

Enlargement of the European Union and Behavior of Real Exchange Rates

by

Ali M. Kutan* and Su Zhou

Kutan - Southern Illinois University Edwardsville; The Center for European Integration Studies (ZEI), Bonn;
and The William Davison Institute (WDI), Michigan.

Zhou - University of Texas at San Antonio

***Corresponding author and address:**

Ali M. Kutan, Economics and Finance Department, Southern Illinois University at Edwardsville, Edwardsville,
IL 62016-1102. USA

Email: akutan@siue.edu; Phone: (618) 650-34734; Fax: (618) 650-3047

Enlargement of the European Union and Behavior of Real Exchange Rates

Abstract

This paper extends the study of von Hagen and Neumann (1994) who investigated the conditional variance and the persistence of real exchange rate (RER) shocks between Germany and some core European Union (EU) members from January 1973 to November 1989. We update their sample through 2004 and include all EU15 countries to test whether the enlargement of the Union has reduced the variability and the persistence of RER shocks between Germany and the rest of the members during the 1990s. We also examine the impact of the introduction of the euro on the variance and persistence of real exchange shocks. Finally, we extend the analysis to the new members joined in May 2004. The results have implications for the economic cost of joining the Union, as well as assessing the timing of the newest members to enter the euro zone.

I. Introduction

This paper empirically investigates the conditional variance and persistence of real exchange rates (RER) of the European Union (EU) countries. We compare the variance and persistence of RER between Germany, which is used as a yardstick to represent the EU standards, and the rest of the Union members to assess the ability of the European Monetary Union (EMU) to reduce the economic costs of joining the Union for its members. Such a cost results from the loss of the nominal exchange rate flexibility as a tool for RER adjustment between countries subject to asymmetric shocks. Assuming sticky goods prices and wages, RER adjustment is quicker and easier through changes in nominal exchange rates rather than region-wide price level movements. If the Union members have been subject to larger and more persistent RER adjustments, then they have paid a larger cost of joining the EMU.

In this paper, we extend the von Hagen and Neumann (1994) study in several ways. First, they used a sample of EU countries, namely, Austria, Belgium, Denmark, France, Italy, Luxembourg, Netherlands and the United Kingdom (U.K), whereas we focus on two sets of countries. The first group includes the core EU15 members, while the second group covers the new ten EU members that joined in May 2004. Second, their sample period runs from 1973 to 1989, while we use a sample period extending 2004. This longer sample period provides more reliable estimates of RER shocks and hence the cost of EMU. It also allows us to assess the impact of the introduction of the euro on RER variability and persistence in the EMU. Finally, we extend

the analysis to the new ten members of the EU that joined in May 2004. We compare the variance and persistence of the new members' RER to those of Germany to assess whether these countries have made substantial progress toward entering to the euro zone. A stable RER adjustment between Germany and these countries would indicate that these countries would face a smaller cost of joining the euro-zone if they were to enter soon.

II. Review of Literature

Vaubel (1976 and 1978) argued that real exchange rate changes can provide a good basis for testing the conditions of joining a currency area, because the theoretical optimum currency area conditions are hard to test empirically. Observing large RER volatility in a currency union would suggest that shocks requiring RER adjustment are big and, therefore, a flexible nominal exchange rate regime would be preferred over a fixed exchange rate regime. Meltzer (1986) and Mussa (1986) used the variability of RER to assess the empirical characteristics of exchange rate regimes. As an application to currency unions, several researchers used the variations in real exchange rates to investigate whether a monetary union is desirable among a set of countries in a region. For example, Teolis and von Furstenberg (1993) and Khamfula and Huizinga (2004) used real exchange rate shocks to identify an optimal currency area for NAFTA and the Southern African Development Community countries, respectively. Vaubel (1978) and von Hagen and Neumann (1994) applied this criterion to

the case of a monetary union in Europe. Using data on real exchange rates for the European Community (EC) members during 1959-1976 and in various subperiods, Vaubel (1978) investigated the desirability of European currency unification. He found that the EC is not as a viable currency area as (the former) currency unions such as Germany and Italy.

von Hagen and Neumann (1994) examined the variability of RER shocks between Germany and some EU countries. Using Germany as a proxy to represent common European Monetary System (EMS) shocks and monthly data from 1973 to 1989, they found that RER variance declined significantly between Germany and the EMU countries in their sample. In addition, the persistence of RER changes between Germany and its EMS partners became similar. Based on these results, von Hagen and Neumann (1994) concluded that, although the conditions for joining EMU had improved, a “Europe of Two Speeds” exists. For example, Germany, her smaller members and France would form a viable union, but further real exchange rate adjustments needed between these countries and Denmark, Italy and the U.K.

In a more recent study, Haug, MacKinnon and Michelis (2000) analyzed the comovements of real exchange rates of 12 EU countries against the Deutschemark to test whether these countries would form a desirable economic and monetary union. Using cointegration techniques and monthly real exchange rate data from 1979 to 1995, they found that, unless several members make significant policy changes, the countries are less likely to form a union. However, a group of countries (Belgium, Denmark, France, Greece, Luxembourg, the

Netherlands, and the U.K) could form a successful union. Their results are consistent with von Hagen and Neumann (1994).

Overall, these studies suggest that a complete adjustment of real exchange rate changes has not been achieved in Europe when the sample period ends in 1995. In this paper, we extend the sample period through August 2004 and include all core and new EU (EU25) members.¹

III. Data and Sample Periods

Our sample includes all EU25 member countries, except Ireland.² Of which, our data set includes the following 14 EU founding members: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Greece, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the U.K. We use Germany as the reference country, representing EU standards. The sample includes 6 Exchange Rate Mechanism (ERM) countries, which began in March 1979: Belgium, Denmark, France, Italy, Luxembourg, Netherlands, and Germany (Italy left the ERM in September 1992). Since January 1999, the euro became the currency for Austria, Finland, Portugal, Spain, and the six ERM members, as well as Ireland but not Denmark. Greece adopted the euro since January 2001. Denmark, Sweden, and the United Kingdom still continue to use their national currencies. Ten new EU

¹ There is a growing literature on the characteristics of real exchange rates in the accession countries of the EU. In this paper, we focus on real exchange rate linkages between Germany and the accession countries. For a survey of the literature on real exchange rates in the new EU accession countries, see Égert., Halpern, and MacDonald (2005).

² Irish CPI data were not available until 1997.

members, namely, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia, joined the EU on May 1, 2004.

We employ monthly data of the nominal exchange rates, consumer price indices, and short-term interest rates. Following von Hagen and Neumann (1994), CPI data are used to construct real exchange rates and data for interest rates are utilized as a measure of monetary policy. All data are obtained from the IFS. The entire sample period runs from January 1973 to August 2004. To assess the impact of the enlargement on RER exchanges over time, the sample span is divided into five periods:

- **Period I:** Pre-EMS period - 1973:1 – 1979:2.
- **Period II:** Early EMS period -1979:3 – 1983:3. During this period, the EMS did not prompt significant monetary discipline as it lacked credibility in fixing exchange rates.
- **Period III:** 1983:4–1990:12. Giavazzi and Spaventa (1990) and Artis and Taylor (1994) call this period as a ‘new EMS’ period because of a shift in the nature of the EMS towards less frequent exchange rate realignments and more collective actions towards internal adjustment.
- **Period IV:** Period IV starts from 1991 following the inauguration of Stage I of European Monetary Union (EMU), which involves the removal of the remaining restrictions on capital movements, increased coordination of individual members’ economic policies and more intensive cooperation between central banks. Although the inauguration of Stage I of EMU was in July 1990, this sub-sample

period starts from January 1991 after the German unification of October 1990 to avoid the inclusion of a possibly disruptive factor and to allow for a transition period for the removal of capital controls in Stage I to be in effect.

Due to differences in data availability and to use all available data for each country, Period IV includes the following sample periods:

1. 1991:1 – 1998:12 for most of countries before the formation of the euro area.
2. 1992:1 – 1998:12 for Latvia and Slovenia, 1993:11 – 1998:12 for the Czech Republic, Estonia, Lithuania, and Slovakia,.
3. 1991:1 – 2000:12 for Greece before it entered the euro zone.

- **Period IV-A and IV-B:** We further divide Period IV into two periods because preliminary results indicated that the variability of RER shocks was higher in period IV than in period III for most of EU countries. Period IV-A runs from January 1991 through December 1995, while Period IV-B is from January 1996 through December 1998. The only exception is Greece for which Period IV-A runs from January 1991 through December 1997 and Period IV-B is from January 1998 to December 2000.

- **Period V:** This is the period following the launch of the euro. For all the countries, except Greece, the sample period is 1999:1 – 2004:8, and it is 2001:1 – 2004:8 for Greece, which adopted the euro in January 2001.

IV. Empirical investigation

For the period before the formation of the euro area, real exchange rates between EU members and Germany are defined as:

$$\text{RER}_t = p_{k,t} - p_{gm,t} - s_{k,t} \quad (1)$$

where $s_{k,t}$ is the log of country k 's currency price of a German mark, $p_{k,t}$ and $p_{gm,t}$ are the logs of country k 's CPI and German CPI, respectively. Similarly, real exchange rate between a euro-area country and Germany is defined as:

$$\text{RER}_t = p_{k,t} - p_{gm,t} \quad (2)$$

and between a non-euro-area country and Germany,

$$\text{RER}_t = p_{k,t} - p_{gm,t} - s_{k,eu,t} \quad (3)$$

where $s_{k,eu,t}$ is the log of country k 's currency price of an euro.

To compute the variability of RER shocks, we follow the methodology used in von Hagen and Neumann (p. 238):

1. Take the first difference of RER_t to get the changes in RER, i.e., ΔRER .
2. Regress ΔRER on a set of 12 monthly dummies (excluding the intercept) and use the residuals, $R_{k,t}$, as seasonally adjusted RER changes [von Hagen and Neumann, p. 238, equation (3a)].

3. Regress $R_{k,t}$ on six own lags to obtain residuals as the unexpected component of RER changes, i.e., RER shocks.
4. Compute the standard deviations of these RER shocks as a measure of the variability of RER shocks.

Table 1 reports the standard deviations of these RER shocks as a measure of the variability of RER shocks. Looking at the euro-zone members first, the results indicate, there is a significant decline in the variance of the shocks over time for all countries. The exception is Period IV-A in which there is an increase in RER shocks for all countries against Germany due to the exchange rate crisis in 1993. Indeed, the findings for periods IV-A and IV-B shows that (1) higher variability of RER shocks in the 1990s is likely due to the European currency crises of the early 1990s, (2) the variability of RER shocks for most of EU countries was lower before they entered the euro zone. The introduction of the euro further decreased the RER variance between Germany and the members, but increased RER volatility between Germany and the Netherlands. For three EU countries whose currency have not been included in the ERM during the 1980s or in the euro zone, the biggest decline in RER volatility is observed for Denmark; the introduction of the euro did not have much impact on the volatility between Germany and Denmark, however. For both Sweden and the U.K., no significant decline in the variance of the RER shocks is observed till the introduction of the euro. However, a significant decline in the variance of the RER shocks between Germany and Sweden is observed after the establishment of the euro, but not between Germany and the U.K. For the new EU members of May 2004, a

comparison of the findings between Period IV (1992-98) and Period V (1999-04) shows a significant decline in the variance of the RER shocks due to the establishment of the euro. The only exception is Hungary. The variance of RER shocks increased between Germany and this country with the introduction of the euro.

Displayed in Table 2 are the results of White's test for heteroskedasticity to check the statistical significance of the changes in RER variances between two consecutive periods. Looking at the results first for EMS or euro zone countries, we observe no statistically significant change in RER variances for all the countries between Period I (1973-79) and Period (1979-83), except for Austria and Italy. Starting with Period III (1983-90), we see a statistically significant change in RER variances for all the countries, suggesting that specific EMS effect was felt beginning in early 1980s. This trend of changing RER variance continues with the introduction of the euro. For those EU countries not in the euro zone, Sweden and the U.K. do not show any significant changes in RER shocks against Germany over time but Denmark does. In terms of the new EU members, Cyprus, Estonia, Latvia, Lithuania, Malta, and Slovenia all indicate a significant change in RER variances against Germany between the periods of 1993-98 and 1999-04, while the early reformers namely, the Czech Republic, Hungary and Poland, do not show any significant changes in RER variances between the two periods, perhaps indicating a policy of maintaining trade competitiveness.

In addition to the variance of RER changes, the persistence of RER shocks is another important characteristic of currency unions. If the economies are more integrated regionally, then we should observe less persistent changes in RER. As measures of persistence, Table 3 lists the first-order autocorrelation of monthly ΔRER and the corresponding marginal significance levels of the tests statistics.³ A finding of a positive autocorrelation coefficient and a large number of significant coefficients show that RER changes do not have a tendency to be reverted over time. Such very persistent RER shocks in a region would suggest that the region does not satisfy the conditions to have a viable currency area. The results in Table 3 indicate significantly negative autocorrelation coefficients for Austria, Belgium, Denmark, France, Italy, Luxembourg, and Netherlands (versus Germany). This finding is interesting because von Hagen and Neumann (1994) reported significantly negative autocorrelation coefficients for only Austria. The results suggest that several member countries' RER convergence with Germany has improved over time. Most of these seven countries were in the ERM for long time. Although Denmark has not joined the euro zone, it has kept pegging its currency value to the German mark and then the euro; as a result, it has reached high level RER convergence with Germany. However, neither the U.K nor Sweden exhibit significantly negative autocorrelation coefficients. For the new accession countries, Cyprus is the only country that does exhibit significantly negative autocorrelation

³ For comparison purposes, the results reported in Tables 1-3 in this paper correspond to Tables 1-3 in von Hagen and Neumann (1994, pp. 238-241).

coefficient but only after the introduction of the euro. It seems that the establishment of the euro (Period V) did not reduce persistent RER shocks in the accession countries that existed in Period IV.

In order to show some sort of connection between the variability of RER shocks and monetary policy coordination, following von Hagen and Neumann (1994), we next examine the difference in the changes in money market rates of EU countries, indicating the degree of monetary policy coordination in the region. Let \mathbf{Id} be the difference in month-to-month changes in money market rates between Germany and other EU countries:

$$\mathbf{Id}_t = \Delta I_{gm,t} - \Delta I_{k,t} \quad (4)$$

where $\Delta I_{gm,t}$ and $\Delta I_{k,t}$ are the monthly changes in the interest rates of Germany and country k , respectively. A smaller \mathbf{Id} and lower variability of \mathbf{Id} indicate a higher degree of policy coordination.

Table 4 reports mean absolute deviations (MAD) and standard deviations (STD) of the differences in the interest-rate changes. The results show that Group One countries' \mathbf{Id} were generally smaller than those of Group Two and Three in the 1980s and 90s. All EU members' \mathbf{Id} , save Greece and the U.K., have been reduced to a rather low level before the formation of the euro zone and kept low since then. Finally, the results

for the new EU members show that their interest rate fluctuations were notably reduced in recent years, indicating that monetary policy coordination and the decline in RER shocks coincided with each other.⁴

The main findings in Tables 1-4 can be summarized as follows:

1. The variability and the persistence of RER shocks of the EU founding members declined significantly during the 1980s and the late 1990s. There existed a “EU of Three Speeds” before the introduction of the euro.

- Group One: Austria and 6 ERM countries (Belgium, Denmark, France, Italy, Luxembourg, the Netherlands) except Italy (who left the ERM in September 1992).
- Group Two: Other EU countries that were going to adopt the euro.
- Group Three: Sweden and the U.K. who continue to use their national currencies.

Group One countries have experienced lower variability of RER shocks than the other EU members. Their RER changes were no longer very persistent in the 1980s and 90s. The variability of RER shocks in Group Two countries was significantly reduced to the level relatively lower than that of Group Three countries. Their RER changes were highly persistent until the late 1990s. Group Three countries have higher variability of RER shocks.

⁴ We do not report the corresponding results for Table 4 in von Hagen and Neumann (1994) based on money supply measures (as another measure of policy coordination), because we do not have consistent set of money supply measures for the EU and non-EU countries.

2. The process of RER convergence continues within the EU for the period beyond the sample of von Hagen and Neumann (1994), especially after the launch of the euro.

However, we still observe a “EU of Three Speeds”. Group Three continues to have higher variability of RER shocks than Group One and Two. While the variance of RER shocks of Group Two countries become comparable to those of Group One, their RER changes appear to be more persistent than those of Group One. This is made evident by that the first-order autocorrelation coefficients of RER changes for Group One countries are significantly negative for the 1999-2004 period, indicating a tendency of RER changes to be reverted over time, whereas those of other EU countries do not show such a tendency.

3. The reduction in the variability of RER shocks coincides with monetary policy coordination. Group One countries had generally smaller and lower variability of changes in money market rates between Germany and other EU countries than those of Group Two and Three in the 1980s and 90s, indicating a higher degree of policy coordination for the Group One. All EU members’ variability of changes in money market rates against Germany, except those of Greece and the U.K., have been reduced to a relatively low level before the formation of the euro zone and it has been maintained since then.

V. Conclusion

This paper investigates the conditional variance and the persistence of real exchange rate (RER) shocks between Germany and all European Union (EU) members since January 1973. We test whether the enlargement of the Union over time has reduced the variability and the persistence of RER shocks between Germany, which is assumed to represent EU standards, and the rest of the members, including the most recent members that joined in May 2004. We also examine the impact of the introduction of the euro on the variance and persistence of real exchange shocks. We also test whether monetary policy coordination and changes in RER shocks have coincided over time.

We find the variability and the persistence of RER shocks of the EU founding members declined significantly during the 1980s and the late 1990s. There existed a “EU of Three Speeds” before the introduction of the euro. The reduction in the variability and the persistence of RER shocks coincides with monetary policy coordination. The process of RER convergence continues after the launch of the euro.

Our results the new EU accession members have implications for their timing of adopting the euro. If we were to view the conditions for entering the euro zone as (i) low variability of RER shocks, (ii) small differences in the changes in money market rates and low variability of such differences (high monetary policy coordination), and (iii) RER shocks are not positively serially correlated, four out of the ten members, namely Cyprus, Estonia, Malta, and Slovenia, seem to already have meet these conditions. Other accession countries

need to address their differences in economic policies and adjust them accordingly to be able to enter the euro zone in the near future. Otherwise, a two-speed entry to the euro zone is advisable to reduce the costs of joining the EMU.

References

- Artis, M.J. and Taylor, M.P. (1994). "The Stabilizing Effect of the ERM on Exchange Rates and Interest Rates: Some Nonparametric Tests". *International Monetary Fund Staff Papers* 41, 123-148.
- Égert, B., Halpern, L. and MacDonald, R. (2005). "Equilibrium Exchange Rates in Transition Economies: Taking Stock of the Issues, CEPR Discussion Paper No. 4807.
- Giavazzi, F. and Spaventa, L., 1990. The 'new EMS'. In: De Grauwe, P., Papademosand, L. (Eds.), *The European Monetary System in the 1990s*, Longman Inc., New York, pp. 65-85.
- Haug, A., MacKinnon, J.G., and Michelis, L. (2000). "European Monetary Union: A Cointegration Analysis" *Journal of International Money and Finance*, 19, 419-32.
- Khamfula, Y. and Huizinga, H. (2004). "The Southern African Development Community: Suitable for a Monetary Union?" *Journal of Development Economics*, 73, 699-714.
- Meltzer, A. H. (1986). "Size, Persistence and Interrelation of Nominal and Real Shocks." *Journal of Monetary Economics*, 17, 161-94.
- Mussa, M. (1986). "Nominal Exchange Rate Regimes and the Behavior of Real Exchange Rates: Evidence and Implications" in Karl Brunner and Allan H. Meltzer (eds.), *Real Business Cycles, Real Exchange Rates, and Actual Policies*. Carnegie Rochester Conference Series 25, Amsterdam: North Holland.
- Teolis, D. P. and von Furstenberg, G. M. (1993). "Reducing Real Exchange Rate Variability and Drift: Mexico on the Way to North American Monetary Union?" *North American Journal of Economics and Finance*, 4(2), 2534-69.
- Vaubel, R. (1976). "Real Exchange Rate Changes in European Community: The Empirical Evidence and its Implications for Currency Unification." *Weltwirtschaftliches Archiv*, 112, 423-70.
- Vaubel, R. (1978). "Real Exchange Rate Changes in European Community: A new Approach to the Determination of Optimum Currency Areas." *Journal of International Economics*, 8, 319-39.

von Hagen, J. and Neumann, M. J. M. (1994). "Real Exchange Rates Within and Between Currency Areas: How Far Away is EMU." *The Review of Economics and Statistics*, 76(2), 236-44.

Table 1. Standard Deviations of Real Exchange Rate (RER) Shocks (1/10000)

Period	AU	BE	DE	FI	FR	GR	IT	LU	NE	PO	SP	SW	UK
I	42	71	107	159	158	214	194	68	72	231	261	138	177
II	29	97	85	159	97	257	72	98	42	143	172	224	182
III	31	33	49	36	46	149	69	36	25	98	108	111	176
IV	33	50	65	167	58	95	175	51	25	118	118	176	164
IV-A	27	60	77	194	64	86	199	58	24	141	144	187	132
IV-B	24	16	19	49	31	78	61	20	15	29	32	146	135
V	20	17	19	23	16	20	18	23	25	25	22	96	140
	CY	CZ	ES	HU	LA	LI	MA	PL	SK	SN			
I	143	N.A.	N.A.	N.A.	N.A.	N.A.	146	N.A.	N.A.	N.A.			
II	142	N.A.	N.A.	242	N.A.	N.A.	161	N.A.	N.A.	N.A.			
III	114	N.A.	N.A.	409	N.A.	N.A.	120	N.A.	N.A.	N.A.			
IV	96	134	110	327	406	275	124	372	129	94			
V	61	118	42	411	132	158	88	349	145	34			

Notes: AU: Austria, BE: Belgium, DE: Denmark, FI: Finland, FR: France, IT: Italy, GR: Greece, LU: Luxembourg, NE: Netherlands, PO: Portugal, SP: Spain, SW: Sweden, UK: United Kingdom. CY: Cyprus, CZ: the Czech Republic, ES: Estonia, HU: Hungary, LA: Latvia, LI: Lithuania, MA: Malta, PL: Poland, SK: Slovakia, SN: Slovenia. Sample periods are I: 1973:1-1979:2, II: 1979:3-1983:3, III: 1983:4-1990:12, IV: 1992:1-1998:12 for LA and SN, 1993:1-1998:12 for CZ, ES, LI, and SK, 1991:1-2000:12 for GR, 1991:1-1998:12 for all other countries, V: 2001:1-2004:8 for GR and 1999:1-2004:8 for all other countries. IV-A and IV-B: 1991:1-1997:12 and 1998:1-2000:12 respectively for GR but 1991:1-1995:12 and 1996:1-1998:12 respectively for other EU founding members. N.A.= Not available.

Table 2. Tests for Constant Variances

<u>Sample</u>	<u>AU</u>	<u>BE</u>	<u>DE</u>	<u>FI</u>	<u>FR</u>	<u>GR</u>	<u>IT</u>	<u>LU</u>	<u>NE</u>	<u>PO</u>	<u>SP</u>	<u>SW</u>	<u>UK</u>
II / I	0.037	0.336	0.169	0.677	0.028	0.856	0.001	0.276	0.024	0.018	0.547	0.048	0.913
III / I	0.031	0.000	0.002	0.003	0.000	0.003	0.000	0.000	0.000	0.000	0.048	0.323	0.890
IV / I	0.059	0.017	0.020	0.450	0.000	0.000	0.190	0.044	0.000	0.000	0.032	0.227	0.629
V / I	0.001	0.000	0.001	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.049	0.355	0.030
V / IV	0.025	0.022	0.039	0.002	0.001	0.028	0.002	0.058	0.335	0.001	0.000	0.005	0.239
IV-B / IV-A	0.107	0.089	0.102	0.009	0.053	0.823	0.020	0.097	0.092	0.040	0.003	0.528	0.605
	<u>CY</u>	<u>CZ</u>	<u>ES</u>	<u>HU</u>	<u>LA</u>	<u>LI</u>	<u>MA</u>	<u>PL</u>	<u>SK</u>	<u>SN</u>			
V / VI	0.005	0.953	0.000	0.349	0.000	0.000	0.060	0.156	0.197	0.000			

Notes: Entries are the marginal significance levels of White's heteroskedasticity tests for constant conditional variances between the relevant samples. Also see notes to Table 1.

Table 3. First-Order Autocorrelation of Real Exchange Rate Changes

Period	AU	BE	DE	FI	FR	GR	IT	LU	NE	PO	SP	SW	UK
I	0.227 (0.048)	0.440 (0.000)	0.066 (0.567)	0.118 (0.304)	0.373 (0.001)	0.382 (0.001)	0.348 (0.002)	0.311 (0.007)	0.217 (0.058)	-0.007 (0.954)	0.200 (0.081)	0.091 (0.425)	0.322 (0.005)
II	0.235 (0.093)	0.269 (0.054)	0.234 (0.094)	0.338 (0.016)	0.286 (0.041)	0.060 (0.669)	0.343 (0.014)	0.264 (0.056)	0.346 (0.014)	0.469 (0.001)	0.292 (0.037)	0.374 (0.008)	0.523 (0.000)
III	0.024 (0.816)	-0.039 (0.704)	0.117 (0.254)	0.287 (0.005)	0.179 (0.082)	0.239 (0.020)	0.155 (0.131)	-0.023 (0.821)	-0.066 (0.518)	0.260 (0.001)	0.220 (0.032)	0.110 (0.283)	0.314 (0.002)
IV	0.124 (0.220)	0.116 (0.251)	0.271 (0.007)	0.455 (0.000)	0.165 (0.103)	0.248 (0.005)	0.350 (0.001)	0.035 (0.731)	0.114 (0.257)	0.240 (0.017)	0.306 (0.002)	0.414 (0.000)	0.424 (0.000)
IV-A	0.082 (0.520)	0.140 (0.270)	0.266 (0.036)	0.476 (0.000)	0.199 (0.118)	0.206 (0.056)	0.322 (0.011)	0.060 (0.639)	0.069 (0.587)	0.248 (0.051)	0.284 (0.025)	0.506 (0.000)	0.376 (0.003)
IV-B	0.204 (0.203)	-0.074 (0.644)	0.035 (0.825)	0.052 (0.746)	-0.121 (0.449)	0.290 (0.070)	0.156 (0.328)	-0.148 (0.356)	0.137 (0.392)	0.057 (0.721)	0.078 (0.625)	0.085 (0.597)	0.309 (0.054)
V	-0.425 (0.000)	-0.305 (0.011)	-0.227 (0.057)	-0.055 (0.648)	-0.372 (0.002)	-0.182 (0.211)	-0.335 (0.005)	-0.344 (0.004)	-0.227 (0.057)	-0.050 (0.678)	0.186 (0.119)	0.048 (0.691)	0.228 (0.056)
	CY	CZ	ES	HU	LA	LI	MA	PL	SK	SN			
IV	0.135 (0.181)	0.071 (0.538)	0.516 (0.000)	0.250 (0.013)	0.212 (0.049)	0.586 (0.000)	0.260 (0.010)	0.362 (0.000)	0.189 (0.104)	0.246 (0.022)			
V	-0.248 (0.038)	0.127 (0.288)	-0.081 (0.497)	0.266 (0.026)	0.342 (0.004)	0.243 (0.042)	0.176 (0.140)	0.214 (0.073)	0.165 (0.167)	-0.065 (0.587)			

Notes: The numbers in parentheses below the first-order autocorrelation coefficients are the marginal significance levels of the t -statistics for the significance of the coefficients.

Table 4. Mean Absolute Deviations and Standard Deviations of the Differences in the Interest-rate Changes (1/10000)

Period		AU	BE	DE	FI	FR	GR	IT	LU	NE	PO	SP	SW	UK
I	MAD	135	171	302	N.A.	129	N.A.	153	N.A.	217	N.A.	413	165	169
	STD	219	257	403	N.A.	221	N.A.	243	N.A.	326	N.A.	612	278	253
II	MAD	53	137	223	56	66	N.A.	52	N.A.	75	N.A.	263	105	180
	STD	71	183	291	87	98	N.A.	72	N.A.	111	N.A.	355	136	266
III	MAD	38	80	36	47	26	26	38	N.A.	26	165	98	62	69
	STD	54	106	54	71	38	45	52	N.A.	37	259	157	95	104
IV	MAD	18	21	51	40	33	37	37	25	15	95	34	177	45
	STD	25	38	110	67	70	53	64	44	19	194	49	989	61
IV-A	MAD	23	29	74	59	50	34	47	33	16	143	41	275	59
	STD	30	47	139	85	88	45	79	54	20	247	58	1258	75
IV-B	MAD	9	8	14	9	6	43	21	11	14	16	23	17	23
	STD	13	10	21	12	8	67	21	15	17	14	26	22	27
V	MAD	N.A.	N.A.	13	10	N.A.	18	10	N.A.	N.A.	N.A.	1	12	59
	STD	N.A.	N.A.	19	15	N.A.	14	14	N.A.	N.A.	N.A.	2	17	83
		CY	CZ	ES	HU	LA	LI	MA	PL	SK	SN			
IV	MAD	35	94	76	85	276	362	15	237	N.A.	523			
	STD	49	186	148	139	423	585	25	359	N.A.	1082			
V	MAD	33	17	31	45	75	96	17	70	23	44			
	STD	47	21	91	65	107	137	23	115	34	61			
V-B	MAD	23	14	5	53	40	62	19	59	20	36			
	STD	35	18	8	76	55	88	24	94	31	47			

Notes: The interest rates used are money market rates (line 60b in the IFS) for all the countries except Greece, Hungary, and Malta for which the Treasury bill rates (line 60c in the IFS) are utilized because their money market rates are not available. Period V-B: 2001:9-2004:8, Period I for Spain: 1974:1-1979:2, Period III for GR: 1985:3-1990:12, Period IV for CY: 1996:1-1998:12, for CZ: 1993:1-1998:12, for ES: 1993:9-1998:12, for LA: 1993:8-1998:12, for LI: 1993:12-1998:12, for SN: 1992:11-1998:12, for SK: 2001:1-2004:8, Period V and V-B for MA: 1999:1-2003:9 and 2000:10-2003:9 respectively, due to the availability of the data. All other sample periods are the same as those indicated in the notes to Table 1.