong exogeneity implied by the five models. Results of Granger non-causality test, given in Table 9, are largely confirmatory of this assumption.[32]

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[30] All econometric analysis is performed by PcGive Version 9.0.

[31] An exception is model (5), which is estimated with k=2 for both samples because of the large number of regressors. For the full-sample case, we have also experimented with five lags for models (6), (8), (12a), and (12b), but none of the fifth lags turn out to be significant.

[32] A few test results for *EST* and *GER* as well as some domestic indicators reject Granger non-causality at 5% in the small-sample, two-lags case. However, only *EST* remains strongly significant eventually in the reduced models, and the most useful forecasting models that we obtain are reduced from four-lags case.

The modelling framework of section 2 allows for various types of comparison between the most data-congruent and parsimonious models of (5), (6), (8), (12a), and (12b). At the model level, we can compare the parsimonious encompassing test results of all the models to infer which model/ models can best capture the regular foreign currency shock propagation to *LATN*; we can make particular comparison of models (5) and (6) to evaluate to what extent domestic initial indicators can act as proxies of regular foreign currency shocks; we can also compare (8), (12a), and (12b) with (6) to assess the differences in currency shock transmission via the two channels. At the country level, two types of comparison are possible too. One is to compare the identified dynamic structures of the shocks from one country between different models and discuss the relative importance of shocks from different countries. Furthermore, we can compare the two sets of models produced from different sample sizes to assess parameter or/ and model constancy. The following subsections report these comparisons in turn.

4.1. Comparison of overall model performance

Four features, at least, stand out immediately from Tables 10a and 10b, and Graph 5. One is the goodness of fit embodied by the R^2, which ranges between 0.5 and 0.7 for all models of full and small samples, respectively. This is remarkable particularly in regard to the fact that our models examine only the effects of foreign currency shocks. Another feature relates to the parameter estimates of $LATN_{t-1}$. The parameter is found to be significant and self-damping (i.e. $0 < \hat{\alpha}$, $\hat{\alpha}^{\#}$, $\hat{\alpha}^{T}$, $\hat{\alpha}^{I}$, $\hat{\alpha}^{S} < 1$) in all models, thus confirming our choice of the theoretical model (3). But what is more interesting is that this parameter appears quite receptive to model configurations. The degree of its cross-sample constancy varies with models, as shown from the recursive graphs as well as Hansen parameter instability tests (in the tables of regression results). The third feature relates to the forecasting performance of the models from their recursive tests. It is discernible from the recursive graphs of various Chow tests that the models are capable of satisfactory short-term forecasts in general, with very few isolated 1-step break points considering the data volatility. Correspondingly, most parameter estimates are relatively invariant, as shown from either the parameter instability tests or the recursive graphs of OLS estimates. Finally, the relatively high goodness of fit is supported by only a small of number of shock variables, especially in the weighted shock models. Starting normally with a general model of over 30 regressors when $k=4$, and over 20 regressors when *k=2*, we are able to reduce the number to four or five while keeping the models' data-congruency.

An effective measure of the relative performance of different model types is the parsimonious encompassing test. We report the test results in Table 11. According to these results, model (6) can parsimoniously encompass model (5) in the small-sample case but neither model is able to encompass the other in the full-sample case, suggesting that model (5) lacks significant superiority over model (6) on the whole. As for the overall comparison between the unweighted shock model (6) and the weighted shock models of (8), (12a), and (12b), model (6) turns out to encompass all the weighted shock models in the full-sample case, indicating that neither trade or finance can monopolise the route of foreign currency shock propagation.[33] If we look at the small-sample results, we find less convincing evidence showing (6) being the best model. In fact, we see a mutually encompassing relation between model (6) and models (8) and (12a), whereas such mutual encompassing is effectively wanting between models (6) and (12b).

More interestingly, encompassing results among weighted shock models in the small-sample case reveal that model (12b) encompasses models (8) and (12a) respectively, whilst (8) and (12a) mutually encompass each other. Superiority of (12b) over (12a) suggests that stock market returns convey more accurate information concerning the capital price movement. Success of (12b) over (8), on the other hand, indicates that currency shock propagation via financial linkages has been more important than via trade linkages.

These results highlight how difficult it is to filter out one best performing model of the short-run disequilibrium in exchange rates, especially when the data sample is small. Consequently, we conclude that *LATN* can be more or less equally explained by several different models within this relatively narrow sample window.

4.2. The roles of domestic initial indicators

Let us now compare models (5) and (6) in more detail. As indicated by the above encompassing test results, model (5) is hardly an improvement of model (6). From Tables 10a and 10b we find that in both samples (5) still contains most of currency shocks significant in (6), and that inclusion of domestic indicators produces only a slight improvement in explanation of the net rate of *lats*. It is also noticeable that the domestic variables tend to lag behind the external shock variables in transmitting cross-currency shocks onto *LATN*. Moreover, the two versions of (5) considerably differ in the configuration of these additional regressors, to which we refer as severe absence of *structural invariance* of these domestic variables in explaining *LATN*. As pointed out earlier, the series of four domestic indicators suffer from low degree of orthogonality and their correlation coefficients vary greatly with the sample size. These are reflected in the total absence of dom_1, in the switching signs of the parameter estimates of dom_4 (since its correlation coefficients with dom_2 and dom_3 change signs), as well as in the overall configuration changes of these variables in the two versions. We thus have to be extremely cautious in interpreting the roles of these variables.

The foreign assets exposure indicator, dom_3, is the only domestic variable which appears in both versions of (5). Its parameter estimates meet the expected negative sign, albeit the shift in its lag structure from the full-sample to the small-sample models. It therefore is supportive of the intuitive view that loss in foreign assets is followed by depreciation pressure, while expansion of the banking system across national boundaries is perceived to strengthen the currency. The positive impact of dom_4 in the full-sample model seems to suggest a significant common lender effect. However, this evidence is very flimsy since its parameter estimate switches sign in the small-sample model (due to the small-sample negative correlation between dom_3 and dom_4), a sample period where we observe stronger factual evidence of the common lender problem than in the full sample. Likewise, similar correlation between dom_3 and dom_2 makes it virtually impossible to interpret the 'wrong sign' of the parameter estimate of dom_2 in the small-sample model.

The above analysis confirms our *a priori* conjecture, that it is practically very difficult to find, from available domestic information, adequate substitutive measures of the external currency shocks, especially in view of the persistent and relatively robust presence of the major external shock variables from Estonia and Russia in both versions of models (5) and (6). Hence, we disregard these domestic variables in the subsequent modelling of external currency effects via trade and financial channels.

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[33] Logically, it is desirable to experiment with an enlarged model which include both trade and finance weighted shocks. However, we are unable to do so for two related reasons: high sample

4.3. Cross-sample model comparison

One feature is discernible from Tables 10a and 10b, as well as from the above subsections, namely that the full-sample and small-sample versions of the same model can differ considerably in terms of both the regressor configuration and the parameter signs and sizes. The unweighted model (6) shows the least difference. Such low *structural invariance* highlights the difficulty of identifying a unique mechanism, or a viable structural explanation, of how short-run exchange rate disequilibrium is caused largely by a regular set of short-run external shocks via particular changing shock transmission channels.

On a close look, we see that the trade and finance weighted models (8) and (12a) are similar to model (6) in the small-sample case and that all the weighted shock models share the same configuration in the full-sample case. Moreover, models of the full-sample case contain more lagged variables from developed economies than the corresponding models of the small-sample case, and these variables appear to crowd out certain more current variables from transitional economies. However, we must be cautious in making cross-sample comparison involving the finance weighted models because of possible data measurement errors due to the fact that a number of these weight series contain extrapolated observations in the early part of the full sample.[34] But even if present, the effect of mismeasurement seems to be outdone by low structural invariance of the models, as the two versions of (12a) and (12b) have very different configuration in the small-sample case when data mismeasurement is absent, whereas they share identical configuration in the full-sample case.

At least, three observations are worth making from the relatively low structural invariance. First, the partial shifts in regressor configuration help us to single out which regressors are relatively more structural invariant and thus should form the core part of models of the short-run net rate, whatever data windows we choose for the estimation. As we have noted earlier, the first lag of *LATN* is very robust in the two versions of all models. As for the shock variables, Estonia and Russia, and also Lithuania are quite

correlation between st_{jt} and skI_{jt} or skS_{jt}, as shown in Table 4, and lack of degrees of freedom.

[34] Particularly, the first observation of Estonian financial weights measured by stock market indices may assume too high openness possibly due to inexperienced stock market at the early stages of its operation. Extrapolation of this possibly flawed estimate, which is later corrected by the market (observe the following drop in its series plotted in Graph 4), may mismeasure the ability of shock propagation via financial linkages. One may possibly find similar problems in the series of financial weights in terms of interest rates. Mismeasurement may also be an issue in the series of Lithuanian and Russian financial weights.

persistent. Secondly, degrees of structural invariance of one-country shock variables appear to be associated with the country groups, which we have categorised. For example, country shocks from the developed regions become less prominent than from the transitional economies when we estimate the models using the narrower and more recent data window, i.e. the small sample. However, this might well be a sample specific feature since the Russian crisis plays a dominant role here, in that the crisis has undoubtedly infected transitional economies much more than developed economies.[35] We shall look at the country comparison in more details later. Finally, the combination of the structural invariance and the relatively constant within-sample parameter estimates tells us that it is possible to reach certain structural explanations, albeit non-unique, of the short-run shock transmission of the exchange rate disequilibrium, but that these explanations need frequent update in terms of model specification and data window for estimation.

4.4. Analyses and comparison at country level

Let us now turn to the country-level analysis by assessing the constancy of parameters and dynamic structure of individual country shocks, and comparing their relative contributions to explaining *LATN*. The analysis follows the country groups introduced in section 2.1.

4.4.1. Estonia and Lithuania

Estonian *kroon* is found to be one of the most significant currencies whose fluctuations feed immediately and positively on to *LATN* in all models, except for the small-sample model (12b). Its positive coefficient exhibits high structural invariance, acknowledging importance of Estonian shock transmission via both trade and financial linkages. EST_t also tends to take the lead in terms of partial R^2. In general, we believe

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[35] Gelos and Sahay (2000) find the effect of Russian crisis on transition economies particularly strong, as compared with the effects of the Czech and East Asian crises of 1997. Herding behaviour of investors is identified as an important contributor to this strong effect. For example, Calvo (1996) argues that, since it is costly for international investors to evaluate the economic situation in every country separately, they pull out from a group of similar countries if they discover tensions in just one of them. Effect of risk reassessment and pooling of transitional economies into the same risk class by investors during the Russian financial crisis due to their "similar fundamentals and other common features" is discussed briefly in Krzak (1998). Evidence of growing interdependence between exchange rates of emerging market economies in the aftermath of Asian crisis is presented in Edison and Reinhart (2001). They suggest that this is caused by the widespread attitude among financial market participants, since the crisis, of regarding these economies as similarly vulnerable to international shocks.

that Estonian *kroon* plays an important role of a transmission port of currency shocks from outside of the Baltic region on to the *lats* market, which is perhaps more important than being a possible instigator of currency shocks. This is because Estonia has integrated itself into the world capital markets more deeply than Latvia and Lithuania,[36] and moreover, its financial institutions have established vigorous presence in Latvia. Our belief finds particular support in the increased magnitude of the EST_t parameter estimates in the small-sample case from the comparable full-sample estimates, and also in the small-sample recursive tests of models (6), (8) and (12a) in Graph 5(d, f, and h), which record temporary value shift of Estonian coefficients in the second half of 1998, revealing its supplementary role in propagating the Russian crisis. Note that there is no comparable effect in the Lithuanian recursive tests.

However, the above inference is weakened by the small-sample model (12b), where the impact of monthly returns of Estonian *kroon* has turned from a current and positive one into a one-period lagged and negative one while the partial R^2 is also reduced. We maintain that this model shift embodies mainly the widely held observation that stock markets are less integrated into international capital markets and thus contain more local information. While the negative impact invalidates the earlier economic inference that Estonia plays the role of a transmission port, the lagged effect makes model (12b) more useful for forecasting, especially in view of the constancy of the parameter estimate during the period of the Russian crisis, as shown from the recursive tests in Graph 5(j).

Lithuanian shocks are found to have consistently negative effect on *LATN.* The relatively high partial R^2 associated with the negative parameter estimates seems to verify that Lithuania is indeed an important competitive neighbour of Latvia. But such economic interpretation should be treated with caution because of the low structural invariance of the Lithuanian parameter estimates, as reflected in their variable dynamic impact and their recurrent failure of Hansen instability tests in the small sample.[37]

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[36] Estonia is the most open transition economy of Central and Eastern Europe with least restrictions on capital flows and the highest trade openness for total trade reaching 160 percent of GDP in 1998. It has fully convertible currency and the second highest stock of FDI per capita among CEE countries after Hungary. For description of Estonian openness see e.g. Weber and Taube (1999) and Garibaldi, Mora, Sahay and Zettelmeyer (1999). Estonia's ability to act as a transmission port of international shocks had been enhanced by its vulnerability to fluctuations in international financial markets due to its weak fundamentals, namely booming private credit expansion and dependence on large capital inflows. For a detailed discussion of financial vulnerability of Estonia see e.g. Fries *et al* (1998), and Lättemäe and Pikkani (2001) for discussion of foreign shock propagation via monetary transmission mechanism.

[37] Related empirical evidence of Lithuanian and Estonian shocks causing adjustment in Latvia is found by Gelos and Sahay (2000). From analysis of market pressure indices composed of fluctuations in

4.4.2. Poland and Russia

Significance of the immediate Russian shock variable demonstrates how much *lats* suffered from the massive depreciation of *rouble* during the Russian crisis of the second half of 1998 (see the rather high partial R^2). We see from Graph 5 a distinct value shift in the recursive parameter estimates of the Russian variable, showing an instantaneous destabilising impact on the Latvian currency. The impact is more striking if we compare configurations of the Russian variables in various models between the two sample cases.

The parameter estimates of RUS_t in model (6) are very similar across both samples. Its presence persists in models (8) and (12a) in the small-sample case. Only model (12b) presents a very different dynamic configuration, i.e. a four-lag difference, which seems to reflect correction for overshooting in financial markets after the actual size of the shock becomes evident. It also includes implicitly an early effect of changing capital mobility measured by stock-market based capital prices, portending escalating financial troubles as early as May 1998. Similar to the Estonian case, we see this mainly due to the reason that stock markets usually contain more local information than interbank money markets, especially in less developed economies.

Polish shocks are the least prominent among shocks from transition economies in terms of partial R^2 as well as significance of the parameter estimates[38]. In all cases, fluctuations of *zloty* have immediate negative impact on *LATN*, possibly indicating the effects of competition for funds between a wider group of transition economies. Note that Polish shocks are never significant in trade-weighted models, which seems to correspond to the minor exposure of Latvian exporters to the Polish markets (only 2% of total exports).

4.4.3. Germany, Sweden and the UK

Currency shocks from this group have lower structural invariance and less explanatory power than those of transition economies. Swedish *krona* shocks are generally insignificant except in the small-sample case of model (6). Shocks from German *mark* and British *pound sterling* have more persistent presence, particularly in

exchange rates, interest rates and international reserves, they find that shocks from the other two Baltic economies Granger cause Latvian market pressure index.

the weighted models of the full-sample case, where both currencies are found to have one period lagged impact on *LATN*. This reflects the importance of the two countries both as major Latvian export markets and as representatives of the developed financial markets. Notice that the parameter estimates for GER_{t-1} and UK_{t-1} in the full-sample case of (12a) and (12b) are effectively the same. This reflects that the difference between the money-market based measure and the equity-market based measure of capital prices can be remarkably small in developed economies.

Shocks from the developed economies on the whole appear to be less prominent in the small-sample case than the full-sample case.[39] UK turns out to be the only robust country here, as UK_{t-1} remains a key significant variable of the two sample cases and its parameter estimates in (12b) stay virtually the same. We are inclined to interpret this as reflecting the key role of *pound sterling* as a major currency of the global trade, equity and money markets. Shocks of German *mark* in the small-sample case are significant only in model (6). However, the dynamic structure and parameter signs of the German variables vary between the two sample cases, thus refraining us from attempting economic interpretation.

4.4.4. General findings in group comparison

There are three major conclusions to be drawn from the country-level analysis. First, we find similarity in the sources of currency shocks across trade and financial models. This supports the view held in the financial contagion literature that trade and financial linkages are historically intertwined and hence both channels identify shocks from the same countries.[40] Second, we find that the Russian crisis of August 1998 had a strong and immediate impact on *lats* market, instigating prolonged depreciation pressure in the second half of 1998 via both trade and financial linkages. Third, we find that the most important sources of cross-currency shock propagation are transition economies, with countries from a single economic region (Estonia and Lithuania) playing the major

[38] Although in some cases Polish shocks are not significant at the 5% level, we retain them in the models mainly because they survive the reduction process till the last stage and their exclusion then would lead to functional-form misspecification.

[39] Notice though that none of the financial weights' series of these countries is extrapolated in the full-sample case.

[40] Van Rijckeghem and Weder (2001) on the similarity of trade and financial channels write that "…[the] role of trade finance may contribute to this high correlation, since it is likely that the historical expansion of bank lending started by financing trade and then gradually expanded into other lending as banks became more knowledgeable about a country. This would lead to a pattern of bank lending that follows the trading routes" (p.304).

role. We maintain that there are two mechanisms driving this result. Internally, the extensive scale of structural adjustment makes transition economies particularly vulnerable to external and internal crises. Externally, these economies are frequently perceived as belonging to the same risk category by the international financial communities, thus generating herding behaviour among large investors in either entering or retreating from these economies, see Krzak (1998), and Darvas and Szapary (1999).

5. Conclusions

In this paper we have assessed the short-run dynamic impact of foreign currency shocks on the deviations of Latvian *lats* market spot rate vis-à-vis US *dollar* from the implied parity during the first six years of *lats'* peg to SDR. The deviations, i.e. the net rate of *lats*, have been transitory, confirming the sustainability of the peg during the researched period. We have set the assessment on basis of the standard theoretical model of dynamic cost adjustment, from which empirical models of the autoregressive distributed-lags form are derived. The resulting parsimonious and data congruent models of the net rate of *lats* have attained rather high goodness of fit with R^2 reaching 0.7. This demonstrates the extensive impact of foreign currency shocks on *lats*, as shocks from any domestic sources are disregarded in our models. However, propagation channels and configuration of the foreign currency shocks are found to be neither unique nor very stable. Our findings highlight the need for the Latvian monetary authorities to follow closely the movements of international foreign exchange markets, particularly those of the neighbouring area. If econometric models are used to assist such monitoring, results from a number of different models should be analysed and compared, and these models should be frequently updated.

More specifically, our modelling experiment has taught us the following:

1. The net rate of *lats* exhibits strong first-order autoregressive property, which has been strengthened in the latter part of the sample, most probably as a result of the Russian crisis of 1998. Strengthening autoregression implies increasing costs of adjustment for *lats* with respect to various shocks, particularly for the monetary authority. Financial liberalisation shall reinforce this effect since the relative size of the central bank to market will diminish, making any intervention programmes by the bank harder to achieve the desired targets. As long as Latvian fiscal and monetary policies continue to be sustainable, central parity should still be viable,

though wider fluctuation bands of adjustment might be recommendable (see Nuti (2000) for Polish experience).

2. It is empirically very difficult to find domestic variables, which would act as initial indicators of foreign currency shocks. This is because the effect of external shocks on the net rate of *lats* is largely direct and immediate, and also because domestic indicators may embody internal shocks more than external shocks.
3. The key external currency shocks are from transitional economies, especially from countries of the same economic region as Latvia, i.e. Estonia and Lithuania. Moreover, we find that Estonian *kroon* may act as a transmission port of currency shocks, more than an original source of shocks. Of the other transition economies, the Russian *rouble* crisis of August 1998 is found to have exerted massive devaluation pressure on *lats*. Opposite movements of the net rate of *lats* with respect to currency shocks from the other transitional economies, suggest a certain tendency of competition for funds among the transition economies. Shocks from developed economies are found to be less influential in comparison. Among them, shocks from the UK are most prominent, illustrating the key role of the British *pound sterling* in the international trade and financial markets.
4. Both trade and financial linkages are found to be highly significant in propagating external currency shocks on to the *lats* market, with the financial channel being the most important of the two. Moreover, models with weighted currency shocks imply that the sources of currency shocks via the two channels are rather similar, confirming the view, held in financial contagion literature, that trade and financial linkages are intertwined.
5. Models with either simple cross-currency shocks or trade- or finance-weighted shocks are found to explain the net rate of *lats* more or less equally well. Moreover, configurations of these models may not stay invariant over changing sample size. The lack of a unique model of foreign currency shocks and the relatively low structural invariance highlights the well-known difficulty of empirically modelling short-run exchange rate disequilibrium movement. Since different models display different merits, we suggest that alternative models should be kept and used for different aims, i.e. our simple cross-currency model can be used to monitor policy significance and immediate effect of external shocks, whilst our small-sample

finance-weighted model using the stock-market information can be used for short sample-window forecasting purposes.

Data Appendix

All series from DATASTREAM, unless stated otherwise. Respective codes in brackets.

Spot exchange rates vis-à-vis US$, beginning of month and weekly observations

Latvia: From 1997M6 Latvian *lats* to US$ (WMR), [LATVLA$]. Before that cross rate through Latvian *lats* to UK£ (WMR), [LATVLAT] and UK£ to US$ [USBRITP]. Parity to SDR calculated from SDR to US$ (WMR), [SPEDRAW]. Correlation coefficient of the cross and actual lats/US$ rates for the overlap period are 0.99 and 0.97 for levels and returns, respectively.
Estonia: From 1997M5 Estonian *kroon* to US$ (WMR), [ESTOKR$]. Before that cross rate through Estonian *kroon* to UK£ (WMR), [ESTOKRN]. Correlation coefficient of the cross and actual *kroon*/US$ rates for the overlap period are 0.99 and 0.99 for levels and returns, respectively. In order to identify shocks specific to Estonia, for shock variable we use difference between return on German *mark* and return on Estonian *kroon*.
Germany: German *mark* to US$ (WMR), [DMARKE$].
Lithuania: Spot rate (close, bid) from Reuters from 1995M7. Before that shock variable is assumed to be zero.
Poland: From 1995M1 Polish *zloty* to US$ (WMR), [POLZLO$]. Before that cross rate through Polish *zloty* to UK£ (WMR), [POLZLOT]. Correlation coefficient of the cross and actual *zloty*/US$ rates for the overlap period are 0.99 and 0.99 for levels and returns, respectively.
Russia: From 1996M3 CIS *rouble* (market) to US$ (WMR), [CISRUB$]. Before that OFICIAL RATE: Russian *rouble* to US$, [RSUSDSP]. Correlation coefficient for the overlap period are 0.99 and 0.88 for levels and returns, respectively.
Sweden: Swedish *krona* to US$ (WMR), [SWEKRO$].
UK: UK£ to US$, [USBRITP].
USA: SDR to US$, [SPEDRAW].

1-month interest rates, weekly frequency

Estonia: From 1996M1 interbank 1-month average rate of TALIBID and TALIBOR (interbank market). Source: Eesti Pank.
Germany: German interbank 1-month offered rate, [FIBOR1M].
Lithuania: From 1999M1 average of 1-month VILIBID and VILIBOR (interbank market). Source: Bank of Lithuania. Before that weighted averages of money market rates for maturities up to 1 month, from 1995M3 to 1996M7 series code 60a, from 1998M8 to 1999M1 series code 60b. Source: IMF International Financial Statistics.
Poland: Poland interbank 1-month middle rate, [POIBK1M].
Russia: From 1994M9 Russia interbank 30-day middle rate, [RSIBK30].
Sweden: Sweden interbank 1-month middle rate, [SIBOR1M].
UK: UK interbank 1-month (LDN:BBA) offered rate, [BBGBP1M].
US: US commercial paper discount 30 day middle rate, [USCP30D].

Stock market indices, weekly frequency

Estonia: From 1996M6 TALSE, price index [ESTALSE(PI)].
Germany: DAX 200 AVERAGE, price index, [DAX200A(PI)].
Lithuania: From 1996M1 LITIN G, price index, [LNLITNG(PI)].
Poland: Warsaw General Index WIG, price index, [POLWIGI(PI)].
Russia: From 1994M9 Moscow Times (RUR), price index, [RSMTIND(PI)].

Sweden: Stockholm Fondbors General, price index, [SWEGENL(PI)].
UK: FTSE 250 VALUE, price index, [FT250VA(PI)].
US: S&P 500 COMPOSITE, price index, [S&PCOMP(PI)].

Latvian export volume and domestic initial indicators

Trade data: monthly Latvian export turnover in LVL. Source: Central Statistical Bureau of Latvia.

Monetary data: Net foreign assets of Bank of Latvia, reserve money, domestic money demand, asset and liability structure of Latvian commercial banks – all in LVL at the end of month. Source: Bank of Latvia.

References

Baig, T. and Goldfajn, I. (1999) "Financial Market Contagion in the Asian Crisis", IMF Staff Papers, Vol.46, No.2, International Monetary Fund.

Calvo, G. (1996) "Capital inflows and Macroeconomic Management: Tequila Lessons", International Journal of Finance and Economics, vol. 1(July), pp.207-23.

Carramaza, F., Ricci, L. and Salgado, R. (2000) "Trade and Financial Contagion in Currency Crises", IMF Working Paper, WP/00/55, International Monetary Fund.

Darvas, Z. and Szapary, G. (1999) "Financial Contagion Under Different Exchange Rate Regimes", National Bank of Hungary Working Paper, 1999/10.

Edison, H. and Reinhart, C.M. (2001) "Stopping hot money", Journal of Development Economics, vol. 66, pp.533-553.

Eichengreen, B., Rose, A., and Wyplosz, C. (1996) "Contagious currency crises", NBER Working Paper 5681.

Feldstein, M. and Horioka, C. (1980) "Domestic savings and International Capital Flows", Economic Journal, vol. 90 (2), pp.314-29.

Forbes, K. and Rigobon, R. (1999) "Measuring Contagion: Conceptual and Empirical issues", mimeo, MIT.

Forbes, K. (2001) "Are Trade Linkages Important Determinants of Country Vulnerability to Crises?", forthcoming in S.Edwards and J.Frankel, eds., *Preventing Currency Crises in Emerging Markets*, University of Chicago Press. Available at http://web.mit.edu/kjforbes/www/Papers/TradeTransmission.pdf

Frankel, J.A. (1991) "Quantifying International capital Mobility in the 1980's", in Bernheim, B.D. and Shoven J.B. eds. *National Saving and Economic Performance*, Chicago: the University of Chicago Press, pp. 227-70.

Frankel, J.A. and MacArthur, A.T. (1988) "Political vs Currency Premia in International Real Interest Differentials, A Study of Forward Rates for 24 Countries", European Economic Review, vol. 82 (2), pp.1083-118.

Frankel, J.A. and Rose, A.K. (1995) "Empirical Research on Nominal Exchange Rates", in G.Grossman and K.Rogoff eds. *Handbook of International Economics vol.III*, Elsevier Science B.V., pp.1689-1729.

Fratzscher, M. (1998) "Why are Currency Crises Contagious? A Comparison of the Latin American Crisis of 1994-95 and the Asian Crisis of 1997-98", Westwirtschaftliches Archiv-Review of World Economics, 134, 664-91.

Fries, S., Raiser, M. and Stern, N. (1998) "Macroeconomic and Financial Stability: Transition and East Asian 'Contagion'", EBRD Working Paper, No28.

Garber, P.M. and Svensson, L.E.O. (1995) "The Operation and Collapse of Fixed Exchange Rate Regimes", in G.Grossman and K.Rogoff eds. *Handbook of International Economics vol.III*, Elsevier Science B.V., pp.1865-1911.

Garibaldi, P., Mora, N., Sahay, R. and Zettelmeyer, J. (1999) "What Moves Capital to Transition Economies", unpublished, International Monetary Fund.

Gelos, G. and Sahay, R. (2000) "Financial Market Spillovers in Transition Economies", IMF Working Paper, WP/00/71, International Monetary Fund.

Glick, R. and Rose, A. (1999) "Contagion and trade: why are currency crises regional", Journal of International Money and Finance, vol. 18 (4), 603-617.

Hendry, D.F. and Doornik, J.A. (1996) *Empirical Econometric Modelling Using PcGive for Windows*. London: International Thomson Business Press.

Hendry, D.F. (1995) *Dynamic Econometrics*. Oxford University Press.

Lättemäe, R. and Pikkani, R. (2001) "The Monetary Transmission Mechanism in Estonia", Baltic Economic Trends, 2001:2, pp.7-15.

Kaminsky, G. and Reinhart, C. (2000) "On Crisis, Contagion, and Confusion", Journal of International Economics, vol. 51 (1), pp.145-168.

Kazaks, M. (2001) "Real Exchange Rate Appreciation and Loss of Competitiveness. Case of Latvia", mimeo, Queen Mary, University of London.

Komulainen, T. (1999) "Currency Crisis Theories – Some Explanations for the Russian Case", BOFIT Discussion Papers*, no 1,* Institute for Economies in Transition, Bank of Finland

Krzak, M. (1998) "Contagion Effects of the Russian Financial Crisis on Central and Eastern Europe: The Case of Poland", in Oesterreichische Nationalbank: "*Focus on Transition 2/1998*", Vienna.

Lemmen, J. (1998) *Integrating Financial Markets in the European Union*, Edward Elgar.

Nickell, S. J. (1985) "Error correction, partial adjustment and all that: An expository note", Oxford Bulletin of Economics and Statistics, vol. 47, pp. 119-30.

Nuti, M. (2000) "The Polish Zloty, 1990-1999: Success and Under performance", AEA Papers and Proceedings, May 2000, pp.53-58.

Obstfeld, M. (1986) "Capital Mobility in the World economy, Theory and Measurement", in: K.Brunner and A.Metzler (eds.), *The National Bureau Method, International Capital Mobility and Other Essays*, Carnegie-Rochester Conference Series on Public Policy, vol. 24, pp.55-104.

Pagan, A. R. (1985) "Time series behaviour and dynamic specification", Oxford Bulletin of Economics and Statistics, vol. 47, pp. 199-211.

Pagan, A. R. (1996) "The econometrics of financial markets", Journal of Empirical Finance, vol.3 (1996), pp.15-102.

Qin, D. (2000) "How much does trade and financial contagion contribute to currency crises? The case of Korea", QMW Economics Department Discussion Paper Series, No 410, 2000;

Qin, D. and Gilbert, C. (2001) "The error term in the history of time series econometrics", Econometric Theory, vol. 17, pp. 424-50.

Qin, D. and Lu, M-Z (1998) "Dynamic Structure of Disequilibrium Models", Economics of Planning, vol. 31, pp.15-27.

Styan, G. P. H. (1973) "Hadamard products and multivariate statistical analysis", Linear Algebra Application, vol. 6, pp. 217-40.

Van Rijckeghem, C. and Weder, B. (2001) "Sources of Contagion: is it Finance or Trade?", Journal of International Economics, 54 (2001), pp.293-308.

Visick, G. (2000) "A quantitative version of the observation that the Hadamard product is a principal submatrix of the Kronecker product", Linear Algebra and its Applications, vol. 304, pp. 45-68.

Weber, R. and Taube, G. (1999) "On the Fast Track to EU Accession: Macroeconomic Effects and Policy Challenges for Estonia", IMF Working Paper, WP/99/156, International Monetary Fund.

Table 1. Unit roots tests for LATN
(by Dickey-Fuller (DF) & Augmented Dickey-Fuller (ADF) tests)

Sample periods	ADF (5) critical values 5% = -1.9 / 1% = -2.6	ADF (1) critical values 5% = -1.9 / 1% = -2.6	DF Critical values 5% = -1.9 / 1% = -2.6
Full sample *(1994M4-2000M5)*	-2.82**	-3.90**	-5.85**
Small sample *(1996M9-2000M5)*	-2.99**	-2.85**	-3.13**

*Notes: The null hypothesis is the presence of a unit root; ** stands for rejection of the null at 1% significance level.*

Table 2. Unit roots tests for currency shocks
(by Dickey-Fuller (DF) & Augmented Dickey-Fuller (ADF) tests)

	ADF (5) critical values 5% = -1.9 / 1% = -2.6	ADF (1) critical values 5% = -1.9 / 1% = -2.6	DF critical values 5% = -1.9 / 1% = -2.6
	Full sample (1994M4-2000M5) / Small sample (1996M9-2000M5)		
Unweighted, Δr			
EST	-4.18**/-6.39**	-12.26**/-5.65**	-16.58**/-14.05**
GER	-2.87**/-2.34*	-5.90**/-3.88**	-8.57**/-6.32**
LIT	-5.45**/-4.08**	-11.07**/-8.52**	-12.99**/-9.96**
POL	-2.17*/-1.82	-5.75**/-4.54**	-7.93**/-6.14**
RUS	-2.55*/-1.80	-4.27**/-3.54**	-5.02**/-4.20**
SWE	-2.82**/-2.63**	-6.43**/-4.44**	-9.67**/-6.31**
UK	-2.69**/-1.73*	-7.47**/-5.96**	-9.18**/-6.73**
Trade weighted, st			
EST	-4.20**/-5.86**	-11.91**/-5.37**	-16.11**/-13.24**
GER	-3.05**/-2.42*	-5.73**/-3.75**	-8.40**/-6.23**
LIT	-5.39**/-4.00**	-11.19**/-8.57**	-12.92**/-9.89**
POL	-2.74**/-2.23*	-6.47**/-5.25**	-8.77**/-6.43**
RUS	-3.26**/-1.83	-3.44**/-3.81**	-4.29**/-4.98**
SWE	-2.67**/-2.39**	-6.32**/-4.65**	-9.45**/-6.86**
UK	-2.07*/-0.91	-6.98**/-5.43**	-9.10**/-6.69**
Finance weighted (interest rates), skI			
EST	-4.16**/-6.41**	-12.31**-5.54**/	-16.84**/-14.01**
GER	-2.87**/-2.34*	-5.89**/-3.88**	-8.62**/-6.34**
LIT	-5.45**/-4.06**	-11.07**/-8.51**	-13.00**/-9.97**
POL	-2.10*/-1.78	-5.58**/-4.39**	-7.80**/-6.03**
RUS	-2.43*/-1.53	-3.84**/-3.68**	-4.87**/-4.87**
SWE	-2.83**/-2.62*	-6.43**/-4.47**	-9.26**/-6.35**
UK	-2.65**/-1.74	-7.40**/-5.92**	-9.70**/-6.73**
Finance weighted (stock market returns), skS			
EST	-4.08**/-7.46**	-12.58**/-5.20**	-16.78**/-13.64**
GER	-2.83**/-2.37**	-6.00**/-3.91**	-8.68**/-6.41**
LIT	-4.68**/-3.94**	-10.92**/-8.40**	-12.86**/-9.87**
POL	-2.10**/-1.80**	-5.51**/-4.26**	-7.66**/-5.82**
RUS	-3.19**/-1.54	-3.46**/-3.45**	-3.98**/-4.08**
SWE	-2.89**/-2.85**	-6.23**/-4.25**	-8.92**/-6.06**
UK	-2.77**/-1.80	-7.60**/-6.07**	-9.77**/-6.77**
Initial domestic indicators, dom_z			
dom_1	-1.31/-0.93	-1.78/-1.40	-2.19*/-2.06*
dom_2	-1.09/0.70	-1.12/0.40	-0.97/0.05
dom_3	-1.26/-0.25	-1.92/-0.35	-1.72/-0.38
dom_4	-3.23**/-2.86**	-4.85**/2.99**	-4.85**/-2.46*

*Notes: The null hypothesis is the presence of a unit root; * and ** stand for rejection of the null at 5% and 1% significance levels, respectively. Although unit root hypothesis is not rejected in this specification for dom_1, dom_2 and dom_3, more detailed analysis finds that dom_1, dom_2, dom_3 are stationary/ trend stationary when adjusted for regime shifts due to different transition periods. Complete unit root tests are available from the authors upon request.*

Table 3. Correlation coefficients between different types of weights

Full sample (1994M4-2000M5) / Small sample (1996M9-2000M5)

	wkI	wkS		wkS
wtEST	-0.48 / -0.19	-0.49 / 0.14	wkI-EST	0.51 / 0.19
wtGER	-0.19 / -0.19	-0.50 / -0.32	wkI-GER	0.37 / 0.50
wtLIT	0.64 / 0.05	0.12 / 0.13	wkI-LIT	0.24 / 0.13
wtPOL	-0.13 / -0.58	-0.01 / -0.20	wkI-POL	0.17 / 0.45
wtRUS	0.04 / 0.37	0.40 / 0.45	wkI-RUS	0.52 / 0.74
wtSWE	-0.06 / -0.12	-0.33 / -0.51	wkI-SWE	0.03 / -0.14
wtUK	-0.11 / 0.08	-0.54 / -0.37	wkI-UK	-0.02 / -0.16

Table 4. Correlation coefficients of currency shock variables

Full sample (1994M4-2000M5) / Small sample (1996M9-2000M5)

	st	skI	skS
rtEST	0.99 / 0.99	0.99 / 0.99	0.99 / 0.98
rtGER	0.98 / 0.99	0.99 / 0.99	0.99 / 0.99
rtLIT	0.99 / 0.99	0.99 / 0.99	0.97 / 0.97
rtPOL	0.86 / 0.95	0.98 / 0.99	0.99 / 0.99
rtRUS	0.80 / 0.97	0.89 / 0.92	0.77 / 0.94
rtSWE	0.98 / 0.98	0.99 / 0.99	0.99 / 0.99
rtUK	0.96 / 0.98	0.99 / 0.99	0.99 / 0.99

	skI	skS		skS
stEST	0.97 / 0.98	0.98 / 0.99	skI-EST	0.99 / 0.98
stGER	0.97 / 0.98	0.98 / 0.99	skI-GER	0.99 / 0.99
stLIT	0.97 / 0.97	0.99 / 0.99	skI-LIT	0.97 / 0.97
stPOL	0.86 / 0.93	0.85 / 0.94	skI-POL	0.99 / 0.99
stRUS	0.96 / 0.92	0.91 / 0.94	skI-RUS	0.91 / 0.97
StSWE	0.97 / 0.97	0.98 / 0.98	skI-SWE	0.99 / 0.99
StUK	0.95 / 0.98	0.96 / 0.98	skI-UK	0.99 / 0.99

Table 5 Correation coefficents of currency shocks (Δr) and domestic indicators (dom_z)

Full sample (1994M4-2000M5) / Small sample (1996M9-2000M5)

	rtEST	rtGER	rtLIT	rtPOL	rtRUS	rtSWE	rtUK	dom$_1$	dom$_2$	dom$_3$	dom$_4$
rtEST	1.00 1.00										
rtGER	-0.09 -0.11	1.00 1.00									
rtLIT	-0.001 0.13	0.19 0.19	1.00 1.00								
rtPOL	-0.04 -0.09	0.60 0.54	0.06 0.02	1.00 1.00							
rtRUS	0.09 0.03	-0.27 -0.28	-0.01 -0.02	0.18 0.24	1.00 1.00						
rtSWE	-0.10 -0.08	0.69 0.72	0.18 0.18	0.42 0.43	-0.11 -0.10	1.00 1.00					
rtUK	-0.04 -0.22	0.57 0.48	-0.02 -0.07	0.26 0.12	-0.26 -0.24	0.46 0.37	1.00 1.00				
dom$_1$	-0.04 -0.16	0.20 0.02	0.07 0.09	0.12 0.08	0.02 -0.15	0.19 -0.06	0.08 0.15	1.00 1.00			
dom$_2$	-0.03 -0.05	0.23 0.05	0.05 0.10	0.11 0.10	-0.02 -0.05	0.26 0.10	-0.005 -0.19	0.86 0.55	1.00 1.00		
dom$_3$	-0.007 0.02	0.22 -0.03	0.04 0.05	0.10 0.03	-0.16 -0.22	0.18 0.001	0.06 -0.02	0.66 0.001	0.84 0.29	1.00 1.00	
dom$_4$	-0.04 -0.01	0.24 -0.08	0.01 -0.02	0.05 -0.13	-0.05 0.10	0.20 -0.09	0.15 0.27	0.73 0.09	0.79 -0.54	0.81 -0.38	1.00 1.00

Table 6. Correation coefficents of trade weighted currency shocks (st)

Full sample (1994M4-2000M5) / Small sample (1996M9-2000M5)

	stEST	stGER	stLIT	stPOL	stRUS	stSWE	stUK
stEST	1.00 1.00						
stGER	-0.06 -0.13	1.00 1.00					
stLIT	-0.01 0.10	0.19 0.19	1.00 1.00				
stPOL	0.02 -0.06	0.51 0.48	0.06 0.03	1.00 1.00			
stRUS	0.17 0.05	-0.27 -0.23	-0.01 -0.03	0.09 0.36	1.00 1.00		
stSWE	-0.04 -0.05	0.65 0.68	0.17 0.18	0.32 0.32	-0.17 -0.08	1.00 1.00	
stUK	-0.04 -0.21	0.53 0.50	-0.05 -0.08	0.17 0.09	-0.27 -0.26	0.42 0.37	1.00 1.00

Table 7. Correation coefficents of financial linkages weighted currency shocks (skI)

Full sample (1994M4-2000M5) / Small sample (1996M9-2000M5)

	skIEST	skIGER	skILIT	skIPOL	skIRUS	skISWE	skIUK
skIEST	1.00 1.00						
skIGER	-0.10 -0.13	1.00 1.00					
skILIT	-0.001 0.13	0.18 0.18	1.00 1.00				
skIPOL	-0.05 -0.10	0.61 0.55	0.06 0.02	1.00 1.00			
skIRUS	0.13 0.02	-0.24 -0.14	0.03 0.03	0.19 0.36	1.00 1.00		
skISWE	-0.10 -0.11	0.70 0.73	0.18 0.18	0.43 0.43	-0.12 -0.07	1.00 1.00	
skIUK	-0.03 -0.23	0.58 0.48	-0.02 -0.07	0.27 0.13	-0.27 -0.22	0.46 0.37	1.00 1.00

Table 8. Correation coefficents of financial linkages weighted currency shocks (skS)

Full sample (1994M4-2000M5) / Small sample (1996M9-2000M5)

	skSEST	skSGER	skSLIT	skSPOL	skSRUS	skSSWE	skSUK
skSEST	1.00 1.00						
skSGER	-0.10 -0.15	1.00 1.00					
skSLIT	-0.02 0.03	0.17 0.17	1.00 1.00				
skSPOL	-0.02 -0.09	0.59 0.53	0.03 -0.008	1.00 1.00			
skSRUS	0.19 0.009	-0.24 -0.16	0.04 0.07	0.09 0.32	1.00 1.00		
skSSWE	-0.10 -0.12	0.70 0.74	0.18 0.19	0.41 0.41	-0.15 -0.09	1.00 1.00	
skSUK	-0.02 -0.22	0.58 0.48	-0.03 -0.08	0.27 0.13	-0.27 -0.23	0.46 0.37	1.00 1.00

Table 9. Granger non-causality tests of LATN to shock variables, p-values for tests of 4 and 2 lags.

Full sample (1994M4-2000M5) / Small sample (1996M9-2000M5)

Shock variable	*EST*	*GER*	*LIT*	*POL*	*RUS*	*SWE*	*UK*
Unweighted, Δr							
4 lags F[4,60]/[4,32]	0.52/0.12	0.26/0.051	0.99/0.97	0.83/0.56	0.57/0.73	0.96/0.97	0.42/0.21
2 lags F[2,66]/[2,38]	0.67/0.021*	0.25/0.022*	0.82/0.64	0.42/0.26	0.84/0.95	0.80/0.66	0.40/0.10
Trade weighted, st							
4 lags F[4,60]/[4,32]	0.64/0.11	0.64/0.054	0.98/0.97	0.72/0.37	0.27/0.70	0.95/0.98	0.13/0.10
2 lags F[2,66]/[2,38]	0.59/0.026*	0.19/0.030*	0.90/0.75	0.49/0.16	0.29/0.95	0.86/0.79	0.16/0.059
Finance weighted, skI							
4 lags F[4,60]/[4,32]	0.49/0.11	0.27/0.050	0.99/0.97	0.84/0.56	0.64/0.74	0.96/0.97	0.40/0.21
2 lags F[2,66]/[2,38]	0.63/0.020*	0.25/0.023*	0.82/0.64	0.44/0.26	0.60/0.63	0.79/0.66	0.39/0.10
Finance weighted, skS							
4 lags F[4,60]/[4,32]	0.43/0.07	0.31/0.06	0.99/0.99	0.91/0.61	0.24/0.70	0.94/0.96	0.46/0.20
2 lags F[2,66]/[2,38]	0.56/0.051	0.30/0.028*	0.98/0.84	0.53/0.28	0.30/0.59	0.75/0.62	0.42/0.10
Domestic indicators	dom_1	dom_2	dom_3	dom_4			
4 lags F[4,60]/[4,32]	0.10/0.56	0.26/0.048*	0.70/0.06	0.94/0.39			
2 lags F[2,66]/[2,38]	0.039*/0.13	0.08/0.004**	0.55/0.07	0.73/0.23			

*Notes: Null hypothesis is that LATN does not Granger cause the respective shock variable. Null hypothesis is rejected at 5% level of significance when p-value is less than 0.05. * and ** stand for rejection of the null at 5% and 1% significance levels, respectively. In the square brackets degrees of freedom for F-test.*

Table 10a. Full sample regression results

Model / Variable	Full sample: 1994M4 – 2000M5 (5)	(6)	(8)	(12a)	(12b)
CONST	*-0.004* (0.004)/(0.10)	…	…	…	…
$LATN_{t-1}$	*0.290* (0.102)/(0.11)	*0.443* (0.094)/(0.25)	*0.481** (0.096)/(0.27)	*0.475** (0.095)/(0.27)	*0.473** (0.096)/(0.26)
EST_t	*0.212* (0.041)/(0.29)	*0.220* (0.042)/(0.29)	*7.710* (1.443)/(0.30)	*0.263* (0.048)/(0.31)	*0.294* (0.057)/(0.29)
EST_{t-1}	…	…	…	…	…
GER_t	…	…	…	…	…
GER_{t-1}	…	…	*-0.294* (0.113)/(0.09)	*-0.054* (0.019)/(0.10)	*-0.057* (0.021)/(0.09)
LIT_Q_t	…	*-5.169* (1.653)/(0.13)	…	…	…
LIT_{t-1}	…	…	…	…	…
$SLIT_{t-1}$	*-3.473* (1.378)/(0.09)	…	…	…	…
POL_t	…	*-0.027* (0.015)/(0.04)	…	…	…
RUS_t	*0.012* (0.003)/(0.13)	*0.011* (0.003)/(0.12)	…	…	…
$D4RUS_t$	…	…	…	…	…
$DRUS_{t-1}$	…	…	…	…	…
SWE_{t-1}	…	…	…	…	…
UK_{t-1}	…	…	*0.474* (0.183)/(0.09)	*0.071* (0.026)/(0.10)	*0.082* (0.028)/(0.11)
$dom2_{t-2}$	…	…	…	…	…
$dom3_{t-1}$	…	…	…	…	…
$dom3_{t-3}$	*-0.008* (0.002)/(0.13)	…	…	…	…
$Ddom4_{t-1}$	…	…	…	…	…
$dom4_{t-3}$	*0.004* (0.001)/(0.10)	…	…	…	…
R^2	0.55	0.51	0.45	0.47	0.45
s.e.	0.00290011	0.00300678	0.0031605	0.00312071	0.00317008
Number of observations	69	69	69	69	69
Diagnostic tests:					
AR	(0.58)	(0.29)	(0.97)	(0.91)	(0.89)
ARCH	(0.74)	(0.52)	(0.57)	(0.88)	(0.87)
Normality	(0.23)	(0.30)	(0.92)	(0.82)	(0.72)
Xi^2	(0.57)	(0.19)	(0.56)	(0.29)	(0.16)
Xi*Xj	(0.66)	(0.24)	(0.71)	(0.33)	(0.53)
RESET	(0.58)	(0.08)	(0.33)	(0.14)	(0.19)

Table 10b. Small sample regression results

Model / Variable	Small sample: 1996M9 – 2000M5 (5)	(6)	(8)	(12a)	(12b)
CONST	…	…	…	…	…
$LATN_{t-1}$	*0.664** (0.078)/(0.65)	*0.524* (0.092)/(0.45)	*0.622* (0.097)/(0.49)	*0.558* (0.099)/(0.44)	*0.742* (0.094)/(0.60)
EST_t	*0.428* (0.107)/(0.29)	*0.545* (0.117)/(0.36)	*13.368* (3.374)/(0.27)	*0.547* (0.14)/(0.26)	…
EST_{t-1}	…	…	…	…	*-0.598* (0.196)/(0.18)
GER_t	…	*0.045* (0.020)/(0.11)	…	…	…
GER_{t-1}	…	…	…	…	…
LIT_Q_t	…	*-5.790** (1.486)/(0.28)	*-55.835* (21.56)/(0.14)	*-5.003** (1.601)/(0.19)	…
LIT_{t-1}	*-3.564** (1.211)/(0.18)	…	…	…	…
$SLIT_{t-1}$	…	…	…	…	*-5.061* (1.912)/(0.14)
POL_t	…	*-0.058* (0.020)/(0.17)	…	*-0.030* (0.018)/(0.06)	…
RUS_t	*0.013* (0.003)/(0.28)	*0.018* (0.004)/(0.33)	*0.111* (0.041)/(0.14)	*0.034* (0.011)/(0.19)	…
$D4RUS_t$	…	…	…	…	*0.091* (0.021)/(0.31)
$DRUS_{t-1}$	*-0.007* (0.003)/(0.14)	…	…	…	…
SWE_{t-1}	…	*-0.034* (0.016)/(0.10)	…	…	…
UK_{t-1}	…	…	…	…	*0.093* (0.023)/(0.27)
$dom2_{t-2}$	*0.021* (0.006)/(0.23)	…	…	…	…
$dom3_{t-1}$	*-0.006* (0.001)/(0.20)	…	…	…	…
$dom3_{t-3}$	…	…	…	…	…
$Ddom4_{t-1}$	*-0.041* (0.010)/(0.30)	…	…	…	…
$dom4_{t-3}$	…	…	…	…	…
R^2	0.78	0.72	0.63	0.65	0.69
s.e.	0.00224051	0.00249857	0.00278829	0.00272513	0.0025741
Number of observations	45	45	45	45	45
Diagnostic tests:					
AR	(0.38)	(0.13)	(0.77)	(0.76)	(0.86)
ARCH	(0.64)	(0.21)	(0.77)	(0.94)	(0.37)
Normality	(0.19)	(0.89)	(0.75)	(0.93)	(0.07)
Xi^2	(0.90)	(0.92)	(0.45)	(0.82)	(0.18)
Xi*Xj	n/a	(0.92)	(0.59)	(0.12)	(0.21)
RESET	(0.72)	(0.64)	(0.72)	(0.13)	(0.55)

Notes: In the brackets next to the estimated parameter value its standard error and partial R^2, respectively. "D" denotes one-lag difference, "D4" denotes four-lag difference, "S" denotes a sum of two *consequtive lags, and "Q" denotes a sum of three consequtive lags or quarterly return. Null hypotheses for diagnostic tests are: 1) no autoregression (AR), 2) no ARCH effects, 3) normality of residuals, 4) no residual heteroskedasticity, 5)/ 6) no functional form misspecification (linear / non-linear) with their F-test p-values in the brackets (λ^2 for residual normality test). Null hypothesis is rejected at 5% level when p-value<0.05. * stands for rejection of no parameter instability hypothesis (Hansen instability test) at 5% level. All parameters are significant at 5% or 1% level of significance except for POL in full-sample case of model (6) with p-value 0.074, and small-sample case of model (12a) with p-value 0.11.*

Table 11. Encompassing tests among models (5) and (6)

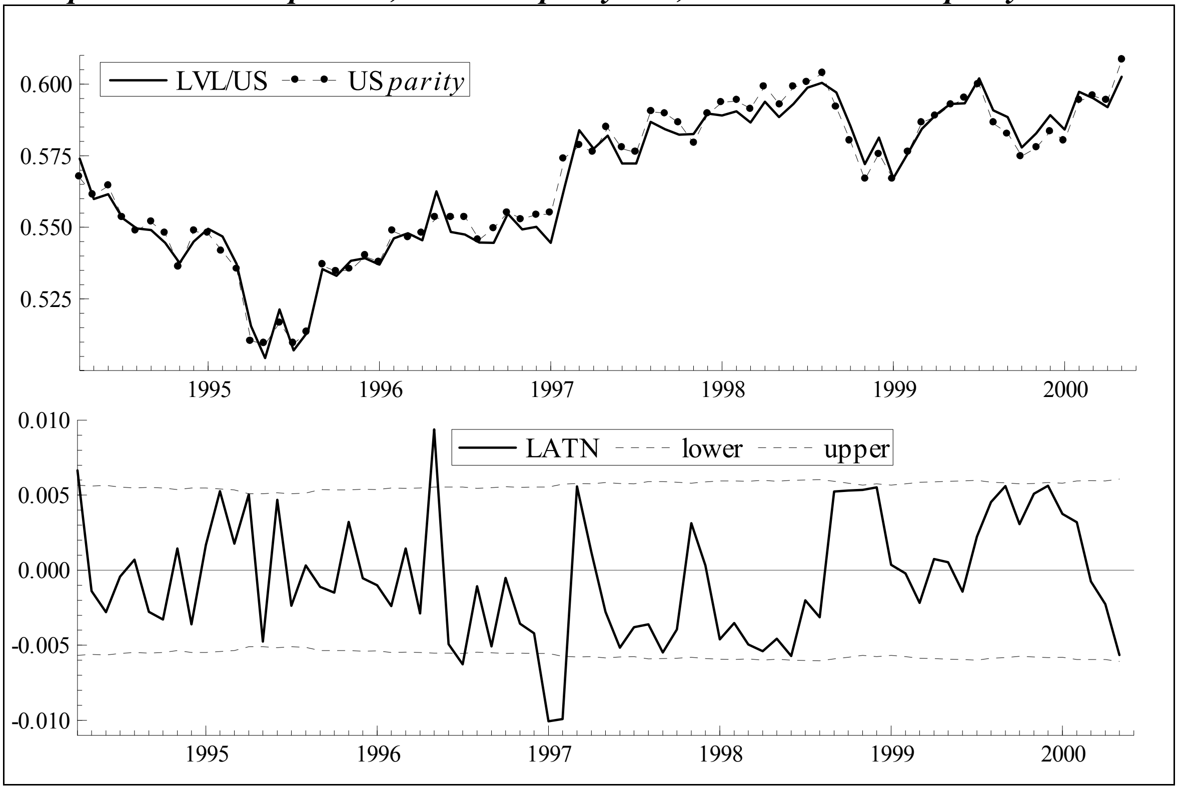
	(5) vs (6)	*(6) vs (5)*
Full sample	[0.039]*	[0.017]*
Small sample	[0.158]	[0.009]**

	(6) vs (8) / (8) vs (6)	*(6) vs (12a) / (12a) vs (6)*	*(6) vs (12b)/ (12b) vs (6)*
Full sample	[0.330] / [0.032]*	[0.0718] / [0.013]*	[0.117] / [0.009]**
Small sample	[0.910] / [0.070]	[0.421] / [0.060]	[0.052] / [0.034]*

	(8) vs (12a)/ (12a) vs (8)	*(8) vs (12b)/ (12b) vs (8)*	*(12a) vs (12b) / (12b) vs (12a)*
Full sample	[0.568] / [0.932]	[0.909] / [0.829]	[0.203] / [0.087]
Small sample	[0.544] / [0.940]	[0.020]* / [0.204]	[0.016]* / [0.092]

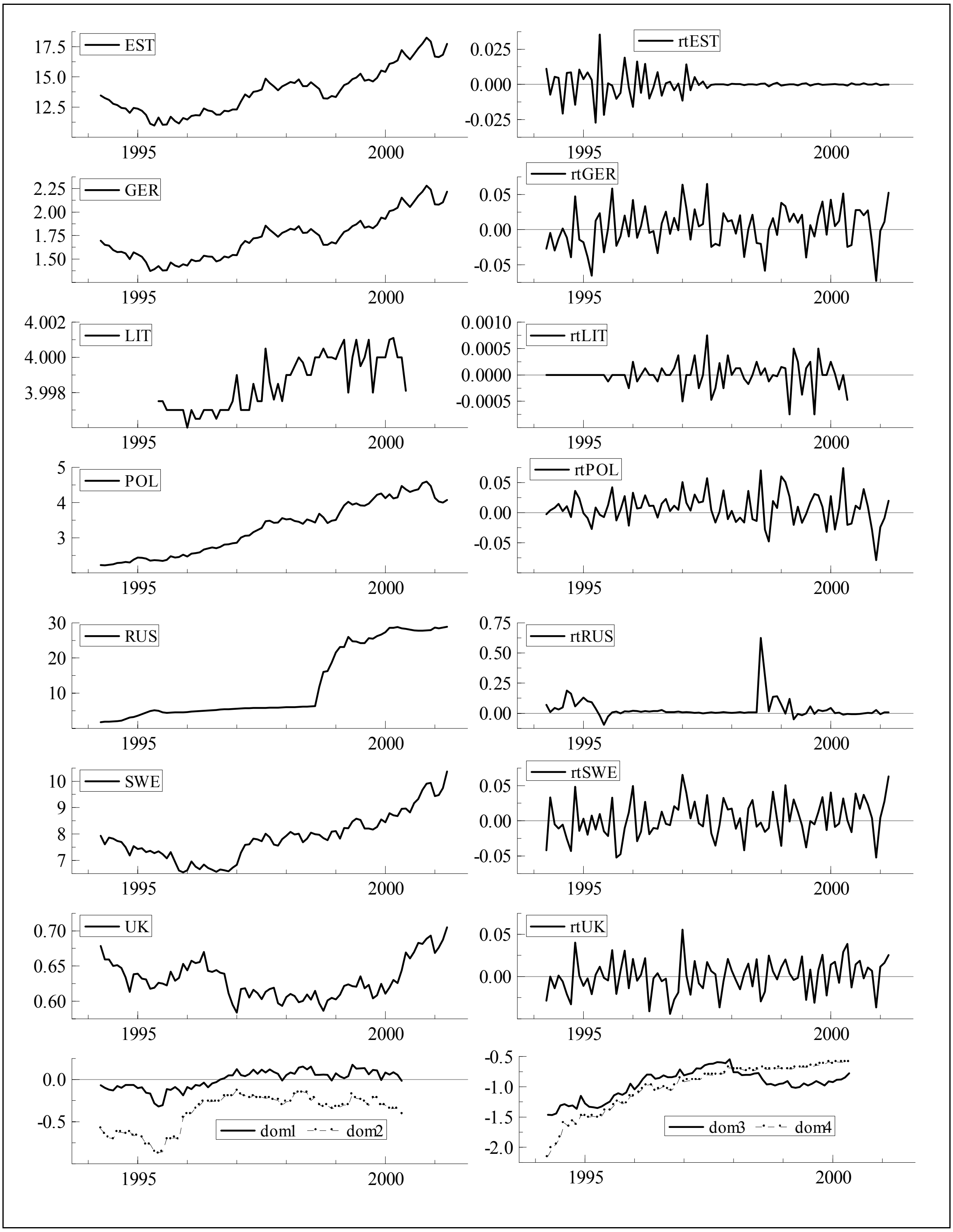
*Note: The null hypothesis that model (5) is encompassing model (6) is on the left; the null hypothesis that model (6) is encompassing model (5) is on the right. p-values in the brackets. Same for other tests. * and ** stand for rejection of the null at 5% and 1% significance levels, respectively.*

Graph 1. LVL/US$ spot rate, LVL/US$ parity rate, and LATN with its parity bands



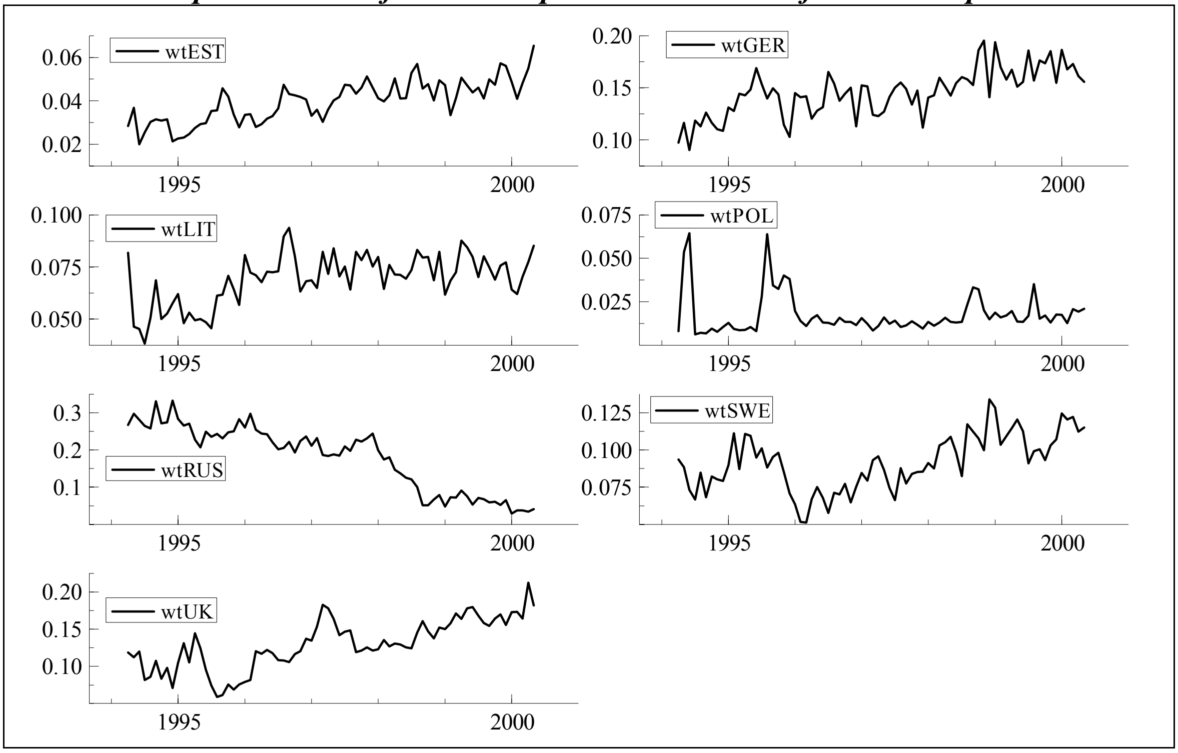
Source: Datastream and authors' calculations.
Notes: Parity rate is calculated via LVL parity to SDR, namely US$ parity = 0.7997[SDR/US$]. Parity bands are ±1% aroud the central parity.

Graph 2. Countries' exchange rates vis-à-vis US$ and their returns, domestic initial indicators



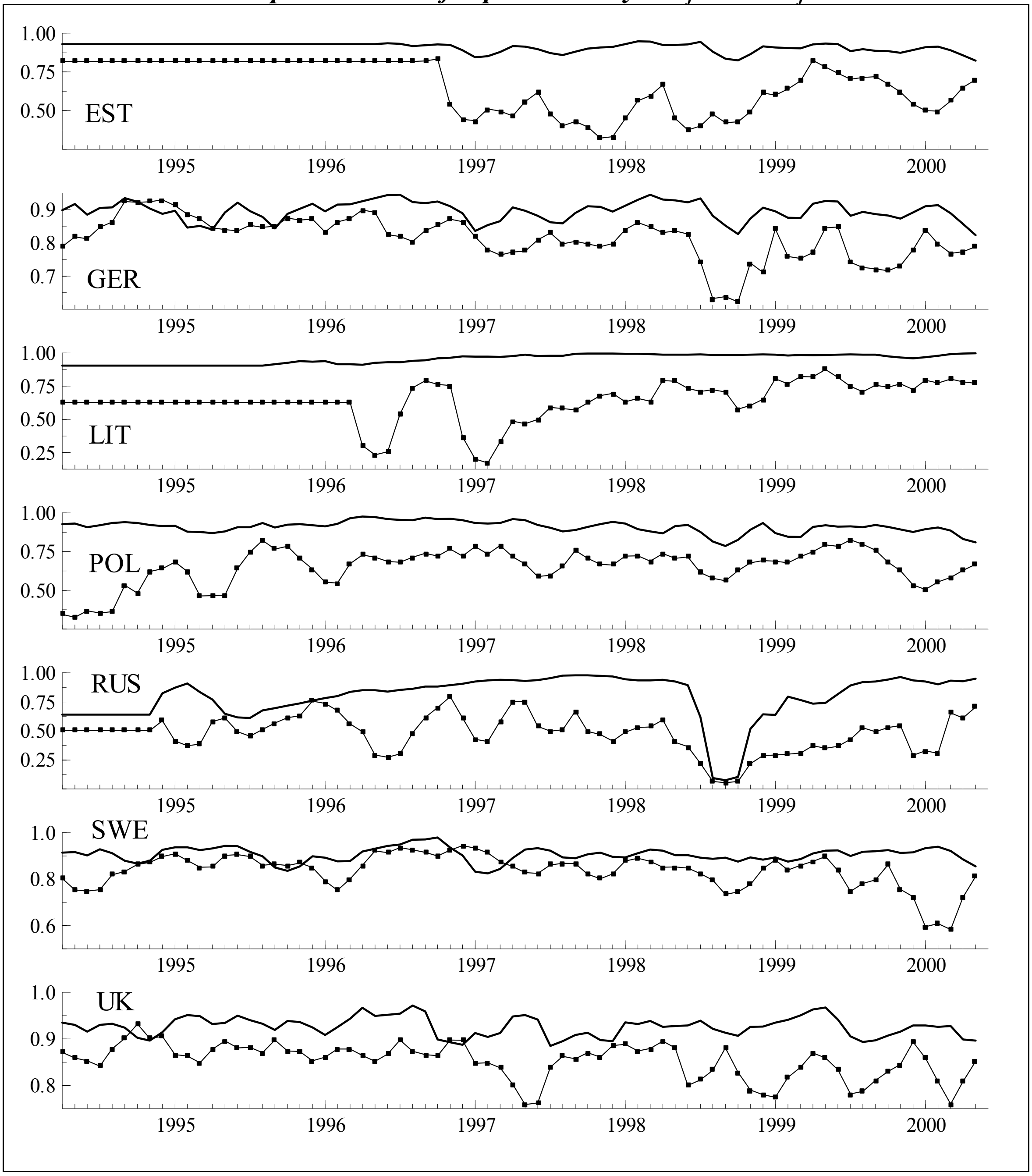
Source: Datastream, Reuters and authors' calculations.
Note: exchange rates are in levels; returns of exchange rates are the first difference of natural logarithms of exchange rate levels; domestic initial indicators are natural logarithms of their ratios.

Graph 3. Shares of Latvian export markets as % of the total exports



Source: Central Statistical Bureau of Latvia.

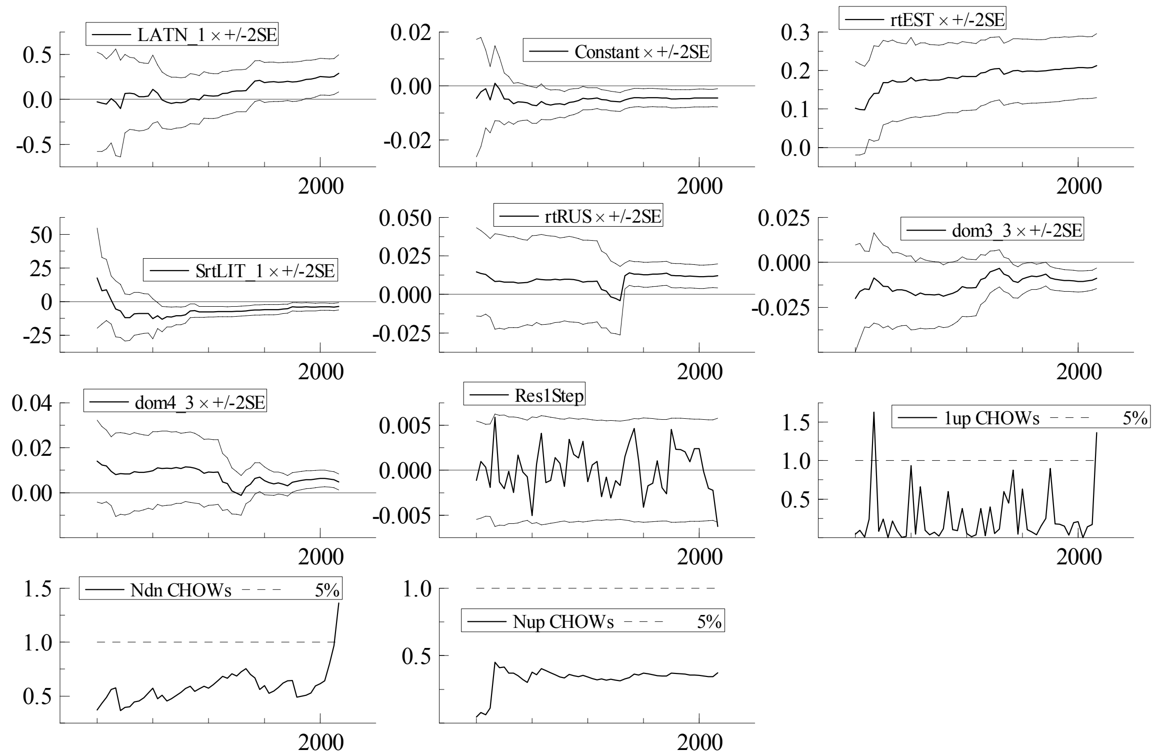
Graph 4. Indices of capital mobility wkI_j and wkS_j



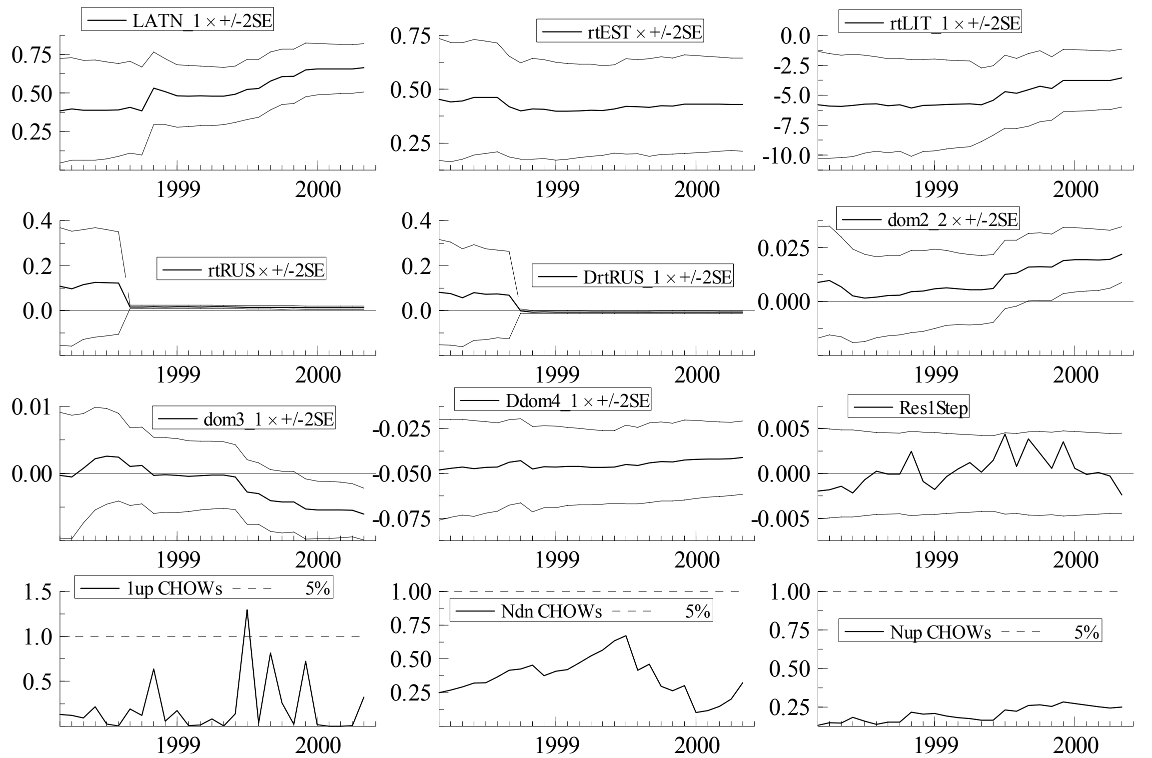
Source: authors' calculations, for data sources see Data Appendix.
Notes: full line: wkI (i.e. interbank interest rate), dotted line: wkS (i.e. stock market returns).

Graph 5. Recursive tests of regression results

a) model (5): full sample



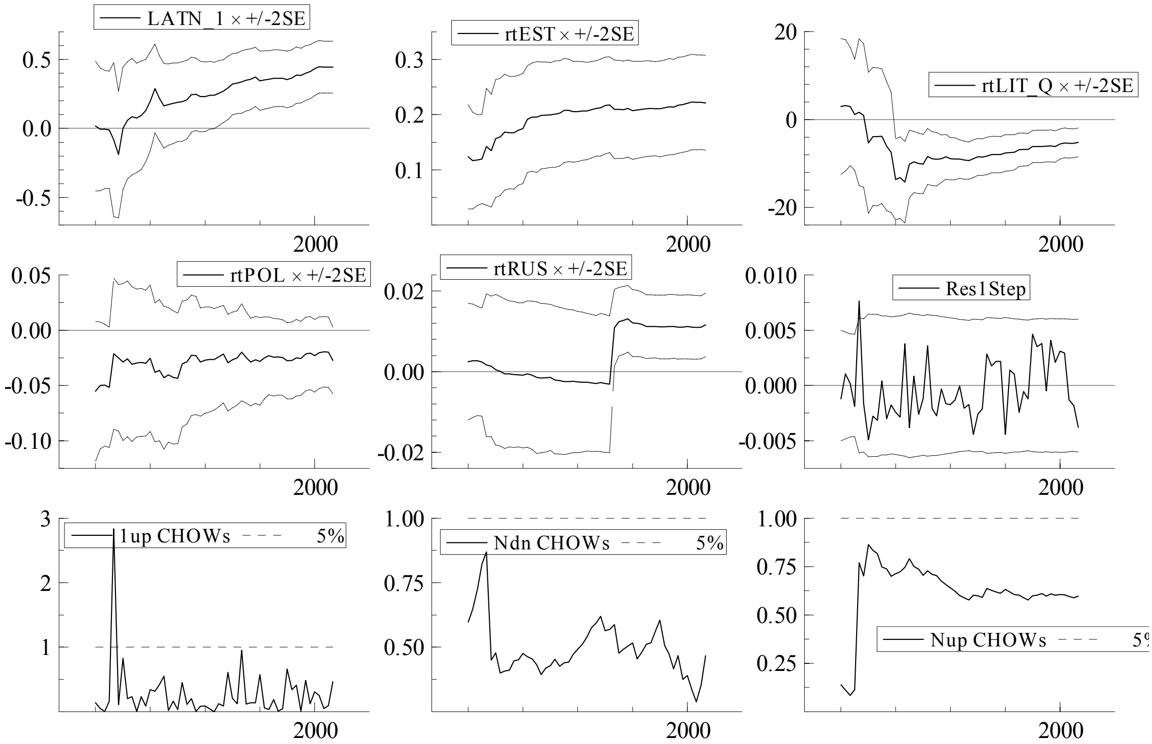
b) model (5): small sample



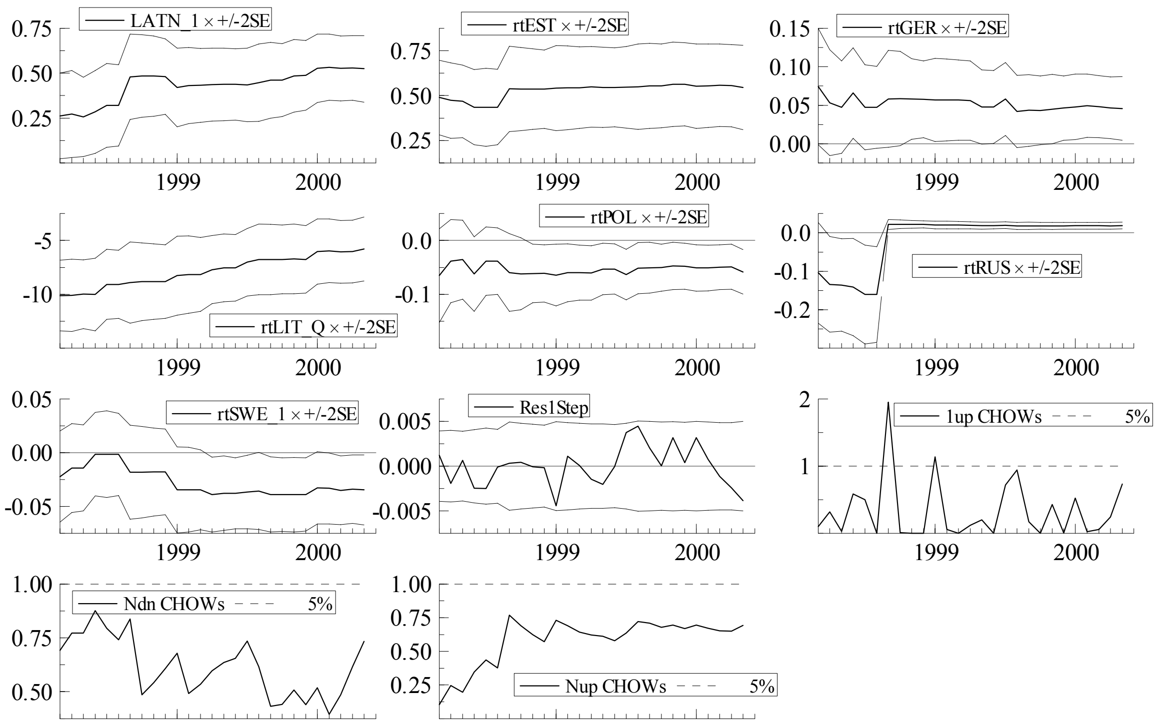
Notes: Parameter coefficient ± 2s.e., the graph is centred around the estimated coefficient value with the approximate 95% confidence interval at each observation shown on either side. Chow tests are 1-step forecast test at t; N decreasing test for constancy from t to T; and N increasing test for constancy from *m+1 to t (with m initial values), respectively. They are scaled by their critical values at the 5% level at each t.*

Graph 5. Recursive tests of regression results (continued)

c) model (6): full sample

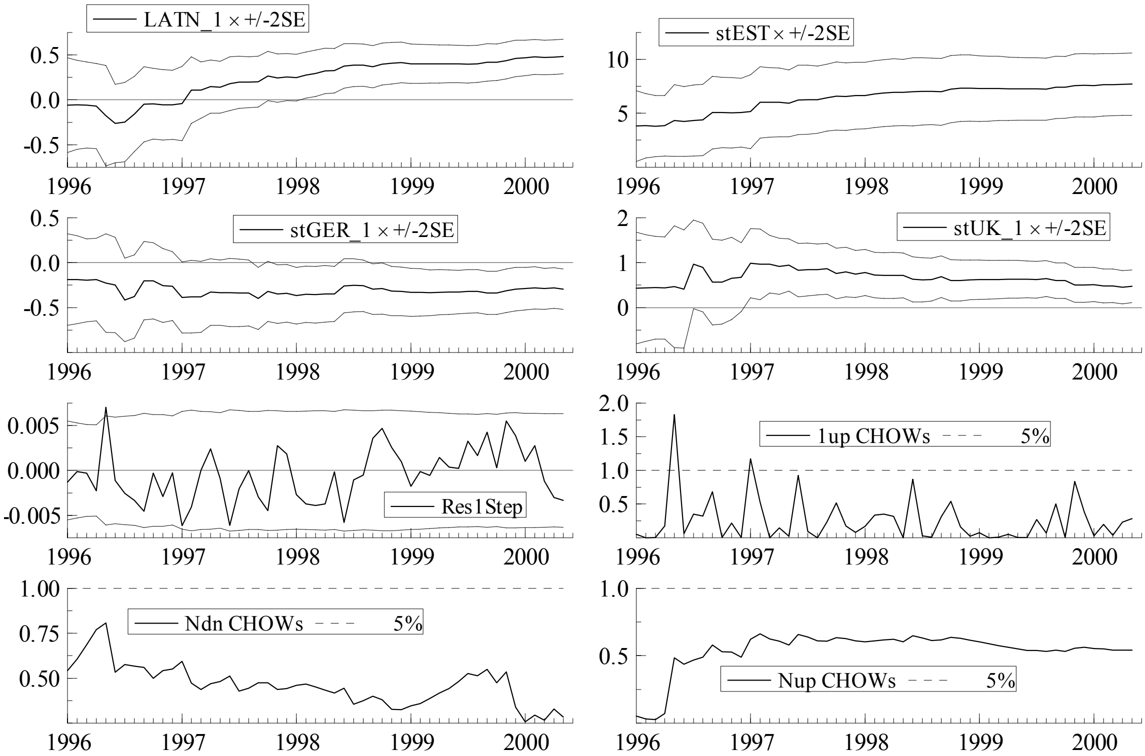


d) model (6): small sample

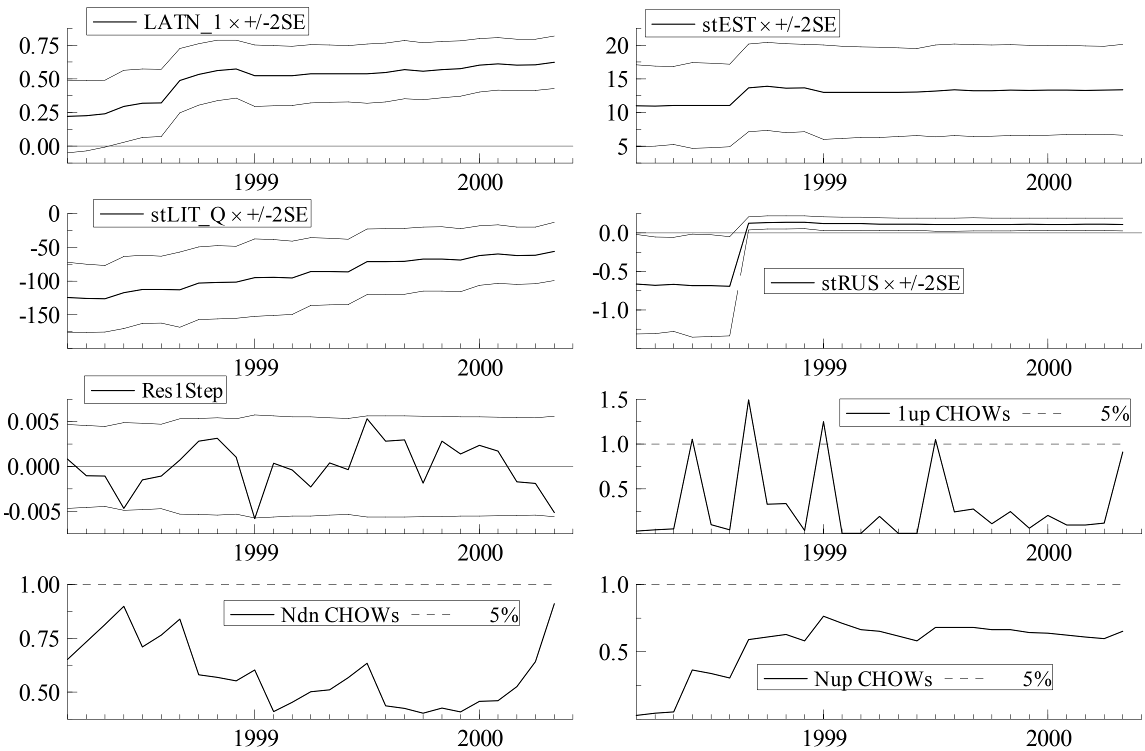


Graph 5. Recursive tests of regression results (continued)

e) model (8): full sample

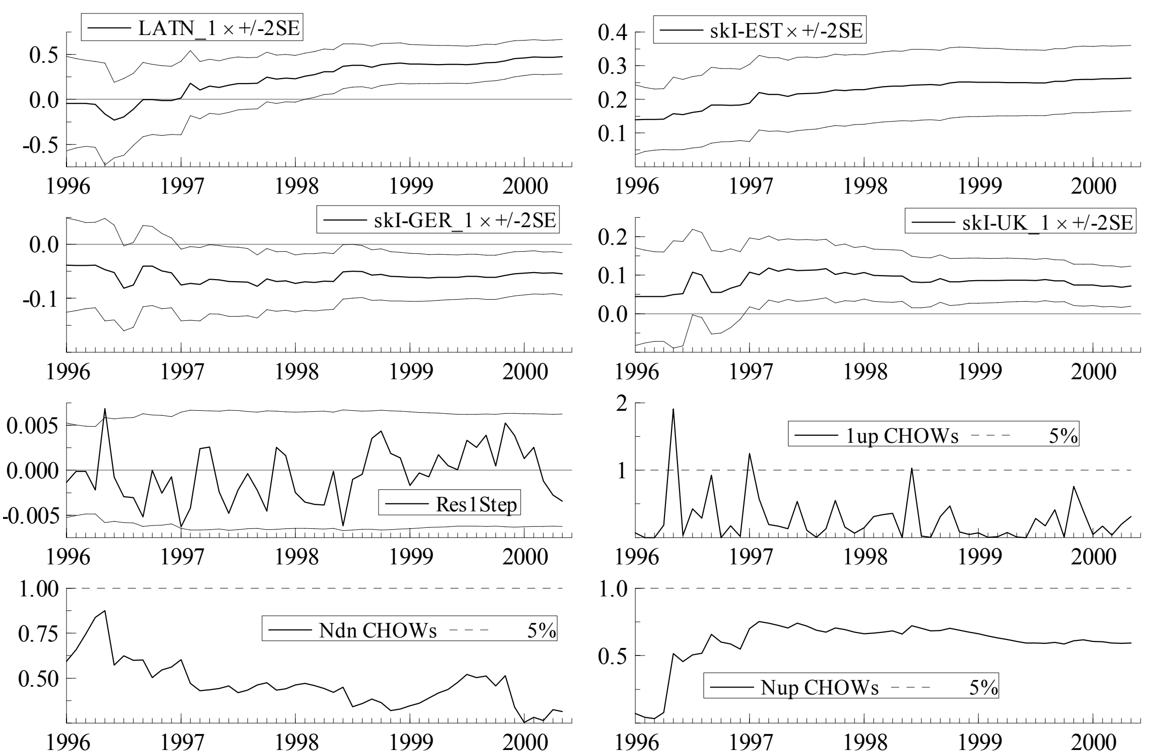


f) model (8): small sample

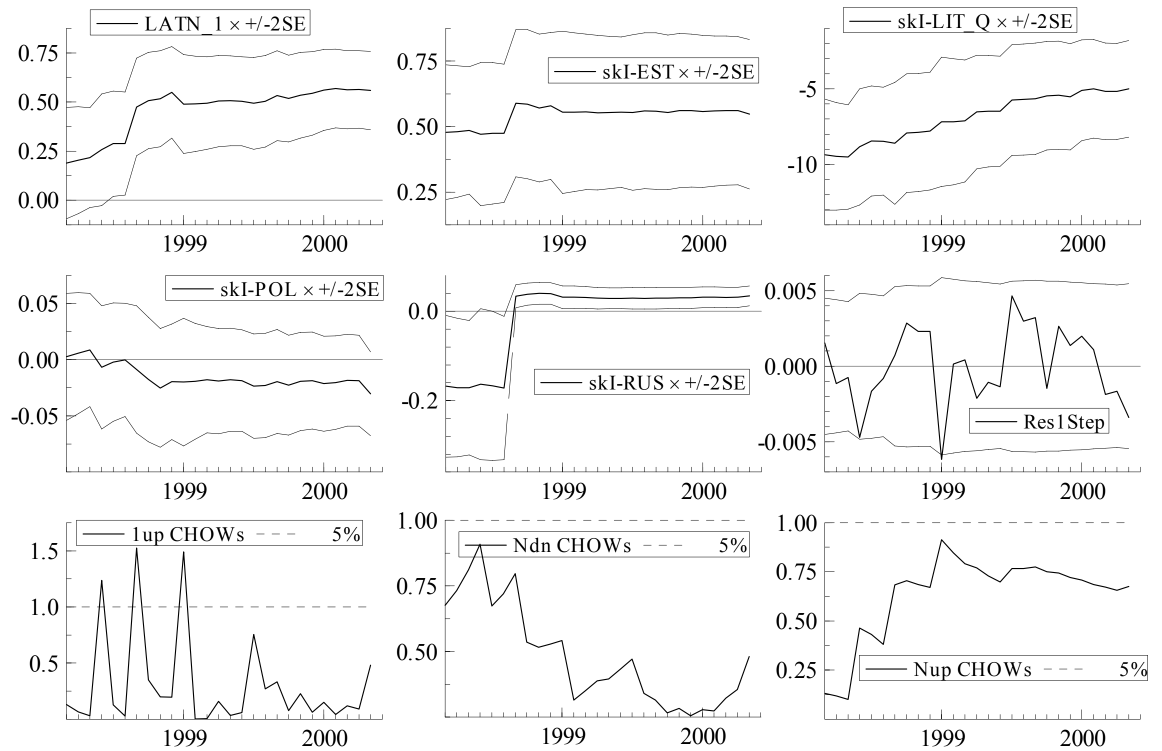


Graph 5. Recursive tests of regression results (continued)

g) model (12a): full sample

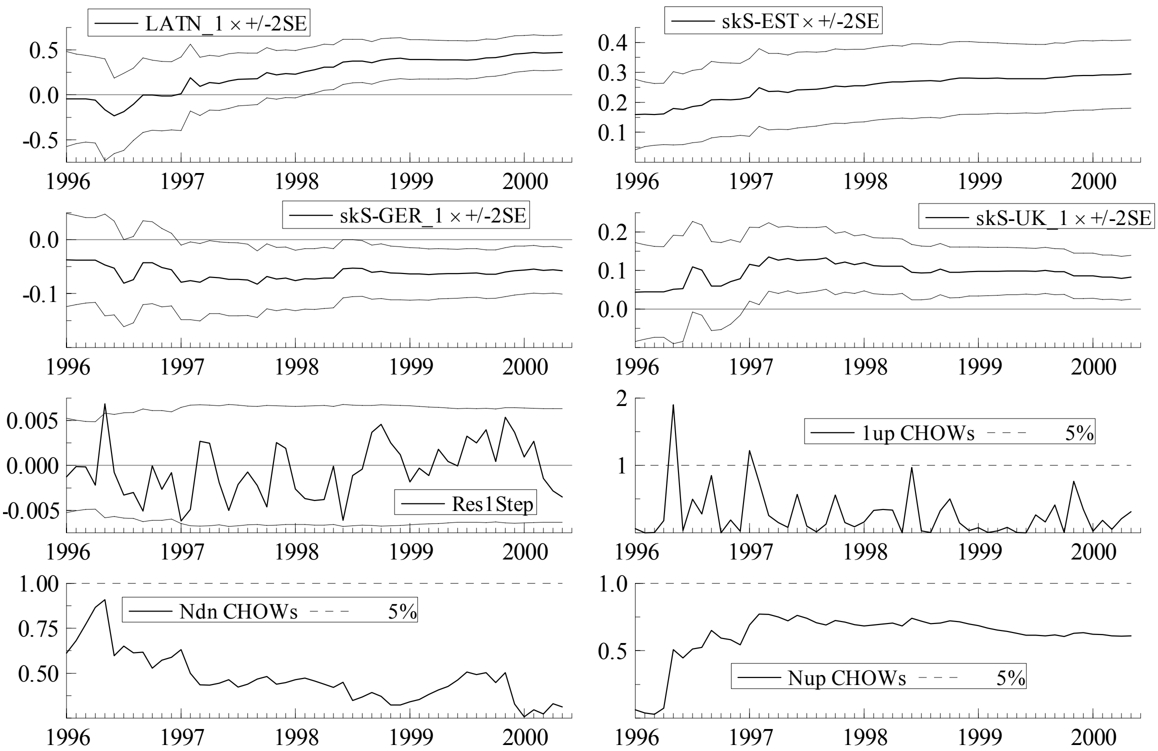


h) model (12a): small sample



Graph 5. Recursive tests of regression results (continued)

i) model (12b): full sample



j) model (12b): small sample