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## Exchange rate regimes, foreign exchange volatility and export performance in Central and Eastern Europe: just another blur project?

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Balázs Égert and Amalia Morales-Zumaquero

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Balázs Égert and Amalia Morales-Zumaquero

## Exchange rate regimes, foreign exchange volatility and export performance in Central and Eastern Europe: Just another blur project?

### Tiivistelmä

Tutkimuksessa arvioidaan valuuttakurssien volatilitteettia ja sekä suoria että epäsuoria vaikutuksia kymmenen Keski- ja Itä-Euroopan maan vientiin. Epäsuorat vaikutukset saattavat johtua valuuttakurssijärjestelmien muutoksista. Tutkimuksessa käytetään tietoja kokonaisviennistä ja eri alojen viennistä. Lisäksi tarkastellaan kahdenvälisiä kauppavirtoja. Ensin pyritään tunnistamaan tapaukset, joissa valuuttakurssien volatilitteetin muutokset johtuvat valuuttakurssijärjestelmän muutoksesta. Näitä tietoja käytetään myöhemmin estimoitavissa vientiyhtälöissä. Saatujen tulosten perusteella näyttää siltä, että valuuttakurssien volatilitteetin ja valuuttakurssijärjestelmien muutosten vaikutukset vientiin vaihtelevat selvästi maittain sekä eri teollisuuden alojen kesken. Lisäksi vaikutukset saattavat muuttua ajan myötä.

Asiasanat: valuuttakurssien volatilitteetti, vienti, ulkomaankauppa, siirtymätaloudet, rakenteelliset muutokset



# Exchange Rate Regimes, Foreign Exchange Volatility and Export Performance in Central and Eastern Europe: Just Another Blur Project?

Balázs Égert\*      Amalia Morales-Zumaquero<sup>† ‡</sup>

June 3, 2005

## Abstract

This paper attempts to analyze the direct impact of exchange rate volatility on the export performance of ten Central and Eastern European transition economies as well as its indirect impact via changes in exchange rate regimes. Not only aggregate but also bilateral and sectoral export flows are studied. To this end, we first analyze shifts in exchange rate volatility linked to changes in the exchange rate regimes and second, use these changes to construct dummy variables we include in our export function. The results suggest that the size and the direction of the impact of forex volatility and of regime changes on exports vary considerably across sectors and countries and that they may be related to specific periods.

JEL: F31

Keywords: exchange rate volatility, export, trade, transition, structural breaks

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# 1 Introduction

The relationship between exchange rate volatility and export flows has been studied in a large number of theoretical and empirical papers. From a theoretical point of view, the effect of exchange rate volatility on international trade is not unambiguous. On the one hand, it may be argued that a rise in exchange rate volatility increases the uncertainty of profits on contracts denominated in a foreign currency because this risk leads risk-averse and risk-neutral agents to redirect their activity from higher risk foreign markets to the lower risk home market. On the other hand, higher exchange rate volatility and thus higher risk represents greater opportunity for profit and might increase trade.<sup>1</sup>

From an empirical point of view, the large body of literature focusing on developed countries generally cannot establish any clear and statistically significant link between exchange rate volatility and aggregate or bilateral export flows. Nonetheless, differentiating between sectors yields more encouraging results even though the evidence from sectoral data suggests that the impact of volatility differs both in magnitude and direction across sectors (Klein, 1990; Bini-Smaghi, 1991; McKenzie, 1998, among others). Interestingly, Fontaigné and Freudenberg (1999) show that exchange rate volatility has a negative impact on intraindustry trade.

More recently, Doroodian (1999), Chou (2000), Achy and Sekkat (2001), Siregar and Rajan (2002), Arize et al. (2004) and Baak (2004) put pen to paper to investigate the case of less developed countries employing multilateral, bilateral and sectoral export data. Generally speaking, these papers unanimously support the hypothesis that exchange rate volatility has a negative effect on exports flows. In other words, an increase in volatility appears to depress exports in less developed countries. Along these lines, a related question very few researchers have investigated is whether changes in exchange rate regimes which can be associated with a shift in the amplitude of volatility cause export flows to decrease (see Fountas and Aristotelous, 1999, for the Exchange Rate Mechanism period and Aristotelous, 2001, for Britain and the U.S.A. from 1889 to 1999).<sup>2</sup>

In this paper, we undertake to dissect the relationship between exchange rate volatility, exchange rate regimes and export performance in ten transition economies in Central and Eastern Europe (CEE), namely Bulgaria, Croatia, the Czech Republic, Hungary, Poland, Romania, Russia, Slovakia, Slovenia and Ukraine. To address this issue, we look not only at yearly and monthly aggregate export data but also analyze export flows to the European Union (EU) and at the sectoral level.

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<sup>1</sup>See McKenzie (1999) for a very complete survey on this topic.

<sup>2</sup>Gravity models offer an alternative to aggregate export functions because they analyze all possible bilateral trade relations for a given set of countries (for instance, a panel of ten countries would comprise 120 bilateral trade series). The impact of forex volatility on trade is not less controversial in the gravity context: a negative relationship is found in Rose (2000), Taglioni (2002), Babetskaia-Kukharchuk and Maurel (2004) and Frankel and Rose (2004), no connection between forex volatility and trade is detected in Tenreyro (2003), and the relationship is positive in Babetskii et al. (2003) and in Bussière et al. (2004).

The methodological framework used here marks a departure from the traditional literature on the impact of exchange rate volatility on export flows. We proceed in three stages. First, we identify changes in exchange rate volatility using two procedures, the Iterated Cumulative Sums of Squares (ICSS) algorithm developed by Inclán and Tiao (1994) and Hansen's (1997) approximation to the p-values of the supreme, exponential and average statistics developed by Andrews (1993) and Andrews and Ploberger (1994). Second, we match shifts in exchange rate volatility with changes in the exchange rate regime and construct dummy variables corresponding to changes in exchange rate regimes in line with the detected structural breaks. Third, we include the indirect forex volatility measure (dummies) and, alternatively, a direct measure of exchange rate volatility (as in the previous literature) in export functions using both panel and time series cointegration estimation techniques.

The issue of forex volatility and trade, which to our knowledge has not yet been analyzed for this group of countries, is of particular interest because five countries from our pool joined the EU in May 2004 and the accession to the EU of three others is in all likelihood only a matter of time. Joining the EU entails the prospect of adopting the euro or even the obligation to do so, with the timing of this step having recently been subject to lively academic and policy discussions. If exchange rate volatility were to impede export flows, commonly perceived as the engine of economic growth in those countries, their motivations for adopting the euro and hence for making a greater effort to meet the Maastricht convergence criteria – in particular those applying to public finances – should increase considerably.

The remainder of this paper is structured as follows. Section 2 gives a detailed overview on the tested export equations, including a volatility measure, the econometric techniques for testing structural breaks in exchange rate volatility, and the cointegration techniques used to estimate the export functions. This is followed by the discussion of the shifts in exchange rate regimes in section 3. Section 4 reports the estimation results of the export functions based on panel and time series data and discusses the results. Section 5, finally, provides some concluding remarks.

## 2 Estimation and Data Issues

### 2.1 Nominal and Real Export Functions

Although the selection of the correct trade equation in general and that of an export equation in particular is problematic, we follow the approach employed, for instance, in McKenzie (1998), who analyzes the relationship between exchange rate volatility and trade flows in a very meticulous and systematic way. The export functions are estimated both in nominal and real terms, and include domestic and foreign income ( $Y_t$  and  $Y_t^*$ ), relative prices ( $P_t$  and  $P_t^*$ ), usually defined as export prices in the domestic economy to import prices in the foreign economy, the nominal exchange rate ( $E_t$ ) for nominal exports ( $X_t^N$ ), the real

exchange rate ( $Q_t = E_t \cdot P_t^*/P_t$ ) for real exports ( $X_t^R$ ), and a volatility measure of the nominal and the real exchange rates, denoted by  $VOL_t^E$  and  $VOL_t^Q$ , respectively.

It is a well-established fact in the literature dealing with transition economies that an increase in the transition economies' export flows was substantially influenced by the massive inflow of foreign direct investment (FDI) into the manufacturing sector. FDI, absorbed either by privatization or by the establishment of greenfield projects, built up substantial exports capacities in the transition economies (see Barrell and Holland, 2000; Campos and Kinoshita, 2002; or Benáček et al., 2003). Table 1 shows the dramatic increase in FDI stocks relative to GDP; by 2003, the figures are close to or well over 30% in Bulgaria, Croatia, the Czech Republic, Hungary, Poland and Slovakia. Changes of exports as a share in GDP are reported in table 2; they more than doubled in most of the countries. Hence, we modified equations of the standard specification by taking account of the prominent role of FDI in export performance:

$$X_t^N = f(Y_t^N, Y_t^{N*}, P_t, P_t^*, E_t, FDI_t, VOL_t^E) \quad (1)$$

$$X_t^R = f(Y_t^R, Y_t^{R*}, Q_t, FDI_t, VOL_t^R) \quad (2)$$

Economic theory suggests that the impact of nominal and real income should be positive on nominal and real exports, respectively. Moreover, an exchange rate depreciation may increase exports and the impact of domestic (foreign) relative prices on exports should be negative (positive). The volatility measure,  $VOL_t$ , is a standard direct measure of volatility, and, alternatively, a dummy variable constructed in accordance with changes in the exchange rate regime and exchange rate volatility. The effect of exchange rate volatility on exports is, from the theoretical viewpoint, ambiguous and may have a positive or negative impact on export flows.

An increase or decrease in exchange rate volatility may impact on exports with a certain delay, given that export contracts may be fixed one or two periods ahead. The same may apply to foreign direct investment, as the fruits of FDI inflows may be felt only with some delay. FDI has been mainly related either to privatization or to greenfield investments. In both cases, some time is needed to restructure the company or to build the plant, which can then produce goods for exports. This is the reason both volatility measures and FDI are used also with a lag of one or two years in equations (1) and (2).

## 2.2 Testing for Structural Breaks

The methodology used in this study to detect structural breaks in the variance of the exchange rate series is based on two procedures: the Iterated Cumulative Sums of Squares (ICSS) algorithm developed by Inclán and Tiao (1994) and Hansen's (1997) approximation to the p-values of the supreme, exponential and average statistics developed by Andrews (1993) and Andrews and Ploberger (1994).

Inclán and Tiao (1994) propose a cumulative sums of squares algorithm to estimate the number of changes in variance and the point in time of each variance shift. Let

$$C_k = \sum_{t=1}^k \epsilon_t^2, \quad k = 1, \dots, n \quad (3)$$

be the cumulative sum of the squared observations from the start to the  $k$ th point in time where  $n$  is the number of observations and denotes a series of independent observations from a normal distribution with zero mean and with unconditional variance  $\sigma^2$ . From equation (5), Inclán and Tiao (1994) propose to use the statistic given by:

$$IT = \sup_k \sqrt{n/2} |D_k| \quad (4)$$

where  $D_k = \frac{C_k}{C_n} - \frac{k}{n}$ . Under the null hypothesis of constant unconditional variance, asymptotically  $D_k$  behaves as a Brownian bridge. The critical value of 1.36 is the 95th percentile of the asymptotic distribution of  $\sup_k \sqrt{n/2} |D_k|$ . Thus, upper and lower boundaries can be set at  $\pm 1.36$  in the  $D_k$  plot. Exceeding these boundaries marks a significant change in the variance of the series. If the series under study has multiple break points, the  $D_k$  function alone is not enough because of the masking effects. To avoid this problem, Inclán and Tiao (1994) design an algorithm that is based on a successive evaluation of  $D_k$  at different parts of the series, dividing consecutively after a possible change point is found.

Our second procedure to detect structural breaks in volatility is based on univariate autoregressive models for first differences (growth rates) of the series, which we denote as  $q_t$ . Following McConnell and Pérez-Quirós (2000) and Camacho (2004), we compute, at any quarter  $t$ , the Generalized Method of Moments (GMM) estimates of the specification:

$$q_t = \mu + \phi q_{t-1} + \epsilon_{1s} \quad (5)$$

$$\sqrt{\frac{\pi}{2}} |\hat{\epsilon}_{1s}| = \alpha_1 D_{1s} + \alpha_2 D_{2s} + \epsilon_{2s} \quad (6)$$

where the dummies are  $D_{1s} = \begin{cases} 0 & \text{if } s \leq T \\ 1 & \text{if } s > T \end{cases}$  and  $D_{2s} = \begin{cases} 1 & \text{if } s \leq T \\ 0 & \text{if } s > T \end{cases}$ , and  $s$  refers to data of the period from the beginning of the sample to  $s$ , the instruments for each period  $s$  are a constant,  $q_t$ ,  $D_{1s}$  and  $D_{2s}$ ,  $T$  is the estimated break point  $\alpha_1$  and  $\alpha_2$  and are the estimators of the standard deviation.<sup>3</sup>

Andrews (1993) and Andrews and Ploberger (1994) develop statistics for cases similar to the previous one, where the parameter  $T$  appears under the alternative hypothesis but not under the null of constant conditional standard

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<sup>3</sup>If  $\epsilon_t$  follows a normal distribution,  $\sqrt{\frac{\pi}{2}} |\hat{\epsilon}_t|$  is an unbiased estimator of the standard deviation of  $\epsilon_t$ .

deviation ( $\alpha_1 = \alpha_2$ ). They define the function  $F_n(T)$  as the Wald (W), Likelihood Ratio (LR) or Lagrange Multiplier (LM) statistic of the hypothesis that  $\alpha_1 = \alpha_2$  for break date  $T$ , where  $n$  is the number of observations. They assume that  $T$  lies in a range  $T_1, T_2$ .<sup>4</sup> Specifically, Andrews (1993) considers the supreme statistic:

$$SupF = \sup_{T_1 \leq T \leq T_2} F_n(T) \quad (7)$$

where  $F = W, LR$  or  $LM$ . Andrews and Ploberger (1994) consider the exponential and average statistics, given by the following expressions:

$$ExpF = \ln \left( \frac{1}{T_2 - T_1 + 1} \sum_{T=T_1}^{T_2} \exp\left(\frac{1}{2}F_n(T)\right) \right) \quad (8)$$

$$AveF = \frac{1}{T_2 - T_1 + 1} \sum_{T=T_1}^{T_2} F_n(T) \quad (9)$$

where  $F=W, LR$  or  $LM$ . The asymptotic distributions of these statistics are nonstandard and have been obtained by Andrews (1993) and Andrews and Ploberger (1994), together with their asymptotic critical values. In this paper we apply these statistics, using the associated p-values obtained following the approximation developed by Hansen (1997). In particular, we use statistics in equations (7), (8) and (9) in a new way: we sequentially apply those tests, compute the p-values associated with the supreme, exponential and average statistics for any date, and obtain a profile of p-values. In doing so, we will have numerical and graphical information that will be used to delimit periods of stability and instability in the variance of the series.

### 2.3 Data Issues

To carry out our empirical analysis, we use two sets of data. The first set of data consists of yearly data and spans the period from 1990 to 2003. It is obtained from the Economies in Transition 2004 database of the Vienna Institute for International Economic Studies (WIIW). Following our export function specification, the domestic and foreign price indices are producer prices. Some studies use consumer prices, but these indices clearly contain elements which have little to do with the exporting sectors (such as administered or regulated prices, changes in indirect taxes and imported goods). Others use export prices for the domestic economy and import prices for the foreign economy. However, we first face a data constraint here in that export prices are available only for four countries (the Czech Republic, Hungary, Poland and Slovenia). For export prices, one may use export unit values or proper export prices. However, the dynamics of the two types of series may be rather different in practice. Another source of confusion is that the series are commonly expressed in U.S. dollar terms, which

<sup>4</sup>We set  $T_1 = .15n$  and  $T_2 = .85n$  (see Andrews, 1993, and Andrews and Ploberger, 1994).

implies that the exchange rate is already included in the series, and, perhaps more importantly, that they are of little use when the other variables are expressed in effective terms or against the euro area. For the sake of consistency, we opted for the producer price series. Nominal exports and GDP are expressed in domestic currency units, and real exports are obtained as nominal exports deflated by producer price series. Real GDP is the cumulated series based on yearly real GDP growth rates. Nominal FDI is the cumulated FDI stock, while for the real export equation, it is constructed as the stock of FDI as a share of GDP. GDP and PPI series for the foreign economy are a weighted average of euro area and U.S. series, where the weight for the euro area corresponds to the share of exports to the euro area in total exports and the weight for the U.S. series represents the rest of total exports.

A sectoral decomposition for exports is available for all countries except Russia and Ukraine; according to this decomposition, exports are classified in nine sectors.<sup>5</sup> Table 1 indicates that most of the eight CEE economies' exports concentrate on manufacturing, representing a share of slightly more than 60% for Bulgaria and Croatia at the lower end and above 80% for the Czech Republic, Hungary and Slovakia at the higher end. The share of machinery and transport equipment alone reaches 50% in the Czech Republic and Slovakia and 60% in Hungary in 2003.

Table 1. The Share of Exports by Sectors in Total Exports, (%), 2003

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S7+S8+S9
Bulgaria	6.7	2.1	6.3	8.4	0.2	9.0	24.7	13.0	28.8	66.5
Croatia	9.1	2.6	5.7	9.6	0.2	9.6	14.0	29.4	19.6	63.0
Czech Rep.	2.7	0.6	2.8	2.9	0.1	5.9	23.1	50.1	11.8	85.0
Hungary	6.2	0.3	1.8	1.6	0.2	6.9	10.3	61.1	10.6	82.0
Poland	7.6	0.3	2.6	4.3	0.0	6.5	23.7	37.8	17.1	78.6
Romania	2.2	0.2	6.2	6.5	0.2	4.8	19.3	21.5	38.9	79.7
Slovakia	2.5	0.4	2.5	5.2	0.1	5.2	23.7	47.4	13.0	84.1
Slovenia	2.1	1.3	1.7	1.4	0.1	13.8	25.6	36.6	17.5	79.7

Source: Calculated on the basis of WIIW Countries in Transition 2004.

Notes: S1: Food and live animals, S2: Beverages and tobacco, S3: Crude materials, inedible, except fuels, S4: Mineral fuels, lubricants, etc., S5: Animal and vegetable oils, fats, waxes, S6: Chemicals and related products, S7: Manufactured goods class. by materials, S8: Machinery and transport equipment, S9: Miscellaneous manufactured articles.

The exchange rate series are defined as units of domestic currency units per one unit of the foreign currency. Hence, a decrease (increase) in the exchange

<sup>5</sup> (1) Food and live animals, (2) beverages and tobacco, (3) crude materials, inedible, except fuels, (4) mineral fuels, lubricants, etc., (5) animal and vegetable oils, fats, waxes, (6) chemicals and related products, (7) manufactured goods class by materials, (8) machinery and transport equipment, and (9) miscellaneous manufactured articles.

rate indicates an appreciation (depreciation). Furthermore, the real exchange rate is calculated using producer price series rather than consumer price series for reasons developed earlier.

The second set of data contains monthly data drawn mostly from the WIIW monthly database on Eastern Europe. It covers the period from January 1993 to September 2004 for the Czech Republic, Hungary, Poland and Romania, and from January 1994 to September 2004 for Croatia, Russia, Slovakia and Slovenia. For Bulgaria and Ukraine, monthly time series for exports start only in 1999 and 1998, respectively; for this reason, they are excluded from the cointegration analysis. If not indicated otherwise, the construction of the series is the same as for the yearly data. Note that the monthly FDI series are obtained by linear interpolation from yearly data. For the Czech Republic, Croatia, Hungary, Poland, Romania, Slovakia and Slovenia, besides aggregate exports, exports to the euro area are also analyzed. Domestic and foreign incomes are proxied by industrial production, the only variable available at a monthly frequency which can be taken as an approximation of gross domestic product.<sup>6</sup> Wherever the presence of seasonality is detected in the data, the series are seasonally adjusted and are taken as a natural logarithm.<sup>7</sup>

A final and important aspect of the data is the construction of variables capturing the volatility of the real exchange rate. For yearly data, two direct measures are used: (1) the standard deviation of monthly changes in the exchange rate for the 12 months of the year (VOLE), and (2) the average of standard deviations computed for each month of the year based on monthly changes in the exchange rate for a window of 12 months (VOLA). For monthly data, a standard deviation for a 12-month window is computed for each month. In addition, dummy variables are also used with the aim of capturing changes in the exchange rate regime and forex volatility. More discussion on this issue is provided in the next section.

## 3 Exchange Rate Regimes and Breaks in Volatility

### 3.1 Changes in Exchange Rate Regimes

Table 2 presents a general overview of how exchange rate regimes changes over time in transition economies. For the CEEC-5, a gradual move from a peg toward more flexibility can be observed for all countries with the exception of Slovenia, which has maintained a de facto crawling peg until its entry into ERM II in June 2004. Both Hungary and Poland started transition using pegged regimes with discretionary adjustments and then switched to crawling peg regimes. Poland widened the fluctuation margins up to  $\pm 15\%$  in consecutive steps to cope with appreciation pressures, and then opted for a pure floating regime in 2000. Hungary maintained its tight-band crawling peg regime for a

<sup>6</sup>Alternatively, quarterly GDP series interpolated to monthly frequency could be also used.

<sup>7</sup>The U.S. Census Bureau's X12 seasonal adjustment program was used.



longer period and adopted a pegged regime with fluctuation margins as high as  $\pm 15\%$  in April 2001.<sup>8</sup> The Czech Republic and Slovakia, which had a common history until 1993, had pegged regimes until 1997 and 1998, respectively, when, after a short-lived widening of the bands in the Czech Republic, and with a brusque shift in Slovakia, they moved toward a managed float. More flexible exchange rate regimes may indeed generate more amplified movements in the nominal exchange rate, which, in turn, make these countries prone to being "victims" of nominal exchange rate volatility.

An opposite tendency becomes apparent in Southeastern Europe, especially in Bulgaria, which can be best described as an abrupt shift from a managed float toward more rigidity (a currency board). The cases of Croatia and Romania are similar to that of Slovenia with long unchanged regimes. Although officially announced as a managed float, the regime Romania has been operating for the past 15 years or so is a de facto crawling peg or band, and Croatia maintained its nominal exchange rate in a very narrowly managed band from 1994 onward.<sup>9</sup> Russia and Ukraine constitute another group of countries with cyclical changes in the exchange rate regime. Starting with a managed float, Russia pegged the ruble to the dollar in 1995 and then introduced a crawling band in 1996, which ended with the return to a managed float in the aftermath of the Russian crisis. Also entering the initial phase of transition with a managed float, Ukraine followed Russia with some delay in pegging its currency to the dollar 1997 and let the hryvna float in 2000 after an uphill struggle against constant depreciation pressures from August 1998 on, which included an increase in the fluctuation band and a shift toward more depreciation of the band.

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<sup>8</sup>Note that formally, the crawling peg regime was abandoned in October 2001, when the rate of crawl was set to zero. However, in practice, the rate of crawl between April and October 2001 was very low and remained insignificant in terms of influencing the exchange rate because of the enlarged fluctuation bands.

<sup>9</sup>Croatia, Romania and Slovenia are the three countries in our sample whose de jure and de facto regimes differ markedly.

Table 2. Exchange Rate Regimes in Transition Economies from 1990 to 2005

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
CEEC5																
Slovenia	a	3a(6)	3a(6)	3a(6)	3a(6)	3a(6)	3a(6)	3a(6)	3a(6)	3a(6)	3a(6)	3a(6)	3a(6)	3a(6)	3a/5	5
Hungary	1	1	1	1	1	1/2	2	2	2	2	2	2/4/5	5	5	5	5
Poland	1	1	2	2	2	4	4	4	4	4	4/7	7	7	7	7	7
Slovakia	1	1	1	1	1	1	5	5	5/6	6	6	6	6	6	6	6
CzechR.	1	1	1	1	1	1	5	5/6	6	6	6	6	6	6	6	6
Southeastern Europe																
Bulgaria	1	6	6	6	6	6	6	0	0	0	0	0	0	0	0	0
Croatia			1	5(6)	5(6)	5(6)	5(6)	5(6)	5(6)	5(6)	5(6)	5(6)	5(6)	5(6)	5(6)	5(6)
Romania	1	3b(6)	3b(6)	3b(6)	3b(6)	3b(6)	3b(6)	3b(6)	3b(6)	3b(6)	3b(6)	3b(6)	3b(6)	3b(6)	3b(6)	3b(6)
CIS																
Russia			6	6	6	6/5	4	4	4/6	6	6	6	6	6	6	6
Ukraine					6	6	6	6/5	5	5	5/6	6	6	6	6	6

Notes: (a) No home currency in circulation; 0: formal or de facto currency board; 1: peg to a currency or to a basket with fluctuation margins less than or equal to  $\pm 2.25\%$ ; 2: crawling peg with fluctuation margins of less than or equal to  $\pm 2.25\%$ ; 3a: float with active management by monetary authorities (implicit crawling peg); 3b: float with active management by monetary authorities (implicit crawling band); 4: crawling peg with fluctuation margins of more than  $\pm 2.25\%$ ; 5: peg to a currency or a basket with fluctuation margins of more than  $\pm 2.25\%$ ; 6: float with intervention; 7: free float without any intervention. In parentheses are the de jure regimes for Croatia, Romania and Slovenia.

### 3.2 Breaks in Volatility

Table 3 reports the breaks in volatility detected when using the ICSS and the Hansen methods for real and nominal exchange rates in effective terms.<sup>10</sup> Note that results are reported only for the effective exchange rate for Russia and Ukraine. A number of general observations can be made: First and perhaps most importantly, the reported results reflect most of the changes in the exchange rate regimes. Nonetheless, there is ample evidence that changes in nominal and real exchange rate volatility also occurred within one and the same exchange rate regime. Second, the two procedures (ICSS and Hansen) may yield different results. The ICSS procedure produces one-off changes in volatility, while the Hansen method shows the periods during which volatility in the exchange rate is different from that in the remaining observations. Generally speaking, the number of reported breaks in volatility is usually higher for the Hansen procedure than for the ICSS procedure. Third, breakpoints in the real exchange rate may or may not corroborate with breakpoints in the nominal exchange rate. Finally, the use of effective exchange rate series obtained from

<sup>10</sup>Results for the euro exchange rates are not reported because they are mostly in line with the results for the real effective exchange rates.

different sources for Hungary (Magyar Nemzeti Bank versus WIIW) may lead to differences in the results. This may be partly traced to the different time period over which the time series are available.

Table 3. Structural Changes in Exchange Rate Volatility

		REER	NEER
Bulgaria	ICSS	1993.9, 1994.4, 1996.3, 1997.5, 1999.7	1994.2, 1996.4, 1997.1, 1998.10
	Hansen	1997.2**, 1997.3*, 1997.4-1998.3**, 1999.5-1999.7**, 1999.9-2000.12**, 2001.1-2004.9*	1995.12-1996.4**, 1997.2-1997.12**, 1998- 2004.12*
Croatia	ICSS	No breaks	No breaks
	Hansen	No breaks	1995.1-1995.6*
CzechR.	ICSS	No breaks	1996.4, 1999.2
	Hansen	1997.12-1998.2**, 1998.3*, 1998.4**, 1998.5-2004.9*	1992.1**, 1992.4-1992.5*, 1992.8- 1992.10**, 1992.11-1995.2*, 1995.3- 1995.5**, 1995.6-2004.9*
Hungary	ICSS	1994.6, 1995.3	1990.11
	Hansen	1992.12**, 1993.3-1993.11*  MNB: 2000.11**, 2000.12*, 2001.3- 2001.4**	1991.1*, 1991.2**, 1996.5-1998.10*, 1998.11-1998.12**  MNB: 1991.1*, 1991.2-1991.4**, 1991.8**, 1991.11**, 1992.2-1992.3*, 1996.8-1996.10**, 1996.11-1998.10*, 1998.11**, 1998.12**, 1999.1-1999.4**, 1999.8-2001.3**, 2001.4*, 2001.5**
Poland	ICSS	1993.5, 1997.9	1993.7, 1997.5
	Hansen	2002.5-2002.9**, 2003.3-2003.10**, 2004.3**	1994.1-1994.2*, 1994.3-1994.4**, 1994.5- 1995.2, 1995.3-1995.4**, 1999.7-2000.3**, 2000.4-2004.9*
Romania	ICSS	1992.10, 1994.4, 1995.9, 1996.11, 1997.2, 1999.5	1992.6, 1993.12, 1997.3
	Hansen	1994.3-1994.8**, 1994.9-1997.2*, 1997.3- 1998.6**, 1998.7-2004.8*	1992.3-2004.9*
Slovakia	ICSS	1993.6, 1994.6	1993.7, 1998.8, 2000.10
	Hansen	No breaks	1994.1-1994.2*, 1994.3-1995.2**, 2000.3**, 2000.5-2000.9**, 2000.10-2004.9*
Slovenia	ICSS	1995.3	1995.2
	Hansen	1997.12-1998.8**, 1999.3-2000.5**, 2003.4**, 2004.7-2004.9**	1997.4-1997.8**, 1997.12-1998.6**, 1998.7-1998.8*, 1998.9-1999.8**, 1999.9*, 1999.10**, 1999.12-2000.5**, 2000.8**, 2000.11**, 2001.5-2001.7**, 2001.9- 2001.11**, 2002.2-2004.9**
Russia	ICSS	1996.7, 1998.6, 1998.11	1996.7, 1998.7, 1998.11
	Hansen	1995.1-1995.2*, 1995.3**, 1995.4*, 1995.5**, 1996.3-1996.5**, 1996.6*, 1996.6*, 1998.1-1998.7**, 2002.1- 2002.5**, 2002.6-2003.11*, 2003.12- 2004.9**	1998.12**, 2001.11-2002.2**, 2002.3- 2004.9*
Ukraine	ICSS	1998.7, 1998.9, 2000.3	1998.7, 1998.9, 1999.12
	Hansen	2003.3**	2001.9-2002.2**, 2002.3-2004.9*

Notes: REER and NEER refer to the real effective exchange rate and the nominal effective exchange rate. The exchange rate series are obtained from the WIIW monthly

database and PPI-based real exchange rate. MNB refers to the exchange rate series provided by the National Bank of Hungary. \* and \*\* indicate evidence for instability at the 5% and 10% significant levels, respectively.

### 3.3 The Construction of Dummy Variables

The dummy variables take the value 0 for the low volatility regime and 1 for the high volatility regime. Table 4 below summarizes the periods for which the dummy variables are constructed along the line of changes in the exchange rate regimes combined with the changes in forex volatility analyzed previously and shows the periods for which the dummy variables take the value 1. For yearly data, only one high volatility regime is used, mainly because of the difficulty of combining several alternative volatility regimes for given countries.<sup>11</sup> This gap is filled for monthly data, where several alternative periods are considered for the Czech Republic, Hungary, Poland, Slovakia and Russia. For Croatia, Romania and Slovenia, only the direct volatility measures are employed in the absence of changes in the exchange rate regime. For Croatia, the identified high volatility regime from 1990 to 1993 cannot be tested for monthly data, as they start only in 1994. As noted earlier, estimations are not carried out on a monthly basis for Bulgaria and Ukraine.

Table 4. Dummy Variables and High Volatility Regimes

	Yearly data	Monthly data	
	High		High
Bulgaria	1991-1996		Not available
Croatia	1990-1993		—
Czech R.	1997-2003	DUM1	1997.5-2004.9
		DUM2	1998.5-2004.9
Hungary	1990-1994; 2001-2003	DUM1	1995.3-2004.9
		DUM2	2001.4-2004.9
Poland	1990-1991; 1995-2003	DUM1	1998.10-2004.9
		DUM2	2000.3-2004.9
Romania	—		—
Slovakia	1998-2003	DUM1	1997.1-2004.9
		DUM2	1998.10-2004.9
Slovenia	—		—
Russia	1990-1994; 1998-2003	DUM1	1994.1-1997.6
		DUM2	1998.9-2004.9
Ukraine	1990-1996; 1999-2003		Not available

<sup>11</sup>It should be noted that the period over which yearly data are available is sometimes longer than the one readily available for monthly data. This is the case, for instance, for Croatia, where large devaluations occurred from 1990 to 1993; this is why we constructed a dummy to cover this period.

## 4 Estimation Results for Panel Data

We start by analyzing the impact of exchange rate volatility and changes in exchange rate regimes on export performance in a panel context. The panel unit root tests indicate that most of the variables are I(1). The two direct volatility measures are exceptions. With this as a background, panel cointegration is used for level variables including the dummy variables, and fixed effect OLS is applied to data in first differences. In the first difference specification, the volatility measures are not first-difference, given the fact that they are already stationary in levels.

The Pedroni mean group statistics reported in Table 5 show the presence of cointegration for most of the specifications. Table 6a contains the estimation results including the volatility measure and FDI with a lag of one year. When all ten countries are included in the panel (CEEC-10), the indirect dummy volatility measure turns out to have a positive sign for the level equations (shaded), indicating that an increase in exchange rate volatility is associated with an increase in exports. For the equations in first differences, all (lagged) volatility measures are mostly insignificant. This result implies that an increase in exchange rate volatility causes exports to decrease with a delay. Nonetheless, results for the CEEC-8 (excluding Russia and Ukraine) indicate that the direct volatility measures (VOLE and VOLA) are statistically significant with a negative sign – for both the nominal and real export equations. These results are fairly robust to the time period investigated, as the results for the period 1993 to 2003 are very similar to those obtained for 1990 to 2003 and 1995 to 2003.

For sectoral exports, it appears that the exchange rate volatility measures are not significant for the first five sectors <sup>12</sup> (and are therefore not reported here). By contrast, as shown in Table 6b, exchange rate volatility is found to hamper manufacturing exports. This does not mean that these sectors were the only ones to be affected. Exports of the chemicals sector are in fact also influenced by exchange rate volatility. Although the effect is mostly positive for the cointegration relationships including the dummy variables, the effect switches sign when data in first differences are used: higher exchange rate volatility appears to dampen export growth in chemicals and manufacturing. These results seem to be most robust for manufactured goods classed by materials and for machinery and transport equipment.

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<sup>12</sup>(1) Food and live animals, (2) beverages and tobacco, (3) crude materials, inedible, except fuels, (4) mineral fuels, lubricants and (5) animal and vegetable oils, fats, waxes.

Table 5. Group Mean Pedroni Panel Cointegration Tests from 1993 to 2003

		Nominal Exports			Real Exports		
		rho-stat	pp-stat	adf-stat	rho-stat	pp-stat	adf-stat
CEEC10	Total Exports	2.994	-10.012***	-5.267***	3.187	-2.259**	-1.262
CEEC8	Total Exports	2.767	-8.698***	-4.003***	2.713	-2.856**	-1.295
	Sector 6	3.136	-3.470***	-1.836*	2.165	-5.484***	-3.349***
	Sector 7	2.595	-7.989***	-6.501***	1.830	-7.481***	-4.829***
	Sector 8	2.879	-7.364***	-3.544***	2.347	-5.326***	-3.054***
	Sector 9	2.912	-4.819***	-4.637***	2.786	-0.929	-0.486

Notes: \*, \*\* and \*\*\* indicate that the null of no cointegration is rejected at the 10%, 5% and 1% level, respectively.

Table 6a. Aggregate Exports: Coefficient Estimates from 1993 to 2003

		Nominal Exports					Real Exports			
		Y/Y*	P/P*	E	FDI	VOL	Y/Y*	Q	FDI	VOL
CEEC10										
DUM	0.695***	-0.219	0.552***	0.188***	0.118**	1.017***	0.453***	0.222***	0.134**	
DUM	0.478**	-0.136	0.686***	-0.125**	0.006	0.865***	0.691***	0.03	-0.005	
VOLA	0.436**	-0.003	0.604***	-0.088	-0.009	0.774**	0.636***	0.093*	-0.019	
VOLE	0.415**	0.016	-0.619***	-0.082	-0.022*	0.801**	0.669***	0.071	-0.022	
CEEC8										
DUM	0.767**	0.007	0.215	0.186***	0.084	1.423***	0.181	0.196***	0.131**	
DUM	0.092	0.355	0.544***	-0.049	-0.014	0.418	0.49**	-0.01	-0.036	
VOLA	0.01	0.559*	0.432**	0.006	-0.045**	0.216	0.41**	0.092*	-0.056**	
VOLE	-0.01	0.551*	0.465**	-0.01	-0.043***	0.267	0.431**	0.047	-0.048**	

Notes: DUM is the dummy variable, VOLE is the standard deviation of changes in the exchange rate for the twelve months of the year, and VOLA is the average of standard deviations computed for each month of the year (see section on data description). CEEC8 excludes Russia and Ukraine. The first row of each group are the estimations for level variables, while the remainder of the table contains estimation results for first differences. \*, \*\* and \*\*\* indicate statistical significance at the 10%, 5% and 1% level, respectively

Table 6b. Sectoral Exports: Coefficient Estimates from 1993 to 2003

Nominal Exports						Real Exports			
	Y/Y*	P/P*	E	FDI	VOL	Y/Y*	Q	FDI	VOL
CEECS-Chemicals and Related Products (Sector 6)									
DUM	1.915***	-1.706***	0.919**	-0.008	0.068	1.82***	0.714**	0.052**	0.105*
DUM	0.832*	-0.628	0.862**	-0.035	0.021	1.26**	0.655**	0.024	0.033
VOLA	0.685	-0.349	0.751**	0.019	-0.051	0.86	0.736**	0.147	-0.049
VOLE	0.635	-0.311	0.773**	0.009	-0.058*	0.658	0.683**	0.147	-0.065*
CEECS-Manufactured Goods Class by Materials (Sector 7)									
DUM	0.902***	-0.374	0.494*	0.115***	0.041	1.16***	0.454**	0.133***	0.081**
DUM	0.107	0.493	0.436**	-0.006	0.018	0.281	0.333*	0.037	0.006
VOLA	-0.024	0.742*	0.337	0.043	-0.046**	-0.026	0.29	0.135**	-0.054*
VOLE	-0.017	0.686	0.386*	0.019	-0.034**	0.084	0.292	0.082	-0.035
CEECS-Machinery and Transport Equipment (Sector 8)									
DUM	0.899	-0.186	0.143	0.367***	0.113	2.641***	0.35	0.354***	0.226**
DUM	-0.134	0.748	0.314	-0.192*	-0.092	-0.203	0.219	-0.108	-0.121**
VOLA	-0.166	0.991	0.101	-0.088	-0.073**	-0.296	0.079	0.064	-0.108**
VOLE	-0.193	0.969	0.157	-0.115	-0.067**	-0.432	0.086	0.028	-0.112**
CEECS-Miscellaneous Manufactured Articles (Sector 9)									
DUM	0.077	1.522***	-0.519*	0.166***	0.075	0.15	-0.831***	0.206***	0.05
DUM	0.067	0.289	0.654***	0.038	-0.043*	0.249	0.653***	0.118**	-0.104***
VOLA	0.102	0.295	0.605***	0.062	-0.012	0.381	0.522**	0.135**	-0.02
VOLE	0.089	0.307	0.609***	0.06	-0.015	0.468	0.584**	0.091	-0.025

Notes: As for Table 6a.

## 5 Estimation Results for Time Series

Estimation results resting on panel data indicate that exchange rate volatility might impact on both nominal and real exports. Given that panel results provide a general picture of the studied phenomenon, there remains an unanswered question about the role of exchange rate volatility in the individual countries. This question, which is of the utmost importance for policymakers, can be best answered by drawing on time series analysis, to which we now direct our radar and other gadgets.

With a very few exceptions, the time series are difference stationary, i.e. I(1) processes. This finding and the more than 120 monthly observations (141 for the period from January 1993 to September 2004 and 129 for the period from January 1994 to September 2004) motivate us to use cointegration to study to what extent, if at all, exchange rate volatility influences export performance. To check our results, we carry out OLS estimations for variables in year-on-year changes ( ) that turn out to be stationary in levels.

We separate the countries under study into two groups. One group contains countries where no changes in the exchange rate regime occurred over the time

span of the monthly data, namely Croatia, Romania and Slovenia. The other group includes the remaining countries. For all countries, results for DOLS and the bounds testing approach are reported. Coefficient estimates are shown only if cointegration relationships could be established for the export equation. Results for year-on-year changes are reported systematically. Lagged values of both the volatility measures and FDI are used for panel data. The outcome of this exercise is included in the paper only if the results are markedly different from the results based on contemporaneous volatility and FDI. The estimation results are displayed in tables 7a to 7e. To save space, these tables only include the coefficient estimates for the volatility measures.<sup>13</sup>

## 5.1 Croatia, Romania and Slovenia

We used only the direct volatility measure for the three countries without changes in the exchange rate regime.<sup>14</sup> The absence of major changes in the exchange rate regime does not necessarily imply that these countries are immune to forex volatility, however. As a matter of fact, they appear to be unevenly affected by exchange rate volatility. Slovene exports do not seem to be linked to exchange rate volatility. For all specifications including real and nominal exports both in effective terms and to the euro area, the coefficient of exchange rate volatility is statistically insignificant except for the case of lagged volatility and FDI for nominal exports to the euro area. Moreover, the coefficient estimates for the rest of the variables in the model generally bear the expected signs when they are significant (except for the domestic relative price).

For Romania, it is difficult to establish cointegration for half of the cases. When cointegration is found, and if the coefficient estimate is significant at any standard significance level, volatility is negatively correlated to exports. However, this only holds for nominal exports. For year-on-year changes, a statistically significant negative relationship is found between exports and lagged forex volatility. The biggest impact of forex volatility on exports could be established for Croatia. Although mostly unimportant when volatility is used in a contemporaneous manner, volatility included with a lag of 12 months is associated negatively with exports, and this relationship appears to be particularly robust: not only are the results very similar for nominal and real exports but they are also very comparable regardless of the estimation method used (DOLS, ARDL or year-on-year changes).<sup>15</sup>

<sup>13</sup>The full results are available upon request from the authors.

<sup>14</sup>Therefore, we do not construct dummies capturing nonexisting changes in the exchange rate regime.

<sup>15</sup>The fact that the coefficient estimates, if significant, usually bear the expected sign deserves mention. For real exports, the sign on the real exchange rate is, however, negative, which indicates that an appreciation of the exchange rate is associated with an increase in exports. The sign on FDI time and again has a counterintuitive negative sign.



## 5.2 The Czech Republic, Hungary, Poland, Russia and Slovakia

This section dissects the results obtained for the group of countries which experienced a number of changes in the exchange rate regime. Putting the Czech Republic under the microscope reveals that exports, especially those to the euro area, are hampered by exchange rate volatility, conditioned on the other variables included in the export functions. This result comes instantaneously without using lagged variables. What is somewhat surprising is the finding that when using the dummy variables aimed at capturing volatility increases related to regime changes, the estimated coefficients usually turn out to be positive, indicating that the shift toward a more flexible regime tends to generate more export flows. This holds true for both dummy variables, each of which captures a somewhat different time period. A possible explanation for the fact that a negative relationship could be found between the direct measure of forex volatility and exports and that the relationship is reversed for the dummies may be that exchange rate volatility during the float and, perhaps more importantly, during the period prior to the float changed.

The story for Hungary is a little bit different than for the Czech Republic. For nominal and real exports, the direct volatility measure is mostly significant and always has a positive sign. However, when volatility is considered with a lag of 12 months, the coefficients switch sign all of a sudden. This is something that we could observe for the panel estimations; it indicates the delay with which an increase in exchange rate volatility (negatively) affects export flows. Such a delay might be the result of export contracts often extending as long as up to one year. Coming to the dummy variables, it appears that the dummy that covers the recent widening of the fluctuation bands to  $\pm 15\%$  most often has a negative sign, with or without lags. However, this observation only holds for the real export equation, as the relationship turns out to be rather insignificant for nominal exports. Regarding the dummy covering the period from 1995 to 2004, the results are conflicting in the sense that the direction of the relationship is fairly difficult to establish across the nominal and real export equations.

In Poland, we can partly observe the Hungarian story. For nominal exports, and for real exports, the effect of the lagged direct volatility measure on export flows is negative if there is a statistically significant relationship. Exactly the same applies for the first dummy spanning the period from October 1998 to September 2004: the lagged dummy always bears a negative sign. However, for the second dummy taking the value of 1 from March 2000 to September 2004, the sign is found to be consistently positive. A first explanation for this may be that exchange rate volatility generated by the widening of the fluctuation bands may have impacted negatively on exports, but after a while, poorly performing export firms dropped out, and only those which were able to cope with increased volatility remained. The second explanation is similar in spirit to the one provided for the Czech case. Over the period from 1998 to 2004, there may have been several forex volatility regimes. Thus, increased volatility took place after the widening of the bands, and volatility calmed down later on. This may

have coincided with the official move toward a free float, which did not generate any additional forex volatility.

The case of Slovakia contrasts with the findings for the other countries because the direct volatility measure seems to be positively associated with exports, and this assessment remains unchallenged even when using the volatility measure with lags. Concerning the impact of the different exchange rate regimes, the situation is astonishingly similar to that observed for Poland: the dummy variable that covers the period starting in January 1997 when the fluctuation margins were widened to  $\pm 7\%$  indicates a negative relationship between the regime shift and exports. However, starting with October 1998, when a managed float was officially introduced, does alter this conclusion, as the sign becomes positive. The two explanations put forwards for Poland may also apply here.

Let us now take a closer look at Russia, for which only exports in effective terms could be examined because of the unavailability of data for exports to the euro area or the U.S. economy alone. The results contradict each other, as both negative and positive signs can be found even if the positive signs appear to outweigh the negative ones. The fact that no clear relationship between volatility and exports could be found is not very surprising in the light of the high share of oil-related products in total exports (amounting to about 50% of total exports in 2003). Exports of oil-related products may be suspected to be linked more closely to the level of the (real) exchange rate than to its volatility. While for the other countries both the real exchange rate and the nominal exchange rate are correlated positively with exports, i.e. a depreciation results in an increase in exports, the results for Russia indicate the opposite to be the case, which is especially true of the real exchange rate: an appreciation of the exchange rate is linked to a rise in exports.

Table 7a. Exchange Rate Volatility and Real Exports for the Czech Republic and Russia

Czech Republic			Russia		
Real Exports					
VOL					
EFF	DOLS(0,3)SIC		EFF	DOLS(0,0)SIC	
	ARDL(1,1)SIC			ARDL(1,1)HQ	-0.052***
	YOY	0.016		YOY	0.004
EUR	DOLS(0,0)SIC	-0.026***	EUR	DOLS(0,0)SIC	0.045***
	ARDL(1,1)SIC	-0.028**	VOL12	ARDL(1,1)SIC	0.053***
	YOY	0.005	FDI12	YOY	0.044***
DUM1					
EFF	DOLS(0,0)SIC		EFF	DOLS(0,1)SIC	
	ARDL(2,2)SIC			ARDL(1,1)SIC	0.025
	YOY	0.071***		YOY	0.111***
EUR	DOLS(1,0)HQ	-0.035**			
	ARDL(1,1)SIC				
	YOY	0.069***			
DUM2					
EFF	DOLS(0,3)SIC				
	ARDL(2,2)SIC				
	YOY	0.065***			
EUR	DOLS(0,0)SIC	0.008			
	ARDL(1,1)SIC				
	YOY	0.065***			

Notes: The lag structure is shown in parentheses after DOLS and ARDL. YOY refers to the OLS estimates on year-on-year changes. VOL is the direct volatility measures, DUM1 and DUM2 are the dummies shown in Table 4. EFF indicates effective exports while EUR is exports to the Euro area. VOL12 and FDI12 show that volatility and FDI are used with a lag of 12 months. \*, \*\* and \*\*\* indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 7b. Exchange Rate Volatility and Nominal Exports for the Czech Republic and Russia

Czech Republic			Russia		
Nominal Exports					
VOL					
EFF	DOLS(0,0)SIC	-0.022**	EFF	DOLS(4,4)SIC	-0.002
	ARDL(1,1)SIC	-0.024		ARDL(1,1)HQ	-0.024**
	YOY	0.002		YOY	0.025
EUR	DOLS(0,0)SIC	-0.072***	EUR	DOLS(0,0)SIC	0.042***
	ARDL(1,1)SIC		VOL12	ARDL(1,1)SIC	0.043***
	YOY	-0.013	FDI12	YOY	0.065***
DUM1					
EFF	DOLS(0,0)SIC	0.068**	EFF	DOLS(0,0)SIC	-0.155**
	ARDL(2,2)SIC	0.081		ARDL(2,2)SIC	
	YOY	0.076***		YOY	0.043
EUR	DOLS(0,0)SIC				
	ARDL(1,1)SIC				
	YOY	0.124***			
DUM2					
EFF	DOLS(3,3)HQ	0.062***			
	ARDL(1,1)SIC	0.058			
	YOY	0.077***			
EUR	DOLS(3,4)AIC				
	ARDL(1,1)SIC				
	YOY	0.182***			

Notes: As for Table 7a.

Table 7c. Exchange Rate Volatility and Real Exports for Hungary, Poland and Slovakia

Hungary			Poland			Slovakia		
Real Exports								
VOL								
EFF	DOLS(0,0)SIC	0.082***	EFF	DOLS(0,0)SIC		EFF	DOLS(0,0)SIC	0.099***
	ARDL(4,4)FIX	0.116***		ARDL(1,1)SIC			ARDL(1,1)SIC	
	YOY	0.057**		YOY	-0.03		YOY	0.081***
EUR	DOLS(0,0)SIC		EUR	DOLS(4,4)SIC		EUR	DOLS(0,0)SIC	0.029**
	ARDL(2,2)SIC			ARDL(1,1)SIC			ARDL(1,1)SIC	
	YOY	0.079***		YOY	-0.045			
EFF	DOLS(0,0)SIC	-0.06***	EFF	DOLS(0,2)HQ	-0.069*			
VOL12	ARDL(4,4)FIX	-0.102**	VOL12	ARDL(1,1)SIC				
	YOY	-0.127***	FDI12	YOY	0.029			
EUR	DOLS(0,0)SIC		EUR	DOLS(0,0)SIC				
VOL12	ARDL(2,2)SIC		VOL12	ARDL(1,1)SIC				
	YOY	-0.09***	FDI12	YOY	0.029			
DUM1								
EFF	DOLS(0,0)SIC	-0.074**	EFF	DOLS(0,0)SIC	0.069***	EFF	DOLS(0,0)SIC	-0.162***
	ARDL(2,2)SIC	-0.164**		ARDL(1,1)SIC			ARDL(1,1)SIC	
	YOY	0.083**		YOY	-0.013		YOY	0.066
EUR	DOLS(0,0)SIC		EUR	DOLS(1,0)SIC		EUR	DOLS(1,0)SIC	-0.063***
	ARDL(2,2)SIC	-0.185**		ARDL(1,1)SIC			ARDL(1,1)SIC	
	YOY	0.02		YOY	-0.004		YOY	0.029
EUR	DOLS(4,4)FIX	-0.115***	EFF	DOLS(0,2)HQ	-0.05*			
VOL12	ARDL(2,2)SIC	-0.204***	FDI12	ARDL(1,1)SIC				
	YOY	-0.049*		YOY	-0.048			
			EUR	DOLS(0,2)HQ	-0.088***			
			FDI12	ARDL(1,1)SIC				
				YOY	-0.04			
DUM2								
EFF	DOLS(0,0)SIC	-0.018	EFF	DOLS(0,4)AIC	0.098***	EFF	DOLS(1,2)AIC	0.218***
	ARDL(4,4)FIX	0.013		ARDL(1,1)SIC			ARDL(1,1)SIC	
	YOY	0.094***		YOY	0.097***		YOY	0.088***
EUR	DOLS(0,0)SIC		EUR	DOLS(0,0)SIC	0.178***	EUR	DOLS(0,0)SIC	0.157***
	ARDL(2,2)SIC	0.014		ARDL(1,1)SIC			ARDL(1,1)SIC	
	YOY	0.102***		YOY	0.088***		YOY	0.041**

Notes: As for table 7a.

Table 7d. Exchange Rate Volatility and Nominal Exports for Hungary, Poland and Slovakia

Hungary			Poland			Slovakia		
Nominal Exports								
EFF	DOLS(0,0)SIC	0.03***	EFF	DOLS(0,0)SIC	0.097***	EFF	DOLS(0,0)SIC	0.058***
	ARDL(2,2)SIC	0.04*		ARDL(1,1)SIC			ARDL(1,1)SIC	
	YOY	0.04***		YOY	-0.028		YOY	0.14***
EUR	DOLS(0,0)SIC	0.033***	EUR	DOLS(0,0)SIC	0.11***	EUR	DOLS(0,0)AIC	-0.104*
	ARDL(1,1)SIC			ARDL(1,1)SIC			ARDL(1,1)FIX	-0.132*
	YOY	0.064***		YOY	0.018		YOY	-0.064
EFF	DOLS(0,0)SIC	-0.039***	EFF	DOLS(0,0)HQ	-0.051***	EUR	DOLS(0,0)AIC	0.124***
VOL12	ARDL(1,1)FIX		VOL12	ARDL(1,1)SIC		VOL12	ARDL(1,1)SIC	
	YOY	-0.06***	FDI12	YOY	-0.067**	FDI12	YOY	0.139***
EUR	DOLS(0,0)SIC	-0.025***	EUR	DOLS(0,0)SIC	-0.06***			
VOL12	ARDL(3,3)AIC	-0.033**	VOL12	ARDL(1,1)SIC				
	YOY	-0.071***	FDI12	YOY	-0.121***			
DUM1								
EFF	DOLS(0,0)SIC	-0.016	EFF	DOLS(4,4)AIC		EFF	DOLS(1,0)AIC	-0.166***
	ARDL(4,4)AIC	-0.01		ARDL(1,1)SIC			ARDL(1,1)SIC	
	YOY	0.134***		YOY	-0.09***		YOY	0.069**
EUR	DOLS(0,0)SIC	-0.005	EUR	DOLS(4,4)AIC		EUR	DOLS(0,0)SIC	-0.179***
	ARDL(2,2)SIC			ARDL(1,1)SIC			ARDL(3,3)AIC	0.197***
	YOY	0.083		YOY	-0.018		YOY	0.02
			EFF	DOLS(0,0)SIC	-0.068***	EUR	DOLS(1,0)AIC	-0.096*
			FDI12	ARDL(1,1)SIC		VOL12	ARDL(1,1)SIC	
				YOY	-0.087***	FDI12	YOY	-0.108*
			EUR	DOLS(0,0)SIC	0.021			
			FDI12	ARDL(1,1)SIC	-0.059*			
DUM2								
EFF	DOLS(0,0)SIC	-0.091*	EFF	DOLS(0,0)SIC	0.044	EFF	DOLS(1,1)AIC	0.155***
	ARDL(4,4)AIC	-0.098		ARDL(1,1)SIC			ARDL(1,1)SIC	
	YOY	0.063**		YOY	0.112***		YOY	0.113***
EUR	DOLS(0,0)SIC	-0.111*	EUR	DOLS(0,0)SIC		EUR	DOLS(0,4)AIC	-0.136
	ARDL(1,1)SIC	-0.088		ARDL(1,1)SIC			ARDL(1,1)SIC	
	YOY	-0.135***		YOY	0.059*		YOY	-0.013
						EUR	DOLS(0,0)SIC	0.207**
						FDI12	ARDL(1,1)SIC	
							YOY	0.036

Notes: As for table 7a.

Table 7e. Exchange Rate Volatility and Exports for Slovenia, Romania and Croatia

Slovenia			Romania			Croatia		
Real Exports								
EFF	DOLS(0,0)SIC	0.032	EFF	DOLS(0,4)SIC	-0.03*	EFF	DOLS(4,1)AIC	0.172
	ARDL(3,3)SIC	0.02		ARDL(2,2)SIC			ARDL(1,1)SIC	
	YOY	0.043		YOY	0.000		YOY	-0.346**
EUR	DOLS(0,0)SIC	0.015	EUR	DOLS(0,3)SIC	-0.017	EUR	DOLS(0,0)SIC	0.028
	ARDL(3,3)SIC	0.016		ARDL(2,2)SIC			ARDL(4,4)AIC	0.034
	YOY	-0.006		YOY	0.006		YOY	0.103
			EFF	DOLS(0,4)SIC		EUR	DOLS(4,1)SIC	-0.087*
				VOL12 ARDL(2,2)SIC			ARDL(4,4)FIX	-0.071*
			FDI12	YOY	-0.034*		YOY	-0.134*
			EUR	DOLS(0,0)SIC				
				VOL12 ARDL(2,2)SIC				
			FDI12	YOY	-0.041*			
Nominal Exports								
EFF	DOLS(0,0)SIC	-0.004	EFF	DOLS(0,1)SIC	-0.019	EFF	DOLS(0,0)SIC	-0.057
	ARDL(3,3)SIC	0.014		ARDL(2,2)SIC			ARDL(1,1)SIC	
	YOY	0.033		YOY	0.004		YOY	-0.458***
EUR	DOLS(0,0)SIC	-0.052*	EUR	DOLS(3,4)AIC	0.012	EUR	DOLS(3,3)AIC	0.035
	VOL12 ARDL(1,1)SIC	-0.058		ARDL(1,1)SIC			ARDL(2,2)SIC	
	FDI12	YOY		YOY	0.061		YOY	0.090
						EFF	DOLS(0,0)SIC	0.124*
							VOL12 ARDL(1,1)SIC	
							FDI12	YOY
								0.1
EUR			EUR			EUR	DOLS(1,0)AIC	-0.083**
							VOL12 ARDL(2,2)AIC	-0.125***
	FDI12	YOY		FDI12	YOY		FDI12	YOY
		-0.21***			-0.21***			-0.21***

Notes: As for table 7a.

## 6 Concluding Remarks

In this paper, we made an attempt to provide answers to the questions of whether changes in exchange rate regimes and exchange rate volatility have any impact on the exports of transition economies.

The countries under study can be divided into two broad groups reflecting the evolution of exchange rate regimes over time. One group of countries, including the Czech Republic, Hungary, Poland and Slovakia, started transition with pegged regimes and then moved, at different paces, toward more flexibility. Bulgaria first had a managed float and then switched to a currency board in 1997. Russia and Ukraine experienced cyclical movements from flexibility to more rigid regimes and then back again to more flexibility. The second group, containing Croatia, Romania and Slovenia, have experienced no changes in their exchange rate regimes for the last ten years or so.

Both the direct impact of forex volatility and the indirect impact via changes in the exchange rate regime were assessed on the basis of standard export equations, augmented with FDI, which captures the very essence of economic transformation. The estimation results for panels, including ten and eight transition economies, suggest that a rise in forex volatility measured either directly or via changes in the exchange rate regime weakens exports to some extent, and that this negative impact is transmitted with some delay rather than being instantaneous. A meticulous look at sectoral exports confirms this finding in the sectors chemicals and different types of manufacturing. These sectors, together providing up to 80% of total exports, are found to suffer from increased exchange rate volatility.

More country-specific insights can be gained from time series estimations based on cointegration and using year-on-year changes in the variables. The results range from one end of the spectrum to the other. For some countries, such as Slovenia and Russia, there is little evidence in favor of a negative relation between forex volatility and exports. This outcome is not surprising in view of the low observed volatility of the Slovenian tolar, as the Bank of Slovenia was trying to target not only the level but also the volatility of the exchange rate. An explanation for Russia's insensitivity toward forex volatility might be the high share of oil-related products in total exports (close to 50%), the demand for which depends more on the level of the exchange rate than on its variance. There is some weak evidence for Romania. Croatia, the Czech Republic, Hungary and Poland are located at the other end of the spectrum; for these countries, the estimation results provide some evidence on the detrimental effect of forex volatility on exports. Although the results are sensitive to the use of real and nominal variables and to different estimation methods, some general conclusions may be drawn bearing these caveats in mind. While exchange rate volatility seems to have an instantaneous effect on exports in the Czech case, it feeds into poor export performance only with some delay in the three other countries. Regarding shifts in the exchange rate regime, more specifically a move toward more flexibility, it appears that the recent period of widening of the fluctuation bands to  $\pm 15\%$  in Hungary can be associated with a fall in exports, conditioned,



of course, on the other variables, such as foreign and domestic output, prices, the level of the exchange rate and FDI. For Poland and Slovakia, what we can observe is that the onset of more exchange rate flexibility is accompanied by a drop in exports, but exports seem to have recovered later on.

To summarize, we did not embark on this enterprise in vain, as we found convincing evidence that exchange rate volatility might impact negatively on export flows in the CEE transition economies. Hence, our project turns out to be not just another blur project. We also found that key exporting sectors, namely manufacturing, might be badly affected by exchange rate volatility. Nonetheless, country-specific results also showed that some countries are concerned to a large extent whereas others seem to be spared the toxic effect of exchange rate volatility. However, the countries with the largest share of manufacturing goods in total exports, such as the Czech Republic and Hungary, are found to be more likely to be exposed to exchange rate volatility than the others. Another reason for the higher vulnerability of these countries to forex volatility might be their large share of intraindustry trade in total trade, and in particular in manufacturing (Fontagné and Freudenberg, 1999).<sup>16</sup> Furthermore, this negative impact might be related to more exchange rate flexibility for some countries. This may be another important motivation for the new EU Member States, especially for Hungary, and perhaps to a lesser extent for the Czech Republic and Poland to push forward with efforts for an early adoption of the euro, which would bring back exports from the open sea to a haven of peace.

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<sup>16</sup>See Fidrmuc and Korhonen (2004) for the share of intraindustry trade in total trade of the countries under study.

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