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Detection of implicit fluctuation bands and their credibility in EU candidate countries

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This paper attempts to identify implicit exchange-rate regimes for currencies of candidate countries vis-à-vis the euro. To that end, we apply three sequential procedures that consider the dynamics of exchange rates to data covering the period from 1999:01 to 2012:12. Our results would suggest that implicit bands have existed in many sub-periods for almost all currencies under study. Once we detect de facto discrepancies between de facto and de iure exchange-rate regimes, we make use of different methods to study the credibility of the detected fluctuation bands. The detected lack of credibility in a high percentage of the sample is robust to the use of several credibility tests, suggesting that economic agents do not behave as if these bands actually were in force at time of making their financial plans. These countries do not improve the confidence on the fluctuation bands as time evolves.

Keywords: credibility; exchange rates; exchange-rate regimes; implicit fluctuation bands
JEL Classification: F31; F33

1. Introduction

The Treaty on the European Union (EU) states that any European country may apply for membership if it respects the democratic values of the EU and is committed to promoting them.

The first step is for the country to meet the key criterion for accession (the so-called 'Copenhagen criteria'), being one of them is the ability to take on and implement effectively the obligations of membership, including adherence to the aims of political, Economic and Monetary Union (EMU). Indeed, one of the economic priorities of the 1999 and 2000 Accession Partnerships was the establishment of an annual surveillance for the candidate countries, aimed at preparing countries for the participation in the multilateral surveillance and economic policy coordination procedures currently in place in the EU as part of the EMU. The Pre-Accession Economic Programmes are part of this procedure, outlining the medium-term policy framework, including public finance objectives and structural reform priorities needed for EU accession, as

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well as offering an opportunity to develop the institutional and analytical capacity necessary to participate in EMU, particularly in the areas of multilateral surveillance and co-ordination of economic policies.

The current candidate countries (CCC) are Albania, Iceland, the former Yugoslav Republic of Macedonia, Montenegro, Serbia, and Turkey. All candidate countries except Albania and Macedonia have started accession negotiations, but the negotiations with Iceland were put on hold by the Icelandic government in May 2013.

Unlike Denmark, Sweden, or the UK, the adoption of the euro is not an option for the CCC of the EU, but an obligation. However, the CCC and the New Member States (NMS) can make decisions regarding the timing of this process. Joining EMU involves the loss of control over the nominal interest rate and the nominal exchange rate. At the same time, these countries will have to abide by the discipline imposed by the Maastricht convergence criteria (price stability, the duration of convergence, obtaining sound, and sustainable public finances and exchange-rate stability) and the Stability and Growth Pact.

The choice of exchange-rate policy becomes one of the most fundamental instruments for achieving macroeconomic stability, offering competitiveness and affecting the overall development of the economy. Prior to EU membership, CCC are free to adopt the exchange-rate regime of their choice and they can enter the EU with their prevailing exchange-rate regime. Since the assessment of exchange-rate stability includes as mandatory the participation for at least 2 years in the Exchange Rate Mechanism II (ERM II) linking the currencies of non-euro area, most of the CCC are expected to join it at some point after their accession to the EU.

Participation in ERM II could help CCC in stabilizing the exchange rate by anchoring the expectations and encouraging low and less volatile inflation, leading to lower risk premium and interest rates, as well as lower transaction costs. Additionally, participation in ERM II would invoke effective pressure for responsible macroeconomic policies and for consolidation and reforming of public finance above all, giving that any form of fixed exchange-rate regimes strictly requires consistent and sound macroeconomic policies. However, there are some potential problems associated with CCC participation in ERM-II. With limited exchange-rate flexibility and an environment of increasing capital mobility, the large capital inflows that will be directed towards these economies (mainly in the form of foreign direct investment) are expected to exert appreciating pressures on domestic currencies. Moreover, their financial systems are not fully developed posing problems in the transmission of the monetary policy. Finally, some credibility problems may arise from the fact that central parities are subject to realignment: in the case of CCC involved in a catching-up process the credibility of the central rate may be eroded over time.

These and other potential gains and shortcomings could have not gone unnoticed for some of the CCC and could have significantly affected their decision to participate de facto, but not de iure in the ERM II, establishing implicit bands and maintaining the exchange rate around a central parity while permitting enough flexibility to adjust to fundamental disequilibrium and allowing some degree of monetary policy discretion.[1] Indeed, the de facto exchange-rate policy adopted by monetary authorities has tended to differ from the announced de iure exchange-rate regime, which is why International Monetary Fund (IMF) classifications are not always a good guide to the true exchange-rate intentions of said authorities (see, for example, Bubula & Ötker-Robe, 2002; Levy-Yeyati & Sturzenegger, 2005; Reinhart & Rogoff, 2004; Shambaugh, 2004 among others).

This paper contributes to the existing economic literature by investigating the existence of implicit fluctuation bands in five of CCC (Iceland, the former Yugoslav Republic of Macedonia, Croatia, Serbia, and Turkey)[2] and by assessing their credibility. To that end, we first make use of three sequential procedures based on the exchange-rate behaviour during the period 1999–2012 to detect implicit bands, and we then apply several credibility measures to evaluate the perception of economic agents with respect to the commitment to maintain such implicit bands.

Most studies in the literature investigate exchange-rate regimes in emerging countries (Ferrari-Filho & De Paula, 2008; Piragic & Jameson, 2005 to name a few), very few explore them in NMS (see, e. g., Åslund, 2011; Bauer & Herz, 2005; Darvas, 2001; Josifidis, Allegret, & Pucar, 2013), but to the best of our knowledge, there is no previous research that empirically evaluate this issue for CCC.

The rest of the paper is organized as follows. In Section 2, we present the statistical procedures based on the evolution of the exchange rates vis-à-vis the euro used to detect implicit fluctuation bands and we examine in detail three instruments as different measures of robustness to determine the credibility of the identified fluctuation bands. In Section 3, we offer the empirical results identifying the de facto fluctuation bands and the sub-periods characterized by the absence of credibility in the exchange-rate system country by country for the five countries mentioned above, covering the period 1999–2012. Finally, in Section 4 some concluding remarks are provided.

2. Methodology

2.1. *Implicit fluctuation bands*

The ERM II was established in 1999 as a framework to manage the exchange rates between EU currencies and ensure stability. It is a regime of fixed exchange rates in which participating currencies can only fluctuate by a maximum of ±15% around the central euro rate, although tighter fluctuation bands can also be agreed. Indeed, the currencies participating in ERM II have remained broadly stable against the euro, trading at, or close to, their respective central rates, suggesting that narrower bands have been effectively implemented. As surveyed in Stockman (1999), proponents of narrow band target zones suggest them as substitutes of a monetary commitment. Giavazzi and Pagano (1988) argued that exchange arrangements like the predecessor of ERM II contributed to import credibility for domestic monetary policies, because differential inflation translates into real exchange-rate appreciation, reducing the policy-maker's incentive to inflate. Therefore, we explore the possibility of the existence of implicit fluctuations bands of ±1 or ±2.

Moreover, we also allow the occurrence of crawling bands, where the currency is maintained within certain fluctuation margins around a central rate and the central rate or margins are adjusted periodically at a fixed rate or in response to changes in selective quantitative indicators. This regime allows the monetary authorities to achieve a balance between the disinflation policy provided by a peg and the preservation of competitiveness. The desired balance between these two targets is obtained by adjusting the size of the preannounced devaluation of the reference rate. Both Hungary and Poland adopted this regime during most of the 1990s: Hungary followed a narrow band crawling peg and Poland adopted a wide band crawling peg (see, e.g. Coudert & Couharde, 2012; Szapáry, 2001). Campos and Torres (2007) and Rodríguez and Rodríguez (2003) contend that an exchange-rate crawling-band system can borrow a portion of those aspects of a target zone that lead to its stabilizing effects on the exchange rate. The main advantages are to avoid economic instability as a result of infrequent and discrete adjustments and to minimize the rate of uncertainty and volatility since the fluctuation in the exchange rate is kept minimal (Kane, 1988).[3]

In this section we will explain in detail the three procedures based on the dynamics of the exchange rate for the detection of implicit fluctuation bands. First, the descriptive procedure used by Reinhart and Rogoff (2004) is based on the monthly percentage variation of the absolute value of exchange rate. This method is based on the probabilities that this variation is maintained within a certain band, it can be ±1%, ±2%, or ±5%, for two or five rolling years. According to this

criterion, if the probability exceeds or equals 80%, we will conclude the existence of a de facto fixed monetary system during the time in which that percentage stays.

Nevertheless, one of the main limitations of this method, according to Ledesma-Rodríguez, Navarro-Ibáñez, Pérez-Rodríguez, and Sosvilla-Rivero (2005a), is the absence of a statistical significance contrast to corroborate the achieved results. To rectify this weakness, they propose a contrast in which the null hypothesis (H_0) says that the probability that the monthly exchange-rate percentage variation is maintained a band of ±1% or ±2% for 24 consecutive months (including the current one) is less or equal than the same threshold established by the above procedure (0.8).

One of the necessary requirements to apply this procedure is to ensure first normality and the absence of serial correlation of the series to analyse. For this reason, we take advantage of the Jarque–Bera, Kolmogorov–Smirnov test, and the test of von-Neumann. Having confirmed these two properties we are able to continue with the statistical test, which formally can be expressed in the following way:

$$H_0 : p \leq p_0,$$

$$H_1 : p > p_0,$$

where p represents the proportion of the population and p_0 is the established probability or threshold. Therefore, this contrast serves to determine if the population proportion is less or equal than a frequency p_0, accepting the absence of bands. According to these authors, the region's acceptance of the null hypothesis happens when $\hat{p} \leq \varepsilon$, $\hat{p}$ being the estimated sample proportion and $\varepsilon = p_0 + z_{1-\alpha}\sqrt{p_0 q_0}/\sqrt{n}$, where $z_{1-\alpha}$ is the critical value of standard normal distribution at confidence level of $1-\alpha$. On the other hand, $\sqrt{p_0 q_0}/\sqrt{n}$ indicates the population deviation, $q_0 = 1 - p_0$, and n is the sample size.

Another variant that also allows us to filter results by their statistical significance for the identification of the implicit fluctuation bands is proposed by Ledesma-Rodríguez, Navarro-Ibáñez, Pérez-Rodríguez, and Sosvilla-Rivero (2005b). Unlike the previous method, this approach does not offer a contrast on the probabilities, but directly on the monthly exchange-rate percentage variations. Based on the normality and independence assumptions, to test if the average of such variations is significantly less or equal than ±1% or ±2% over a period of 24 consecutive months:

$$H_0 : \mu \leq \mu_0,$$

$$H_1 : \mu > \mu_0,$$

where μ represents the population mean of these variations and μ_0 is the given mean (±1% or ±2%). In this contrast, the acceptance region happens when $\bar{x} \leq \varepsilon$, $\bar{x}$ being the sample mean and $\varepsilon = \mu_0 + t_{1-\alpha} S/\sqrt{n}$ where $t_{1-\alpha}$ is the critical value of the t-Student distribution at a confidence level of $1 - \alpha$, S is the quasi-variance and n is the sample size.

2.2. *Credibility test of fluctuation bands*

The entrance to the ERM II for many countries means an increase in the level of credibility about the monetary and exchange commitments made by monetary authorities, especially for those who have experienced inflationary periods, since it allows them to act as a real anchor on exchange-rate policy. Credibility becomes a key issue in examining the behaviour of a target zone agreement

such as the ERM II, since the possibility that the official authorities change the central parity could be anticipated by the economic agents, triggering expectations of future changes in the exchange rate that could act as a destabilizing element of the system. In this context, credibility refers to the perception of economic agents with respect to the commitment to maintain the exchange rate around a central parity. For this reason, in this section we present three alternative indicators as measures of credibility that have been widely used in the empirical literature.

2.2.1. *Svensson simple test*

The simple and robust Svensson (1991)'s method is an indicator that is commonly used to verify the credibility of the exchange-rate regime of a target zone exchange-rate regime with fluctuation bands. A target zone delimits explicitly what are the bands of appreciation and depreciation of the exchange rate.

Under the assumption of perfect capital mobility (which is the lack of opportunities for arbitrage between different currencies), the annualized rate of return in terms of the domestic currency, *ex post*, associated with the purchase of a financial asset at time t in foreign currency with a maturity period τ can be obtained from the following expression:

$$R_t^{\tau} = (1 + i_t^{*\tau})\left(\frac{S_{t+\tau}}{S_t}\right)^{12/\tau} - 1,$$

where the maturity period of the asset (τ) is measured in months. According to Svensson (1991), if an investor invests a national currency unit that is equivalent to say investing $1/S_t$ units of foreign currency, which means that, after the maturity period, the investor acquires a yield of $(1 + i_t^{*\tau})^{\tau/12}/S_t$ units of foreign currency. Once again, to express this performance in units of national currency it must be multiplied by the exchange rate ($S_{t+\tau}$) which is being equal to $(1 + R_t^{\tau})^{\tau/12}$.

By definition in a context of a target zone is expected that the exchange rate is between minimum ($\underline{S}$) and maximum ($\bar{S}$) limits. As the τ-month ahead exchange rate is uncertain at time t, the previous limits in the national currency appreciation and depreciation involve a delimitation of the rate of return, which is to be found between the lower limit ($\underline{R}_t^{\tau}$) and the upper limit ($\bar{R}_t^{\tau}$):

$$\underline{R}_t^{\tau} = (1 + i_t^{*\tau})\left(\frac{\underline{S}}{S_t}\right)^{12/\tau} - 1\ ; \quad \bar{R}_t^{\tau} = (1 + i_t^{*\tau})\left(\frac{\bar{S}}{S_t}\right)^{12/\tau} - 1.$$

It is necessary to clarify that even if the national interest rate is within these bands it cannot be guaranteed with firmness that the target zone is credible. On the other hand, if the domestic interest rate falls significantly outside of the return bands, we are able to confirm that this exchange-rate system during the period under study is not credible.

2.2.2. *Drift adjustment test*

Svensson (1991)'s test has been criticized because it cares only about the possibility of a realignment (change in the established central parity level) when the exchange rate is close to the fluctuation band limits. For this reason, we have selected another alternative procedure, known as the method of *Drift adjustment* (DA). This method, originally proposed by Bertola and Svensson (1993), consists of estimating, through a linear regression model, the realignment expectations of economic agents conditioned to have experienced one of these events before. This indicator,

reverse of the measure of credibility, is obtained by taking the uncovered interest parity hypothesis, decomposing the exchange rate into two components (central parity and exchange rate within the band) and taking into account that

$$E_t[\Delta x_{t+\tau}] = (1 - p_t^\tau)E_t\left[\frac{\Delta x_{t+\tau}}{\text{nr}}\right] + p_t^\tau E_t\left[\frac{\Delta x_{t+\tau}}{r}\right],$$

where p_t^τ is the probability determined at time t of experiencing a realignment during the period between t and $t + \tau$. The right side of the expression indicates if the expectation is conditioned to having submitted a realignment (r) or not having it experienced (nr). Moreover, taking into account the definition of devaluation, the following expression contains in its first term on the right side the expected realignment and in the second one its own expected depreciation within the band:

$$g_t^\tau = \frac{E_t[\Delta c_{t+\tau}]}{\tau} + \frac{p_t^\tau}{\tau}\left\{E_t\left[\frac{x_{t+\tau}}{r}\right] - E_t\left[\frac{x_{t+\tau}}{\text{nr}}\right]\right\}.$$

Finally, we obtain that

$$g_t^\tau = i_t - i_t^* - \frac{E_t[\Delta x_{t+\tau}/\text{nr}]}{\tau}.$$

To obtain the expected devaluation we proceed in the following way: first, we estimate the expected depreciation within the band conditioned on not having suffered any realignment (last term in the right side of this equation) and subsequently applying the interest rate differential we achieve g_t^τ. Instead of working with the point estimation, we calculate confidence intervals with a 0.10 significance level for our interest variable.

In order to estimate the expected depreciation within the band according to the DA method, we use the linear regression model proposed by Svensson (1993) in which the explanatory variables to consider are the logarithm of the distance of the exchange rate with respect to the central parity (x_t) and 3 months interbank interest rates, both national and Euro Zone (i_t and i_t^*, respectively):

$$\frac{x_{t+\tau} - x_t}{\tau} = \sum_j \alpha_j d_j + \beta_1 x_t + \beta_2 i_t + \beta_3 i_t^* + \epsilon_{t+\tau}.$$

The dummy variables d_j take value one during the sub-period between realignments and fluctuation bands enlargement.[4]

Since the expected depreciation with the band needs to be predicted taking into account that it is conditioned on not having experienced any episode of realignment, Svensson (1993) removes the observations associated with the 3 months preceding the realignments occurred. However, to avoid reducing the number of observations significantly, we follow the Ledesma-Rodríguez, Navarro-Ibáñez, Pérez-Rodríguez, and Sosvilla-Rivero (2000) and Ledesma-Rodríguez et al. (2005a)'s procedure, the estimation is based on the whole sample. This means that, instead of obtaining the expected devaluation g_t^τ, we get the expected realignment.

2.2.3. *Discrete choice models*

Since our interest is to be able to calculate the probability of realignment for these five countries, we consider non-linear probabilistic models that allow reliable estimates for the dichotomous variables. The most common models focus on the function of logistic and standard normal distribution, known as Logit and Probit models, respectively. This paper presents the results related to the Logit model, since the Logit and Probit estimated coefficients are very similar[5] (see, e.g. Ameniya, 1981, in which it is stated that: $\hat{\beta}_{\text{LOGIT}} = 1.6 * \hat{\beta}_{\text{PROBIT}}$).

Our dependent variable will be built based on the results obtained by the DA method in order to get estimated probabilities' time series. In particular, when both confidence interval limits of the expected depreciation within the band are greater or less than zero, we say that there is no credibility, assigning value 0 to the interest variable ($y_t = 0$) and when this condition is not fulfilled the dependent variable takes value 1 ($y_t = 1$), indicating credibility in the exchange system. The probability that agents assign the value 1 in a given moment can be calculated from the following expression:

$$P(y_t = 1) = \Lambda(\hat{z_t'}\,\beta) = \frac{e^{\hat{z_t'}\,\beta}}{1 + e^{\hat{z_t'}\,\beta}} ,$$

where $\hat{z_t'}\,\beta = \beta_1 + \beta_2 z_{1t}$, Λ (.) is the cumulative logistic distribution function, z_{1t} is the explanatory variable (this model considers the exchange rate, the distance from the central parity, the distance from the upper limit of the band, and the interest rates differential) and $P(y_t = 0)$ is the probability of realignment.

3. Empirical results

In this section we proceed with the detection of de facto fluctuation bands of the exchange rates for the five countries during the period 1999:01–2012:12 using the three sequential procedures. In addition, we analyse, country by country, the results of the three credibility indicators as a measure of robustness, making a comparison between them, trying to figure out which one is the most accurate in identifying stages of credibility crisis. The monthly exchange rates are spot rates expressed as domestic monetary units per euro and have been downloaded from the European Central Bank (ECB) and the Eurostat websites. Figure 1 (Panels A–E) reflects the evolution of the five countries exchange rates vis-à-vis the euro, besides their central parities and their fluctuation bands. We exhibit the main conclusions about the implicit fluctuation bands, country-by-country, relying on Table 1.[6]

Croatia: The behaviour of the Croatian kuna/euro exchange rate (HRK/EUR) shows patterns consistent with a de facto fixed exchange-rate regime that is endorsed by our detection criteria, although in a different degree. The contrast directly on average variations proposed by Ledesma-Rodríguez et al. (2005b) concluded the presence of ±2% and ±1% fluctuation bands in 100% of the sample, selecting the latter for being the narrowest. In the same line Reinhart and Rogoff (2004)'s method is positioned, who also identified that bands of ±2% throughout the period reduced this percentage to 74.85% of the sample after proceeding to its relevant statistical contrast (1999:01–2001:07 and 2003:04–2012:12). Analysing potential ±1% bands, the percentage is still quite significant, we are talking that the first procedure detects a 61.40% (1999:01–2001:07 and 2005:03–2012:12), keeping a 37.43% (2001:2001–01:03, 2006:04–2008:11, 2010:11–2012:12) in the second.

From Figure 1 (Panel A) can be seen two sharp declines in the exchange-rate HRK/EUR; the first, in July 2001 and the second episode is associated with the global financial crisis, which

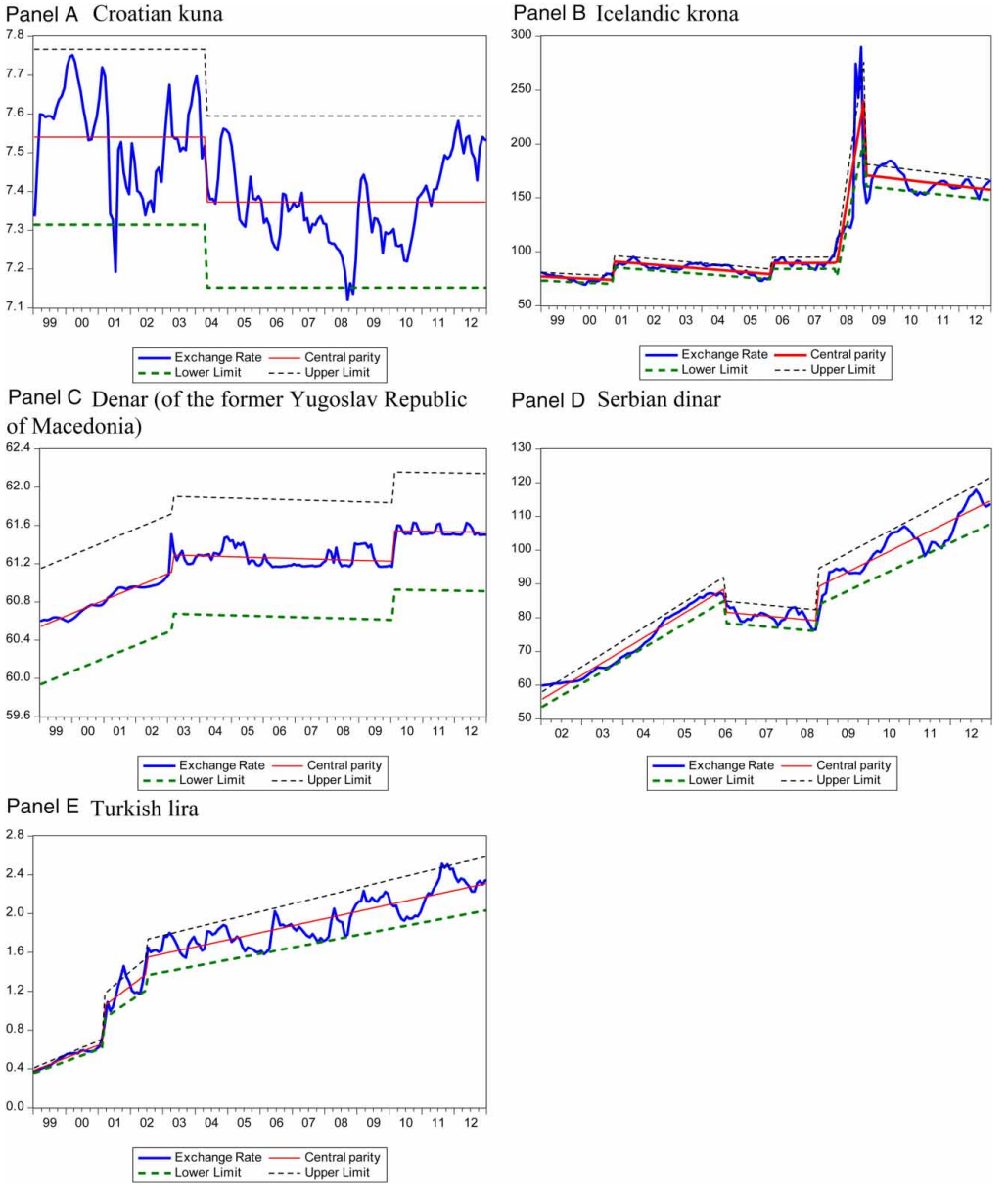

Figure 1. Evolution of the exchange rates vis-à-vis the euro, their central parities and their fluctuation bands. Panel A: Croatian kuna; Panel B: Icelandic krona; Panel C: Denar (of the former Yugoslav Republic of Macedonia); Panel D: Serbian dinar; and Panel E: Turkish lira.

eventually lead to the appreciation of the local currency in September and November 2008. Based on the Svensson (1991)'s test, both events have coincided with a lack of credibility in the fluctuation band by economic agents (Figure A1, Panel A in the Appendix). This figure shows high volatility in the credibility throughout the whole period identifying stages in which the evolution of the interest rate is above the return band and stages in which the opposite happens.

Table 1. Detection of ±1% or ±2% implicit fluctuation bands country-by-country using Reinhart and Rogoff (2004), Ledesma-Rodríguez et al. (2005a), and Ledesma-Rodríguez et al. (2005b)'s procedures.

Reinhart and Rogoff (2004)		Ledesma-Rodríguez et al. (2005a)		Ledesma-Rodríguez et al. (2005b)	
±1%	±2%	±1%	±2%	±1%	±2%
Croatia					
1999:01–2001:08 2005:03–2012:12	1999:01–2012:12	1999:01–2001:03 2006:04–2008:11 2010:11–2012:12	1999:01–2001:07 2003:04–2012:12	1999:01–2012:12	1999:01–2012:12
Iceland					
–	1999:01–2000:12 2003:12–2005:05 2011:05–2011:08 2012:01	–	–	2003:10–2005:09	1999:01–2008:12 2010:10–2012:12
Macedonia					
1999:01–2012:12	1999:01–2012:12	1999:01–2012:12	1999:01–2012:12	1999:01–2012:12	1999:01–2012:12
Serbia					
–	1999:01–2007:12 2010:07–2011:12	–	1999:01–2006:06 2010:12–2011:04	1999:01–2008:10 2010:04–2012:02	1999:01–2012:12
Turkey					
–	–	–	–	–	2004:06–2008:10 2010:02–2012:12

In addition to the phase associated with not much credibility after the realignment occurred in 2004:05, that the DA method detects from 2004:10 to 2005:02, other previous stages are identified (1999:12–2000:04, 2001: 07, and 2004:01) and subsequent phases coinciding with the financial crisis (2009:02–2009:03). The last criterion using all the explanatory variables reinforces the previously identified stages: 1999–2001, along with the stage at the end of 2008 and at the beginning of 2009.

Iceland: Beginning our analysis for the checking of the existence of ±2% fluctuation band in the exchange-rate Icelandic krona/euro (ISK/EUR), the last procedure is capable of specifying the following sub-periods 1999:01–2008:03, 2008:05, 2008:07–2008:08, 2008:10–2008:12, and 2010:10–2012:12 as those in which the exchange rate does not experiment deviations with respect to the above-mentioned bands. This 72.51% that it represents on the whole sample period moves away enough of the contributed ones for the remaining methods. The first one just determines a 14.04% (1999:01, 2003:12–2005:05, 2011:05–2011:08, and 2012:01), whereas the second one accepts the hypothesis of the absence of bands during the whole period. We do not also find any evidence of which the probability of these percentage absolute monthly variations of the exchange-rate ISK/EUR is under ±1% fluctuation bands in any subperiod, result that it reiterated after having been filtered through its statistical significance.

On the other hand, and taking into account that the critical region is above the average of percentage variations, this means the acceptance of the presence of minor or equal to ±1% bands for the following sub-periods: 2000:12, 2001:02–2001:03, 2003:10–2005:09, 2008:10–2008:11, 2012:01–2012:02, and 2012:04–2012:07 which represent a 20.47% of the sample.

The sharp depreciation of the exchange rate at the end of 2008 which can be perceived as quite remarkable from Figure 1 (Panel B) is due to the financial crisis that took place in this economy. Even though the interest rate is within the return bands during only 3 months, this fact does not guarantee, according to Svensson (1991) a period of credibility on the fluctuation bands. However, we can affirm that from October 2008 onwards there is evidence of a lack of credibility by the economic agents. In addition, the exchange-rate ISK/EUR also shows evidence of deviations from the minimum limit, both 2000:03–2000:05, 2005:10–2006:03, and 2010:08–2010:12, this situation is a consequence of the high lack of credibility associated with the fluctuation bands (see Figure A1, Panel B in Appendix). This argument is also applicable to stages in which the exchange rate has experienced deviations from the upper limits of the fluctuation bands (2009:08–2010:01).

The absence of credibility detected in 2001:03 by the DA mechanism (Figure A2, Panel B in Appendix) confirms the ability by the economic agents to anticipate correctly that the later (in 2001:04) would lead to a realignment of the exchange rate. This situation is reiterated in the third and fourth realignment, which takes place as a result of the economic crisis and the difficulties to refinance its short-term debt, leading to the collapse of three major commercial banks in its country.

Unlike prior procedures, in which a larger number of confidence crisis are detected, the binary choice method only identifies, by unanimity, the stage at the end of 2008, and at the beginning of 2009 (see Panel B in Figures A3 and A4 in Appendix).

The former Yugoslav Republic of Macedonia: In spite of the fact that Macedonia is a candidate country to became part of EU, the exchange-rate Denar (of the former Yugoslav Republic of Macedonia)/euro (MKD/EUR) presents a standard behaviour typical enough of an exchange system distinguished by the stability, which would suppose an impulse on trade and investment.[7] This statement has its base in the achieved results across the three sequential procedures that consider the exchange rate's dynamic. All of them support the existence of ±1% fluctuation bands and of ±2% throughout the whole period.

Although the exchange rate remains stable without deviating at any time from its fluctuation bands (Figure 1, Panel C), both the Svensson test and DA method confirm the lack of confidence in the exchange rate during this period. In Figure A1 (Panel C) the profitability associated with borrowing in foreign market to finally lend on the national one stays significantly away from the return bands. On the other hand, the expectation of depreciation within the band for this candidate country holds throughout the whole period, since both confidence interval limits are greater than zero (see Figure A2, Panel C in Appendix).

Serbia: The disparity between previous methods becomes evident for the Serbian dinar/euro exchange rate (RSD/EUR). If we focus on the potential band of ±1%, Reinhart and Rogoff (2004) and Ledesma-Rodríguez et al. (2005a)'s methods suggest the lack of ±1% bands. In contrast, the last criterion proposes the following sub-periods: 2010:04–2012:02 and 2012:05 as those in those where the average of percentage variations does not deviate from a ±1% band or from a narrower band (representing 60.74% of the sample). Major conformity seems to exist when ±2% fluctuation band is considered, though not so much in magnitude. The first mechanism is capable of detecting a 49.63% (1999:01–2007:12 and 2010:07–2011:12), the second one diminishes its percentage up to 26.67% (1999:01–2006:06 and 2010:12–2011:04), whereas the last one recognizes the totality of sample (in this case given the available information: 2002:01–2012:12).

Examining the behaviour of the Serbian dinar vis-à-vis the EUR, it can confirm how barely trading around the central parity in fact is often close to the upper and lower fluctuation bands (Figure 1, Panel D).

At the beginning of the period, the lack of credibility was clearly significant, but in spite of this scenario, a gradually reduction to its minimum in 2007:08 is achieved (Figure A1, Panel D in Appendix). From this date, since the return bands delimit the evolution of the exchange rate, the absence of credibility disappears, increasing again in 2009:01, a time when the interest rate stands at 18.61%. Given the availability of data from the interbank rate for this economy, we are unable to confirm whether the positive deviation from the upper limit of the fluctuation band has been due to the lack of credibility of the agents to these bands.

According to the DA procedure (Figure A2, Panel D in Appendix), the expected depreciation within the band becomes more important in 2004:02–2005:11, just at the moment in which realignments occur (2006:07 and 2008:10) and, like the Svensson test, from January to May 2009 and again in July 2010.

Figure A3 (Panel C) in Appendix shows a clear trend of increase in the probability of realignment as time evolves, presenting values around 0.61 in the two realignments upcoming dates. Around more than 50% is the probability for the first realignment when we analyse the distance from the central parity as an explanatory variable, a completely opposite situation for the second realignment, where barely reach 10% (Figure A4, Panel C in Appendix). Considering the distance from the upper limit of the fluctuation band,[8] we also identify a high volatility in the estimated probability of the exchange system collapse since at least this probability is around 30% at any time during the whole period.

Turkey: We do not find evidence that allows us to confirm the presence of ±1% not of ±2% implicit fluctuation bands for the Turkish lira/euro exchange rate (TRY/EUR) using the first two approaches. On the one hand, if we analyse Table 1, we can verify that the proportion of monthly TRY/EUR exchange-rate variation does not exceed threshold nor the critical region, respectively. On the other hand, the last procedure does not identify the presence of narrow bands of ±1%. Nevertheless, it is capable of detecting the following substages (2004:06–2008:10 and 2010:02–2012:12), in which the exchange rate does not turn aside ±2% bands representing 52.38% of the sample.

This other candidate country for EU membership does not present a clear trend of currency depreciation or appreciation; nevertheless, it identifies significant fluctuations during the 13 years examined (Figure 1, Panel E). As a consequence of speculative attacks, it has generated an uncertain environment supported by the three methods used as tools for robustness. First, the Svensson test shows no credibility from the beginning to the end of the period analysed, although it shows a downward trend, reducing significantly from mid-2005 (Figure A1, Panel E in Appendix). The DA method also offers a multitude of accurate dates for which the expected depreciation within the fluctuation band acquires more importance; among them, at the end of 1999, during 2001 and 2002 (coinciding with the realignment of 2001:03 and 2002:07) and subsequently to the extension of bands in 2004:05–2004:11, 2006:06, and 2011:08.

Finally, the discrete choice method shows an average probability of the expected realignment over than 20%. With the exception of Panel D of Figure A3 in Appendix, where an increase in agents' confidence is detected as we move away along the time horizon, the Panel D of Figure A4 in Appendix shows short periods but high distrust in the exchange rate over the whole sample period.

4. Conclusions

Having applied three sequential procedures based on the evolution of the exchange rate vis-à-vis the euro on five candidates countries to join the EU, our results suggest the presence of ±2% and

±1% implicit fluctuation band in high percentages of the sample period. These percentages vary depending on the methodology used, even reach 100% in countries such as Croatia, the former Yugoslav Republic of Macedonia and Serbia. Therefore, this paper provides new empirical evidence that strengthens the hypothesis that the implemented policies differ from those announced by the monetary authorities, identifying the existence of de facto fixed monetary systems along a large number of sub-periods for different currencies. In other words, it has been detected that many of these countries act as if they were already de facto (but not de iure) in the ERM-II, showing an evolution of their currencies consistent with the existence of fluctuation bands vis-à-vis the euro.

Nevertheless, the simple Svensson test, the DA method, and discrete choice models indicate lack of credibility for a high percentage of the sample in which the evolution of the exchange rate exceeds the detected minimum and/or maximum fluctuation bands' limits, suggesting that economic agents do not behave as if these bands actually were in force at the time of making their financial plans. Furthermore, these countries do not show signs of improvement in the confidence on the fluctuation bands as time evolves. In fact, in countries such as Croatia, the former Yugoslav Republic of Macedonia, and Turkey an important volatility in the credibility throughout the period analysed can be observed, a conclusion that is reinforced by the implementation of the three different methods. The other candidate countries reveal extended stages of absence of credibility accompanied by an upward trend in the probability of realignment.

It should be emphasized that the three alternative procedures have been able to capture accurately those stages of absence of credibility prior to those realignments that really occurred subsequently. In some cases, the three methods coincide identifying the sub-periods of lack of credibility, while in others they complement each other improving the results. On the other hand, the figures associated with the simple Svensson test reveal us a pattern of behaviour that can be seen in most of the analysed currencies: the domestic interest rate deviates quite often above the upper limit of the return band indicating the ease of borrowing abroad to subsequently lend in the domestic market.

Thus, it seems that the results offer a wide variety of strategies in the countries under study when they link de facto to the ERM-II to try on the one hand to capture the benefits of their participation (helping actively to stabilize their economies – especially on prices and consolidation of public accounts – and the increase in the governments reputation), moderating somewhat the potential problems arising from formal participation (de iure) in the ERM-II (primarily the possibility of currency appreciation episodes due to capital inflows, especially by foreign direct investment).

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Notes

1. For example, the latest Flash Eurobarometer issued by the European Commission ('Introduction of the euro in the Member States that have not yet adopted the common currency') indicates that over half of the respondents think that the impact of euro has been positive in the countries that have already adopted it, but a relative majority think that adopting the euro will mean that their country will lose control over its economic policy.
2. We will consider Croatia as a CCC since it becomes the 29th Member State of the EU from 1 July 2013. Regarding Iceland, although on 13 September 2013, the Government of Iceland suspended its application to join the EU, it was also a CCC during the examined sample. Nevertheless, the EU has stated that Iceland had not formally withdrawn the application.
3. This exchange rate system has been adopted by developing countries experiencing high inflation. Examples are Chile, Colombia, Israel, Indonesia, Ecuador, Russia, and Venezuela.
4. As Ledesma et al. (2005a, 2005b), we also implemented the fluctuation bands expansion, given the importance within ERM II.
5. The similarity of the coefficients is due to their own distribution functions. To be symmetric around zero it is reasonable that the estimated coefficients are practically equal and differ closed to the tails. Both models are very similar with respect to the predicted probabilities (Cameron & Trivedi, 2010).
6. Due to space limitations, we do not show graphically the detection of implicit fluctuation bands for each currency analysing the three alternative procedures for ±1% and ±2%, but they can be requested from the authors.
7. Given that under fixed exchange rates the monetary authority is committed to defend its exchange rate maintaining its central parity or ensuring that its path is within the fluctuation band provokes a favourable context for investment and trade as a result of the reduction in the degree of uncertainty and reduced transaction costs.
8. Due to space limitations we do not show graphically the estimated realignment probability of the exchange rates vis-à-vis euro based on the distance from the upper fluctuation band nor based on the interest rate differential with respect to the Euro Zone, nevertheless it is possible to request them from the authors.
9. Both the national and the Euro Zone interest rate corresponds to the 3-month interbank extracted from Eurostat and the ECB.
10. Recall that these estimated coefficients have no interpretation to which we are accustomed to work in traditional econometrics, for this reason the calculation of the marginal effects is necessary, but as an the objective of this paper, we are concerned about their sign to see how these variables influence the probability of realignment.

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Appendix. Additional results

Figure A1 (Panels A–E) indicates, for each of the investigated countries, at what time the domestic interest rate[9] is outside the return bands since this is evidence of the lack of credibility in these sub-periods. Each of these figures is explained in detail when we focus on a particular interpretation of each country making a comparison between the three considered approaches.

The results on how the explanatory variables of the method DA influence the expected depreciation within the band are provided in Table A1. These coefficients have been estimated by OLS, correcting their standard errors for possible heteroskedasticity or serial correlation using the Newey and West (1987) covariance estimator. Among the main conclusions, note that the coefficient associated with the logarithm of the distance from the central parity (x) is highly significant and inversely affects the expected depreciation within the band, corroborating the average of exchange rate reversion hypothesis for all currencies under study. This negative sign means that if economic agents observe at time t a deviation from its central parity they form stabilizing expectations, that is, expect that the exchange rate is close to the central parity in the following period stabilizing their behaviour towards equilibrium. However, in our study there is no consensus on how it affects the profitability of holding financial assets in domestic currency (i) and foreign currency (i^*) on the expected depreciation. Starting with the domestic interest rate, the only currency that matches with the results of Svensson (1993), Rose and Svensson (1994), and Ledesma-Rodríguez et al. (2000, 2005a) is the Icelandic krona reflecting the expected negative sign, being significant at 10%. Other currencies show both positive and negative signs varying with the level of significance.

With respect to the reference interest rate relative to the Euro Area, this variable cannot be considered as explanatory of the expected depreciation behaviour since it does not display significance in any country. Finally, taking into account the high p-values that show the dichotomous variables, the limited relevance of the different exchange rate regimes can be concluded.

Moreover, Table A2 shows the results of estimating the Logit model for the different explanatory variables explained in Section 2, in order to assess the probability of realignment. In this procedure, and given our interest, we focus on the signs interpretation of the estimated coefficients.[10] As in Ledesma-Rodríguez et al. (2005a), we find that in most of the sample, there is enough empirical evidence to say that as a result of depreciation of the domestic currency, an increase (decrease) in the probability of realignment (credibility) occurs.

As in Ledesma-Rodríguez et al. (2005a), we find that in most of the samples, there is enough empirical evidence to confirm that a domestic currency depreciation provokes an increase (decrease) in the probability of realignment (credibility). However and contrary to expectations, for the Turkish lira, it can be seen that a depreciation vis-à-vis the euro would trigger a significant increase in the credibility of the exchange rate system. In general, with the exception of the Serbian dinar, Croatian kuna, and Icelandic krona, it shows, with high significance, how the fact of turning aside the central parity negatively affects the probability of the exchange regime credibility. Another indicator that has been used in this paper as a robustness measure is the distance with respect to the upper fluctuation band.

As expected, the domestic interest rate differential with respect to the Euro Zone triggers a negative and highly significant impact on the probability of credibility, thereby increasing the probability of a realignment in the exchange rate.

Due to space limitations, Table A3 provides the most important descriptive statistics (mean, median, and standard deviation) of the estimated probability of realignment for all exchange rates analysed in this paper according to the four explanatory variables, however anyone interested in the rest of descriptive statistics can request them from the authors.

[9]Both the national and the Euro Zone interest rate corresponds to the 3-month interbank extracted from Eurostat and the ECB.

[10]Recall that these estimated coefficients have no interpretation to which we are accustomed to work in traditional econometrics, for this reason the calculation of the marginal effects is necessary, but as an the objective of this paper, we are concerned about their sign to see how these variables influence the probability of realignment.

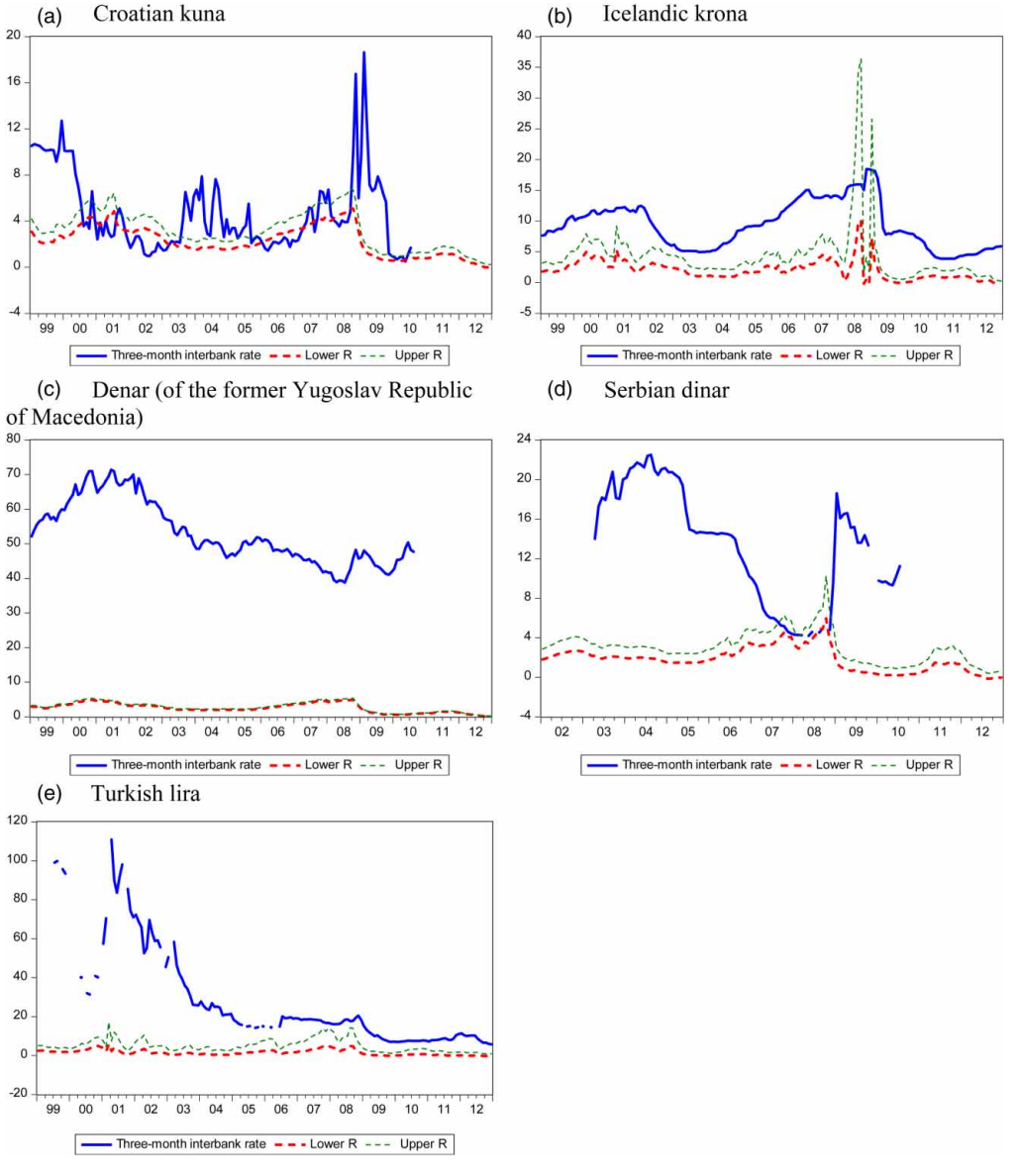

Figure A1. Svensson (1991)'s credibility test of the exchange rate fluctuation bands vis-à-vis the euro.

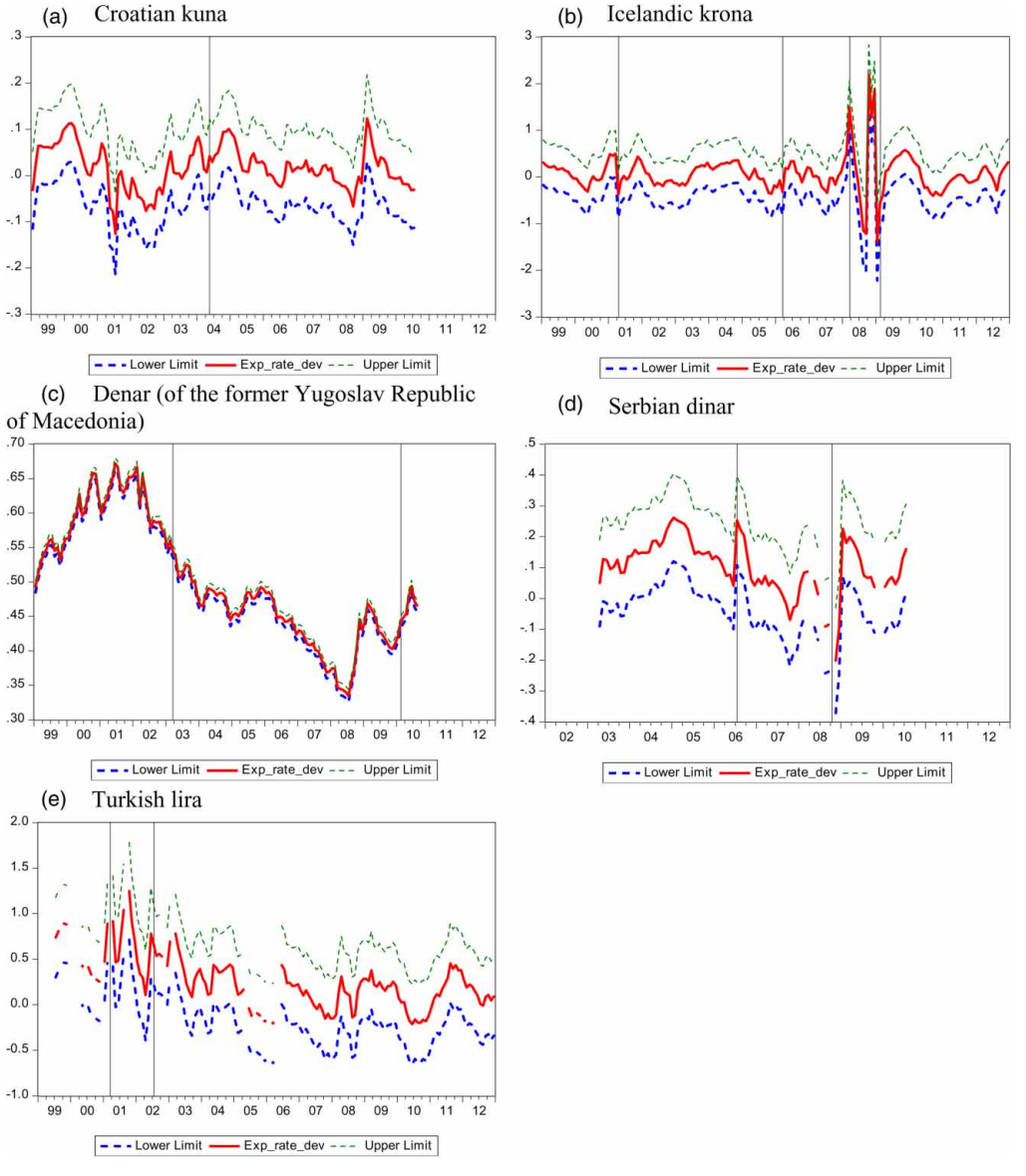

Figure A2. Expected realignment rate of the exchange rates vis-à-vis the euro and its confidence interval at 90%.
Notes: The vertical lines correspond to realignments and bands extensions.

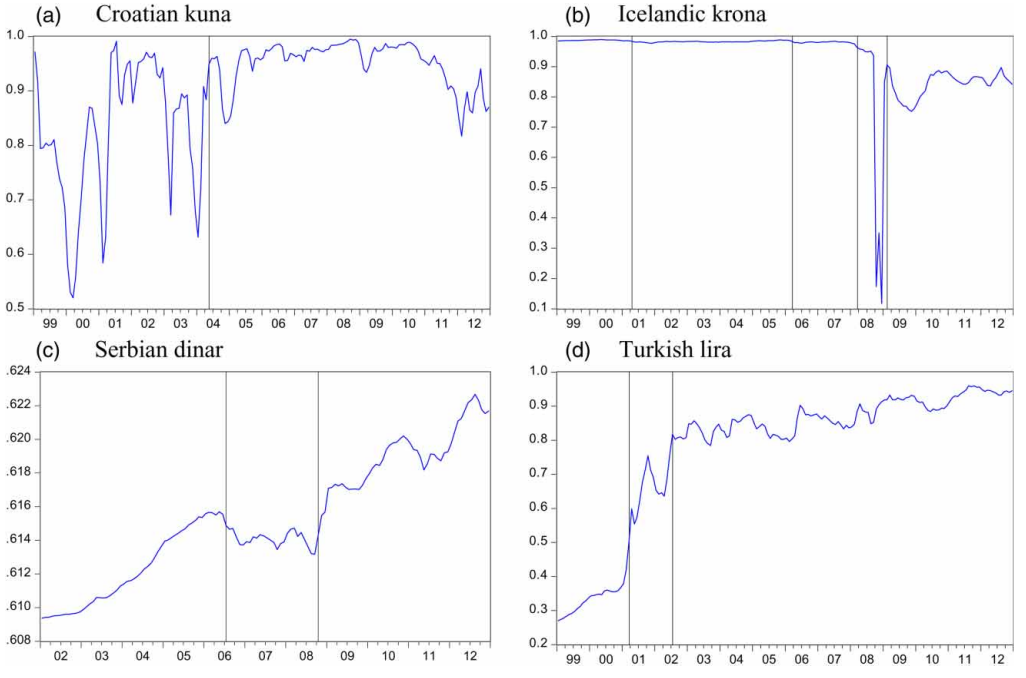

Figure A3. Estimated realignment probability of the exchange rates vis-à-vis the euro based on its exchange rates vis-à-vis the euro.

Notes: The vertical lines correspond to realignments and bands extensions. It is not possible to represent the exchange rates graphically for those cases where the dependent variable always takes the same value (either one or zero) since this procedure cannot be applied.

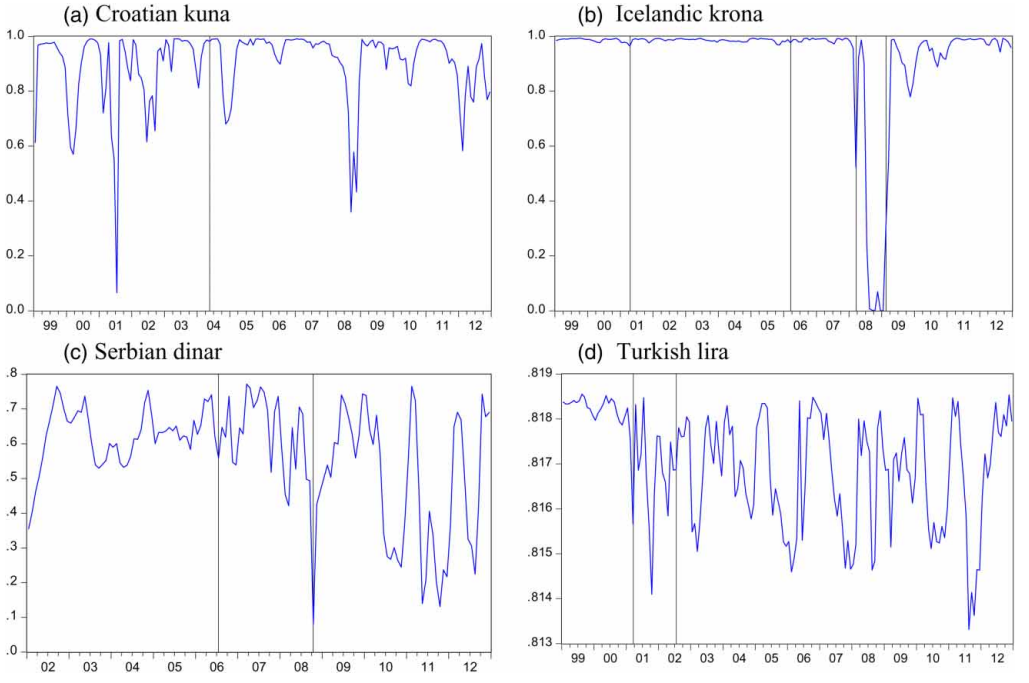

Figure A4. Estimated realignment probability of the exchange rates vis-à-vis the euro based on the distance from the central parity.
Notes: The vertical lines correspond to realignments and bands extensions. It is not possible to represent the exchange rates graphically for those cases where the dependent variable always takes the same value (either one or zero) since this procedure cannot be applied.

Table A1. Expected depreciation of the exchange rates within the band.

	HRK/EUR	ISK/EUR	MKD/EUR	RSD/EUR	TRY/EUR
D1	−0.0035	0.0071	−0.0035	0.1275	−0.0898
	(0.8439)	(0.9641)	(0.5700)	(0.2098)	(0.5724)
D2	−0.0213	0.0495	−0.0025	0.0171	−0.0579
	(0.1915)	(0.7122)	(0.5714)	(0.8727)	(0.8004)
D3		0.1398	0.0002	0.1357	−0.0057
		(0.4083)	(0.9704)	(0.0760)	(0.9427)
D4		−0.2223			
		(0.3939)			
D5		0.0867			
		(0.3249)			
X	−2.7071	−5.2159	−2.3167	−2.3138	−2.8542
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
i	0.5283	−1.4886	0.0012	−0.7743	0.3303
	(0.0052)	(0.2540)	(0.9047)	(0.0582)	(0.0667)
i^*	−0.6588	2.7714	0.0679	0.4702	−2.6932
	(0.2462)	(0.4985)	(0.3009)	(0.8338)	(0.3155)

Notes: In parentheses are the *p*-values. The dummy variables D1–D5 take value one between realignments and fluctuation bands enlargement, *X* represents the logarithm of the distance of the exchange rate with respect to the central parity and *i* and *i** show national and Euro Zone 3-months interbank interest rates, respectively.

Table A2. Estimation results of the Logit model.

	HRK/EUR	ISK/EUR	RSD/EUR	TRY/EUR
Exchange rates				
δ_1	64.6116	6.5904	2.0528	−1.7263
	(0.0003)	(0.0000)	(0.3674)	(0.0244)
δ_2	−8.3249	−0.0296	−0.0093	1.9515
	(0.0004)	(0.0002)	(0.7332)	(0.0000)
Distance from the central parity				
δ_1	4.8031	5.0495	1.2222	1.5066
	(0.0000)	(0.0000)	(0.0258)	(0.0000)
δ_2	−21.4428	−0.2322	0.0377	−0.1153
	(0.0001)	(0.0001)	(0.8979)	(0.9699)
Distance from upper fluctuation band				
δ_1	−1.2482	3.5159	−0.5363	−1.4635
	(0.0627)	(0.0000)	(0.3791)	(0.0039)
δ_2	19.7021	−0.0697	0.5669	22.7604
	(0.0000)	(0.0005)	(0.0031)	(0.0000)
Interest rate differential with respect the Euro Zone				
δ_1	2.9402	6.2424	−0.2713	4.0098
	(0.0000)	(0.0000)	(0.6175)	(0.0000)
δ_2	−0.2545	−0.4456	0.2289	−0.0744
	(0.0007)	(0.0001)	(0.0140)	(0.0000)

Notes: In parentheses are the *p*-values. In each case we show the estimated parameters associated with each explanatory variable (exchange rates, distance from the central parity, distance from upper fluctuation band, and interest rate differential with respect to the Euro Zone) that we consider explains the probability of realignment.

Table A3. Statistical summary of the estimated probability.

	HRK/EUR	ISK/EUR	RSD/EUR	TRY/EUR
Exchange rates				
Mean	0.9022	0.9286	0.6152	0.7703
Median	0.9507	0.9813	0.6147	0.8484
Std. dev.	0.1037	0.1179	0.0036	0.2052
Distance from the central parity				
Mean	0.8985	0.9286	0.5688	0.817
Median	0.9592	0.9869	0.6163	0.8172
Std. dev.	0.1365	0.2007	0.1593	0.0013
Distance from upper fluctuation band				
Mean	0.8704	0.9286	0.6343	0.7769
Median	0.9642	0.956	0.6314	0.9358
Std. dev.	0.1897	0.1234	0.1776	0.2751
Interest rate differential with respect the Euro Zone				
Mean	0.8993	0.9286	0.6342	0.8169
Median	0.946	0.9612	0.8442	0.9507
Std. dev.	0.1075	0.1168	0.3524	0.2742