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The Determinants of Financial Euroization in a Post-Transition Country: Do Threshold Effects Matter?*

Marijana IVANOV – Graduate School of Economics and Business, Zagreb (mivanov@efzg.hr)
Marina TKALEC – Institute of Economics, Zagreb (mtkalec@eizg.hr)
Maruška VIZEK – Institute of Economics, Zagreb (mvizek@eizg.hr) – *corresponding author*

Abstract
This paper investigates the long-run and short-run determinants of financial euroization (FE) using both linear and threshold models. We model deposit euroization (DE) and credit euroization (CE) in Croatia, a post-transition country recording very high and persistent unofficial FE. The results suggest that only the portfolio view is important for explaining DE and CE. The market failure view does not seem to matter for FE in Croatia. Both nominal and real exchange rate changes have a strong effect on FE in the long run; the former is more important for DE and the latter for CE. In the short and long run CE is also determined by matching behavior of banks' foreign currency positions. Both DE and CE respond to changes in inflation and exchange rate volatility. Threshold cointegration confirms that FE determination is subject to significant threshold effects, while error correction models suggest that FE adjustment is very slow and asymmetric, partly due to very strong FE persistence.

1. Introduction

The origins of unofficial financial euroization (FE) in most post-transition European countries can be traced back as far as the 1980s. In spite of the economic and political stability, strong growth performance, and increased central bank credibility witnessed in the last 15 years, the incidence of FE has persisted in most post-transition European countries. The exchange rate depreciation experienced in some countries during the economic downturn in 2009 showed just how dangerous it is to underestimate the pervasiveness of FE. To that end, the EBRD in its latest Transition Report for 2010 cites FE as one of the major weaknesses of post-transition European countries that needs to be tackled in order to achieve stable and sustainable growth in the future (EBRD, 2010).

Policy makers in post-transition economies acceding to the EU did not insist on financial system de-euroization owing to the assumption that euro adoption was imminent, which in turn implied that FE was a temporary phenomenon.[1] Moreover, since the banking systems of post-transition countries consisted mostly of banks owned by parent banks from the Eurozone, FE was considered a natural extension of the financial integration process.

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[1] One must note, however, that due to a high level of public debt, euro adoption cannot be considered an exit option for those new EU member states and candidate countries whose public debt level has approached or surpassed the Maastricht criteria. Moreover, the authorities in these countries focused rather on restricting borrowing in foreign currencies, while saving in foreign currencies was generally very limited.

However, since the global economic crisis shook the economies of the region it has become increasingly obvious that the adverse effects of FE as well as the limits it imposes on policymakers were perhaps somewhat underestimated. Large exchange rate depreciation in euroized countries can not only affect the stability of the banking system, but also deepen or even trigger recession instead of helping the economy to recover (Cook, 2004).

In such a situation, it is clear that more research is needed in order to understand the FE phenomenon in the region and to undertake appropriate policy actions. We analyze data for Croatia, one of the post-transition countries characterized by very high and persistent FE. We use empirical analysis in order to answer the following key questions. First, what drives deposit and credit euroization and are any of the drivers susceptible to policy measures? Second, is FE more elastic to changes in the nominal or real effective exchange rate (REER)? Third, are deposit and credit euroization characterized by threshold effects?

Besides having direct implications for economic policy, the results of this analysis also contribute to the body of literature in several respects. First, to the best of our knowledge, all existing empirical studies on substituting the domestic currency with the euro use linear models,[2] although it is well documented that euroization (dollarization) increases sharply during episodes of macroeconomic instability and that it remains stubbornly high even long after successful stabilizations, thereby implying either asymmetric or threshold effects. In the same vein, it is less likely that the level of FE will change if nominal or real effective exchange rate changes are small or negative (i.e., if the exchange rate appreciates). The opposite is true for large and positive changes of the nominal or real effective exchange rate. Several studies, such as Neanidis and Savva (2009) and Rennhack and Nozaki (2006), incorporate an index of asymmetric exchange rate movement into a linear econometric framework, which could be considered implicit confirmation of the existence of a bias toward local-currency depreciation. Moreover, threshold effects may also matter for the responses of FE to exchange rate volatility and inflation changes. Therefore, in this study, we estimate both linear and threshold models of short-run FE behavior in order to determine whether any threshold effects exist, and in which cases linear models of FE are appropriate.

Second, by using separate models we test the effects of nominal and real effective exchange rate changes on FE. Although the portfolio and market failure approaches to explaining FE emphasize the REER as the FE determinant, empirical papers usually control either for the nominal exchange rate or for REER changes and by doing so they neglect to compare which exchange rate has a stronger effect on FE. We feel that nominal exchange rate changes might have a stronger effect on FE because they are more easily observed and thus agents may react more strongly than to REER changes. Moreover, the threshold cointegration models used in this paper assume that the adjustment is discrete, or, in other words, all agents adjust to long-run discrepancies in the level of euroization at the same time. The observability of the nominal exchange rate facilitates discrete adjustment, thus making the nominal exchange rate more suited for the threshold cointegration model as compared to the REER.

[2] The notable exception is Heimonen (2001), who focuses on substitution of a substitute currency, while we are interested in financial euroization.

Finally, unlike other empirical studies on FE for post-transition European countries, our analysis includes the period of the latest economic downturn, which coincided with an intensive FE upswing. Hence, the inclusion of the newest observations may add relevant information content to the empirical model and consequently provide new insights into FE behavior.

The remainder of the paper is organized as follows. Section 2 reviews the empirical literature on FE, giving special attention to the results for European post--transition countries and Croatia. The third section presents a brief overview of FE in Croatia. The fourth section discusses the methodology applied, the data, and the results of the empirical analysis, while section 5 concludes the paper.

2. Literature Review

The term euroization (or dollarization) refers to a variety of cases in which a domestic currency is to a certain degree substituted by a foreign currency. While official euroization implies legally approved foreign currency use for all money functions, unofficial euroization represents a situation in which both the domestic and foreign currency are used simultaneously but the foreign currency is not legal tender. Unofficial euroization comes in different forms: currency substitution (the foreign currency takes on the medium of exchange function), asset substitution (the foreign currency takes on the store of value and unit of account functions) and real euroization (the foreign currency is used for denomination of prices and wages). Instead of asset substitution, during the last decade the literature coined the term financial euroization (FE), further divided into deposit and credit euroization. Deposit euroization (DE) is the propensity of households, enterprises, and even governments to hold deposits in foreign currency, while credit euroization (CE) is the propensity of commercial banks to approve loans either in foreign currency or indexed to foreign currency.

The early literature on dollarization in Latin America focuses primarily on currency substitution and its repercussions for conducting monetary policy. Currency substitution is thus explained through a negative correlation between demand for local currency and the rate of inflation (Savastano, 1996). Levy Yeyati (2006) outlines three main paradigms in modern theoretical analysis of FE. The portfolio view explains FE as an outcome of decisions on an optimal (minimum variance) portfolio given the real returns on different currencies. Returns on local currency assets are uncertain due to domestic inflation, while returns on foreign currency assets are uncertain due to real exchange rate risk (Ize and Levy Yeyati, 2003; Basso, Calvo-Gonzales, and Jurgilas, 2007). Since this setting assumes that the uncovered interest rate parity holds, the emphasis is placed on variances. Namely, if the variability of domestic inflation increases relative to the real devaluation rate, the local currency becomes less attractive and the FE ratio rises.

The market failure view explains FE as a result of optimal decisions by risk neutral agents in the presence of default risk (enhanced by moral hazard/asymmetric information). If the central bank of an economy characterized by large and sudden exchange rate depreciations in the past, insists on a stable exchange rate, moral hazard problems will arise and borrowers and lenders will not fully internalize the risks of borrowing (or lending) in foreign currency. Consequently, they benefit from a lower cost (and lower risk) of borrowing and lending in foreign currency, which in turn increases the level of FE.

The institutional view analyzes the presence of FE in relation to the credibility of central bank and government policies, i.e., it explains FE as being a result of domestic market and legal imperfections. A weak institutional framework and low credibility of economic policies increase the government's quest to build up confidence by using the exchange rate anchor. Since such dollar- or euro-friendly regulations represent a commitment mechanism by which the government or monetary authorities borrow credibility and make the cost of a potential depreciation prohibitively high, FE becomes the collateral cost of low institutional credibility (Nicoló, Honohan, and Ize, 2005; Rajan and Tokatlidis, 2005).

Several empirical papers focus on FE in post-transition European countries. All of them use linear models to control for the behavior of FE, except the study by Heimonen (2001). For the case of Estonia, Heimonen (2001) estimates possible portfolio shifts between two substitute currencies – euros and dollars. He identifies the dynamics of such substitution in both the short and long term using threshold cointegration. However, his research does not focus on the determinants of financial euroization, nor does it consider substitution between the domestic and foreign currency.

By examining foreign currency shortages in dollarized economies, Rajan and Tokatlidis (2005) claim that liability dollarization is a response to institutional weaknesses and lack of monetary credibility. Moreover, their results indicate that higher inflation in the past leads to dollarization strengthening, while the opposite is not true when inflation falls, suggesting CE is persistent. Neanidis and Savva (2009) estimate a panel of 11 Central and Eastern European (CEE) and Commonwealth of Independent States (CIS) countries in order to model the short-run determinants of DE and CE. In the short run, the negative effects of depreciation and monetary contraction are particularly pronounced in countries with high euroization. CE is driven in the short run by DE, while both types of euroization are influenced by interest rate differentials. Basso, Calvo-Gonzales, and Jurgilas (2007) use an unbalanced panel of 24CEE and CIS countries in order to explain FE. The results indicate that access to foreign funds as well as higher interest rate differentials increase CE but decrease DE. Moreover, the tradeoff between inflation and REER volatility is found to be a significant factor in explaining FE, thereby proving the validity of the portfolio approach. Similar results are confirmed by Rosenberg and Tirpák (2009), who find that CE increases together with rising interest rate differentials, foreign funding, and openness. Other authors agree that a higher degree of trade openness contributes to CE. Luca and Petrova (2008) use aggregate data in a panel of 21 CEE and CIS countries in order to model CE. Empirical results suggest CE is positively related to interest rate differentials, domestic monetary volatility, and DE, while it is negatively related to exchange rate volatility. Moreover, export openness seems to promote CE, as export-oriented firms use natural hedges. The authors also show that the presence of a deep forward foreign currency market decreases the level of CE. As explored by Guscina (2008), financial development, openness, and falling inflation promote government debt de-euroization and therefore tend to decrease CE.

Stix (2010) uses a unique household survey data for Croatia, Slovenia, and Slovakia in order to understand the factors driving DE persistence. Probit estimations show that expectations of inflation and exchange rates do not affect DE, while trust in the banking system determines the choice between foreign currency cash and foreign currency deposits. On the other hand, age and level of income and education of savers are positively correlated with DE. Brown, Kirschenmann, and Ongena (2009) analyze CE in Bulgaria using a unique data set on individual loan contracts of a Bulgarian bank with small and medium-sized businesses. The results show that Bulgarian firms are more likely to request a foreign currency denominated loan if they have foreign exchange revenues and if the requested loan amount is larger and the maturity longer. Higher inflation volatility and interest rate differentials also promote demand for foreign currency denominated loans. At the same time, banks seem hesitant to lend long term in local currency and are eager to match the currency structure of their assets and liabilities. Moreover, exploring a large sample of small firms from a number of emerging market economies, Brown, Ongena, and Yeşin (2009) confirm the results of Brown, Kirschenmann, and Ongena (2009) but find that CE is more strongly related to foreign currency revenues than to interest rate differentials. Kokenyne, Ley, and Veyrune (2010) separately model CE and DE in Croatia in order to determine whether prudential regulation has an effect on the level of FE. They find that both CE and DE show a moderate response to prudential measures in Croatia. Besides prudential measures, CE also reacts to changes in the REER and inflation, while DE seems to be characterized by a high degree of persistence.

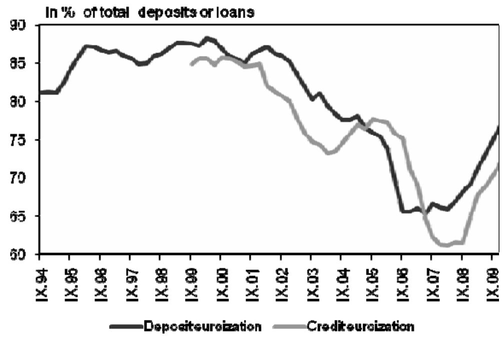
3. Financial Euroization in Croatia

The Croatian financial system is characterized by a very high and persistent level of euroization. Judging from data on DE and CE collected both by Luca and Petrova (2008) and by Levy Yeyati (2006), Croatia is (together with Armenia and Georgia) by far the most financially euroized country in Europe. Moreover, once Croatia joins the EU (which can be expected during 2013 or 2014), it will become the EU member state with the most pervasive FE. The main features of FE in Croatia include the use of the euro as a unit of account and store of value, a very high level of both DE and CE, less pronounced currency mismatches on commercial banks' balance sheets, and very pronounced currency mismatches on the balance sheets of non-tradable business sectors and households. Similar features can also be identified in other Western Balkan countries (Serbia, Macedonia, Kosovo, and Albania), some CIS countries (Armenia and Georgia), and to a smaller degree in two Baltic countries, Latvia and Lithuania. On the contrary, in many Central and Eastern European countries DE is much less pronounced, loans are indexed also to CHF and JPY, and commercial banks' exposure to currency mismatches is much more pronounced.

Euroization of the Croatian financial system first appeared in the 1980s during the period when Croatia was a part of the former Yugoslavia. It emerged due to hyperinflation, several sharp devaluations of the domestic currency as well as due to the general instability of the domestic banking system.[3] The emergence of euroization was supported also by a significant inflow of workers' remittances and high tourism revenues, both in foreign currency. In the first few years of the 1990s, the Croatian economy was stricken by war and by a transition recession that further destabilized the financial system. Economical stagnation in combination with hyperinflation

[3] At the time, the Deutsche Mark was used to substitute for the domestic currency, not the euro.

Figure 1 Financial Euroization in Croatia



Source for original data: Croatian National Bank

amounting to 1,616 percent annually in 1993 resulted in erosion of the credibility of economic policies and caused additional distrust in the domestic currency. In spite of the successful implementation of a stabilization program in October 1993 and low inflation rates in later years, general confidence in the domestic currency has not been established. The domestic currency has never fully assumed its unit of account function, while the store of value function was mostly reserved for the Deutsche Mark and later the euro (Vizek, 2006). Consequently, both deposit and credit euroization have remained a permanent characteristic of the financial system, although their levels have varied somewhat over the years.

In the period from 1994 to 2000, DE was particularly high, with the ratio of foreign currency deposits to total deposits fluctuating between 85 and 90 percent. This was a consequence of macroeconomic instability during 1993, compounded by a banking crisis, a brief economic downturn, and increasing depreciation pressures on the nominal exchange rate in the 1998–1999 period. See *Figure 1*.

After 2000, DE leveled off and gradually descended to the 65 percent recorded during 2006–2008. A prolonged period of macroeconomic stability and increasing monetary policy credibility, higher interest rates on domestic currency deposits, and appreciation of the domestic currency contributed most to such movements. Along with deposit euroization, credit euroization also trended downwards, as evident in the data gathered since 1999. Starting from 2000, when foreign currency denominated loans amounted to 85 percent of total loans, the level of CE started to subside, reaching its bottom during 2008 at around 60 percent. After the global financial crisis erupted and macroeconomic instability increased, the downward trends in deposit and credit euroization both reversed, suggesting that credibility of the domestic currency and monetary authorities was never truly established.

4. Empirical Analysis

4.1. Methodology

The aim of the econometric analysis is to model the long-run and short-run behavior of DE and CE. Therefore, we use both the linear approach (the Johansen cointegration and vector error correction model) and the threshold approach (the Engle-Granger threshold cointegration and threshold error correction model). Each aspect of financial euroization (DE and CE) is modeled with two models with the same endogenous variables, except for a variable that proxies the exchange rate. As explained in the introduction, we use two exchange rate proxies: the REER and the nominal exchange rate of the domestic currency against the euro.

The following general-to-specific modeling strategy is employed: first, we estimate the model for both DE and CE with the largest number of potential determinants and test for Johansen cointegration in order to obtain a long-run equilibrium relationship between euroization and its determinants. If no cointegration is found, we reduce the model by one variable and test again for cointegration. Once a linear long-run relationship is found, we test for threshold cointegration. If threshold cointegration is established, we continue with the estimation of the threshold error correction model of DE and CE. If no threshold cointegration is found, we estimate a vector error correction model of DE and CE in order to model the short-run behavior of financial euroization.

We continue with the exercise by further reducing the number of exogenous variables until we find a significant threshold cointegration relationship and derive a threshold error correction model. The results of this exercise will show that Johansen cointegration is detectable in relatively large models for which no threshold effects are discovered. On the other hand, threshold effects are present in relatively parsimonious models of DE and CE.

For the Johansen cointegration test, we use finite sample corrections of trace and max statistics (Cheung and Lai, 1993) instead of original test statistics (Johansen, 1988; Johansen, 1991), mainly because trace and max statistics tend to detect cointegration more often in finite samples when the models include a large number of variables and lags.

In order to detect threshold cointegration in the behavior of FE in Croatia, we use a threshold cointegration method developed by Enders and Siklos (2001) by extending the generalized threshold autoregressive (TAR) and momentum-TAR (M-TAR) tests for unit roots.[4]

The model used for testing threshold cointegration has the following specification:

$$\Delta\mu_t = I_{jt}\rho_1\mu_{t-1} + \left(1 - I_{jt}\right)\rho_2\mu_{t-1} + \varepsilon_t \qquad j = 1,2 \tag{1}$$

where μ_t is the disturbance term of the Engle-Granger long-run model, while I_{1t} and I_{2t} are the Heaviside indicator functions for the TAR and the M-TAR models, respectively, such that:

$$I_{1t} = \begin{cases} 1 & \text{if} \quad \mu_{t-1} \geq \tau_1 \\ 0 & \text{if} \quad \mu_{t-1} < \tau_1 \end{cases} \tag{2}$$

in the TAR case, and

$$I_{2t} = \begin{cases} 1 & \text{if} \quad \Delta\mu_{t-1} \geq \tau_2 \\ 0 & \text{if} \quad \Delta\mu_{t-1} < \tau_2 \end{cases} \tag{3}$$

[4] More details about the TAR and M-TAR models can be found in Tong (1983), Caner and Hansen (2001), and Enders and Siklos (2001).

in the M-TAR case. τ_1 and τ_2 are the values of the threshold and ε_t is a sequence of IID random variables with mean zero and constant variance. The threshold τ is either set to zero or determined endogenously using an algorithm developed by Chan (1993). In each of the four cases, depending on the type of asymmetry under consideration $(I_{1t}$ or $I_{2t})$ and on the value of the threshold, we estimate the regression equation (1) and test the null hypotheses $\rho_i = 0$ and $\rho_1 = \rho_2 = 0$, which are direct tests of the existence of cointegration.[5] The empirical F statistics obtained from the latter test are compared to the critical values tabulated by Wade, Gilbert, and Dibooglu (2004).[6] Finally, we test the null hypothesis $\rho_1 = \rho_2$ using the Wald test in order to determine whether the cointegration relationship is characterized by threshold effects.[7]

4.2 Data

Data for the DE model are available at monthly frequency from January 1997 to May 2010. As a proxy for DE, we use the share of foreign currency deposits in total deposits. Apart from the standard variables used in this kind of empirical exercise as possible DE determinants, such as the nominal exchange rate, the REER, exchange rate volatility (calculated as the standard deviation of the daily exchange rates in a given month), CPI inflation, the M1 monetary aggregate, and the share of M4 in M1 (a variable representing financial system development), we also use three variables suggested by the main paradigms in the theoretical analysis of FE. The first variable is the past rate of inflation suggested by the currency substitution view (Savastano, 1996), where past inflation in the contemporaneous period is calculated as average inflation over the 24 months (in the case of DE models) or 8 quarters (in the case of CE models) prior to the contemporaneous period. The second variable is the minimum variance portfolio (MVP) suggested by the portfolio view (Ize and Levy Yeyati, 2003), which measures the euro share of the MVP calculated from historical inflation and real depreciation rates. The third variable represents the market failure view (Levy Yeyati, 2006) and measures the correlation between the probability of default and the REER. The more procyclical the REER, the stronger the euroization bias. Levy Yeyati (2006) proxied the probability of default by real GDP growth, but since we need observations at monthly frequency we use industrial production growth, which in Croatia is closely correlated to GDP changes.

Data for the CE model are available at quarterly frequency from the third quarter of 1999 to the second quarter of 2010. As a proxy for CE, we use the share of foreign currency loans and loans indexed to foreign currency in total loans. Besides using all the endogenous variables already specified above as potential DE determinants, we also use total bank foreign debt and the share of foreign currency deposits in total deposits as additional CE determinants representing commercial banks'

[5] For the tests, we used the larger of the t values and F statistics, which were later denoted by Tmax and Φ both in the text and in the corresponding tables.

[6] The complete table with critical values tabulated by Wade, Gilbert, and Dibooglu (2004) is provided in the *Appendix*.

[7] The null hypothesis assumes linearity, while the alternative assumes threshold behavior. Test statistics are denoted by W both in the text and in the corresponding tables.

foreign currency funding sources and consequent matching behavior of banks' foreign currency positions. All the variables are seasonally adjusted using the X12ARIMA method and are in logarithms. ADF unit root test results suggest that all the variables are stationary in first differences.[8] A more detailed description of the variables and their sources can be found in the *Appendix*.

4.3 Results

The Johansen cointegration tests suggested that the following variables are cointegrated with DE: the exchange rate (nominal or REER), exchange rate volatility, the minimum variance portfolio, monetary aggregate M1, and inflation. The long-run model of CE includes the exchange rate (nominal or REER), exchange rate volatility, the minimum variance portfolio, bank foreign debt, deposit euroization, the share of M4 in M1, and average past inflation.[9]

Unrestricted and restricted long-run coefficients, together with related adjustment parameters are reported in *Table 1* for the DE model and in *Table 2* for the CE model. The results of the individual zero restrictions on the cointegrating parameters suggest that none of the variables displayed in *Table 1* can be excluded from the long-run equilibrium relationship. Since we found one cointegration vector, we need only one restriction per model to be able to identify the long-run coefficients and adjustment parameters. However, we introduce a greater number of restrictions in order to add more information content to the system. In the long-run DE model with the REER as a proxy for the exchange rate, we restrict the long-run coefficient for the REER to be equal to -1. In addition, we impose weak exogeneity of DE and exchange rate volatility.[10]

Concerning the DE model with the nominal exchange rate, we do not manage to restrict the coefficient for the nominal exchange rate.[11] Since the estimated long--run elasticities of DE to changes in the nominal exchange rate and REER amount to 2.4 and 1, respectively, we can conclude that depreciation of the nominal exchange rate has a much stronger effect on the long-run behavior of DE. Furthermore, in the DE model with the nominal exchange rate, we impose the unit elasticity restriction on the coefficient for inflation together with weak exogeneity of exchange rate volatility and M1.

The long-run coefficients also suggest that exchange rate volatility and inflation contribute to a rise in DE, while monetary expansion has an effect in the opposite direction. The results for M1 are not surprising given that an increase in the money supply promotes local currency deposits. Those findings are supported by earlier studies.

Along with the long-run DE models, we also try imposing similar restrictions on the CE models. The unit elasticity restriction on the REER coefficient in the CE

[8] The unit root test results are not presented in the paper to save space, but can be obtained upon request from the authors.

[9] Due to space considerations, the Johansen test results are not presented in the paper, but can be obtained upon request from the authors.

[10] Please note that the restrictions relate to long-run coefficients written in vector notation.

[11] The restriction that the long-run coefficient of the nominal exchange rate in a restricted model is equal to -1 is rejected with a Chi-square test statistic equal to 14.8 [0.01].

Table 1 Long Run Coefficients and Short Run Adjustment Factors (Deposit Euroization)

Model	Variable in cointegration vector	Before imposing restrictions β	Before imposing restrictions α	After imposing restrictions# β	After imposing restrictions# α	Testing restriction $\beta = 0$ Chi^2(1)	Testing weak exogeneity $\alpha = 0$ Chi^2(1)
Deposit euroization with real effective exchange rate	Deposit euroization	1.00	0.022	1.000	0.00	17.3 [0.00]**	1.54 [0.21]
	Exchange rate volatility	-0.076	-1.18	-0.074	0.00	22.3 [0.00]**	1.37 [0.24]
	REER	-0.934	0.093	-1.000	0.113	7.1 [0.007]**	14.9 [0.00]**
	M1	0.141	-0.165	0.146	-0.228	9.5 [0.002]**	5.2 [0.022]*
	Inflation	-0.521	0.042	-0.546	0.041	6.6 [0.01]*	15.0 [0.00]**
	Minimum variance portfolio	0.584	-0.654	0.539	-0.773	32.9 [0.00]**	24.5 [0.00]**
	Constant	2.362	-	2.51	-	5.8 [0.016]*	-
Deposit euroization with nominal exchange rate	Deposit euroization	1.00	0.024	1.000	0.025	5.6 [0.02]*	3.6 [0.05]
	Exchange rate volatility	-0.145	-0.200	-0.151	0.00	24.6 [0.00]**	0.07 [0.78]
	Nominal exchange rate##	-2.428	0.070	-2.409	0.072	19.5 [0.00]**	24.0 [0.00]**
	M1	0.238	-0.085	0.208	0.00	10.5 [0.00]**	2.3 [0.13]
	Inflation	-1.081	0.026	-1.000	0.025	8.2 [0.004]**	8.5 [0.004]**
	Minimum variance portfolio	0.512	-0.342	0.539	-0.286	11.3 [0.00]**	8.1 [0.004]**
	Constant	4.078	-	3.261	-	17.2 [0.00]**	-

Notes: β – cointegrating coefficient; α – adjustment coefficient; *p*-values presented in brackets; ** – null hypothesis rejected at 1 percent significance level; * – null hypothesis rejected at 5 percent significance level. # in the case of the model with REER, restrictions are accepted with Chi^2(3) = 3.23 [0.36], while in case of the model with the nominal exchange rate the restrictions are accepted with Chi^2(3) = 3.0531 [0.3835]; ## the restriction that the long run coefficient of the nominal exchange rate in a restricted model is equal to -1 is rejected with Chi^2(5) = 14.8 [0.01].

Source: calculation of the authors

Table 2 Long Run Coefficients and Short Run Adjustment Factors (Credit Euroization)

Model	Variable in cointegration vector	Before imposing restrictions		After imposing restrictions[#]		Testing restriction	Testing weak exogeneity
		β	α	β	α	β = 0 Chi^2(1)	α = 0 Chi^2(1)
Credit euroization with real effective exchange rate	Credit euroization	1.000	0.059	1.000	0.059	3.9 [0.048]*	7.7 [0.006]**
	REER[##]	-3.697	0.038	-3.669	0.037	5.8 [0.02]*	4.9 [0.03]*
	Bank foreign debt	-0.269	-0.181	-0.261	-0.188	7.7 [0.006]**	4.3 [0.04]*
	Exchange rate volatility	-0.053	1.764	-0.035	0.000	5.1 [0.02]*	3.3 [0.07]
	Minimum variance portfolio	1.174	-0.269	1.187	-0.315	20.1 [0.00]**	6.8 [0.009]**
	M4/M1	0.599	0.022	0.604	0.000	1.9 [0.17]	0.3 [0.61]
	Constant	6.880	-	6.770	-	2.8 [0.09]	-
Credit euroization with nominal exchange rate	Credit euroization	1.000	-0.098	1.000	-0.161	6.4 [0.01]*	17.8 [0.00]**
	Exchange rate	-3.523	0.014	-1.000	0.032	6.3 [0.01]*	1.1 [0.30]
	Bank foreign debt	-0.432	0.074	-0.340	0.000	13.2 [0.00]**	0.7 [0.41]
	Deposit euroization	-3.501	0.010	-2.638	0.031	16.8 [0.00]**	0.2 [0.7]
	Average past inflation	-0.252	-0.006	0.515	-0.008	0.1 [0.75]	17.6 [0.00]**
	Minimum variance portfolio	-1.103	0.371	-0.806	0.518	33.3 [0.00]**	9.5 [0.00]**
	Exchange rate volatility	-0.032	0.375	-0.008	0.000	2.9 [0.09]	0.1 [0.74]
	M4/M1	1.057	-0.110	0.082	0.000	2.2 [0.14]	5.1 [0.02]*
	Constant	2.463	-	0.929	-	2.4 [0.13]	-

Notes: β - cointegrating coefficient; α – adjustment coefficient; *p*-values presented in brackets; ** – null hypothesis rejected at 1 percent significance level; * – null hypothesis rejected at 5 percent significance level; [#] in the case of the model with REER, restrictions are accepted with Chi^2(2) = 3.36 [0.19], while in the case of the model with the nominal exchange rate the restrictions are accepted with Chi^2(4) = 8.26 [0.08]; [##] the restriction that the long run coefficient of real effective exchange rate in a restricted model is equal to -1 is rejected with Chi^2(1) = 6.01 [0.01].

Source: calculation of the authors

model is rejected with chi-square equal to 6.01 and an underlying p-value of 0.01. We impose weak exogeneity of exchange rate volatility and the ratio of M4 to M1. In the CE model with the nominal exchange rate, we restrict the long-run coefficient for the nominal exchange rate to -1 and impose weak exogeneity of exchange rate volatility, bank foreign debt, and M4/M1. As is the case for DE, we find a positive relationship between CE and both the nominal and real effective exchange rate, suggesting that CE also increases after depreciation. However, contrary to DE, CE seems to react more strongly to changes in the REER as compared to the nominal exchange rate. Growing exchange rate volatility, bank foreign debt, DE, and average past inflation contribute to a rise in CE, while financial system development (represented by M4/M1) reduces it.

As a next step, we construct vector error correction models for the four cases examined where each case consists of the error correction term derived from the belonging restricted cointegration vector. To save space, we present only error correction models for deposit and credit euroization. All error correction models for DE and CE satisfy diagnostic tests and are presented in *Table 3*. One can notice that disequilibria in short-run CE models adjust very slowly, while there seems to be no adjustment in the case of DE. Block exclusion restrictions on all lags of the individual right-hand side variables suggest that in the short run DE only responds to changes in inflation and the minimum variance portfolio. Moreover, the results suggest that persistence is important for both DE and CE short-run behavior. In the CE model with the nominal exchange rate incorporated, changes in DE, bank foreign debt, and average past inflation all have an effect on euroization in the short run.

To sum up the results of the linear models, the portfolio view seems to be important for explaining both DE and CE in the long run, thus confirming the results of Basso, Calvo-Gonzales, and Jurgilas (2007). The market failure view does not seem to matter, while the currency substitution view matters only for explaining the behavior of CE. Besides the variables suggested by the theory, DE in the long run increases as a result of consumer price inflation and nominal and real effective exchange rate depreciation. DE is more elastic to changes in the nominal exchange rate as compared to REER changes, while the opposite is true for CE. CE also shifts upward after an increase in bank foreign debt and DE, suggesting that bank currency matching behavior is very important for long-run CE determination in Croatia. Contrary to the results of Luca and Petrova (2008) and Kokenyne, Ley, and Veyrune (2010), we find that greater exchange rate volatility promotes both DE and CE. The results also suggest that monetary expansion promotes local currency deposits, thereby confirming the results of Neanidis and Savva (2009). The adjustment is quite slow and characterized by a high degree of persistence, thereby supporting the findings of Kokenyne, Ley, and Veyrune (2010). The emergence of persistence as an FE driver could, however, be a result of the choice of DE and CE proxies. The backward-looking nature of the variables used as proxies (stocks of foreign exchange denominated deposits/loans to total deposits/loans) might give rise to persistence tendencies and therefore the importance of persistence must be somewhat downplayed. Moreover, in the short run both CE and DE react to changes in inflation, but they do not react to changes in either the nominal or the real effective exchange rate. DE also responds to short-run changes in the MVP, while CE responds to short-run changes in banks' foreign sources of financing, thus supporting the findings of Brown, Kirschenmann,

Table 3 Vector Error Correction Models

Dependent variable	Δ Deposit euroization$_t$	Δ Deposit euroization$_t$	Δ Credit euroization$_t$	Δ Credit euroization$_t$
Constant	0.049 [0.45]	0.047 [0.41]	0.004 [0.25]	-0.0005 [0.89]
ECT_reer_{t-1}	0.02 [0.44]	-	-0.052 [0.03]*	-
ECT_ex_{t-1}	-	0.015 [0.42]	-	-0.145 [0.00]**
$A_1(L)\Delta Exchange\_rate\_volatility_{t-1}$	1.49 [0.14]	1.332 [0.21]	0.001 [0.78]	0.003 [0.42]
$A_2(L)\Delta REER_{t-1}$	1.27 [0.24]	-	-0.435 [0.08]	-
$A_2(L)\Delta Exchange\_rate_{t-1}$	-	0.875 [0.57]	-	0.158 [0.57]
$A_3(L)\Delta M\_1_{t-1}$	1.03 [0.42]	0.930 [0.52]	-	-
$A_4(L)\Delta Inflation_{t-1}$	2.03 [0.03]*	1.82 [0.06]	-	-
$A_5(L)\Delta Minimum\_variance\_portfolio_{t-1}$	2.08 [0.028]*	2.31 [0.014]*	0.020 [0.65]	0.047 [0.21]
$A_6(L)\Delta Deposit\_euroization_{t-1}$	3.05 [0.002]**	3.73 [0.0002]**	-	0.419 [0.002]**
$A_7(L)\Delta M\_4/M\_1_{t-1}$	-	-	0.115 [0.28]	0.087 [0.30]
$A_8(L)\Delta Bank\_foreign\_debt_{t-1}$	-	-	0.103 [0.06]	0.181 [0.00]**
$A_9(L)\Delta Average\_past\_inflation_{t-1}$	-	-	-	4.198 [0.002]**
$A_{10}(L)\Delta Credit\_euroization_{t-1}$	-	-	0.479 [0.002]**	-0.007 [0.96]
Number of lags	12	12	1	1
Number of observations	161	161	43	43
sigma	0.0027	0.0028	0.0066	0.0050
R^2	0.69	0.67	0.59	0.77
AR test	1.06 [0.39]	1.22 [0.30]	2.36 [0.09]	1.33 [0.28]
ARCH test	0.31 [0.94]	1.76 [0.41]	0.30 [0.83]	1.20 [0.33]
RESET test	2.13 [0.15]	0.33 [0.56]	0.62 [0.44]	1.13 [0.30]

Notes: *p*-values presented in brackets; ** – null hypothesis rejected at 1 percent significance level; * – null hypothesis rejected at 5 percent significance level; ECT_reer – error correction term from the restricted cointegration vector for deposit euroization with REER as an endogenous variable; ECT_ex – error correction term from the restricted cointegration vector for deposit euroization with nominal exchange rate as an endogenous variable; lag length chosen according to SBIC – Schwartz Bayesian Information Criterion; $A_i(L)$ is the first order polynomial in the lag operator L; statistics corresponding to $A_i(L)$ refers to *F* statistics and associated *p*-value of block exclusion restriction on all lags of an individual variable.

Source: calculation of the authors

and Ongena (2009), Brown, Ongena, and Yeşin (2009), and Basso, Calvo-Gonzales, and Jurgilas (2007).

As a next step, we test the four Johansen cointegration relationships detected for threshold cointegration. Comparing the test statistics for the Φ test with

Table 4 Threshold Cointegration (Quintvariate Cases)

Dependent variable	Credit euroization			
Endogenous variables	Nominal exchange rate, exchange rate volatility, average past inflation, constant	Nominal exchange rate, exchange rate volatility, bank foreign debt, constant	Nominal exchange rate, exchange rate volatility, inflation, bank foreign debt	REER, exchange rate volatility, average past inflation, constant
	M-TAR	M-TAR	M-TAR	M-TAR
Threshold =	0.0054	0.0032	0.0067	0.0046
ρ_1 =	-0.205	-0.179	-0.227	-0.246
ρ_2 =	-0.491	-0.536	-0.520	-0.469
Tmax	-1.70	-1.63	-1.89	-2.02
$\Phi(\rho_1 = \rho_2 = 0)$	11.496**	14.451***	12.127**	10.530**
$W(\rho_1 = \rho_2)$	5.81 [0.02]**	9.02 [0.00]***	5.74 [0.02]**	4.00 [0.045]**
AR test	0.24 [0.87]	0.87 [0.47]	0.28 [0.84]	0.12 [0.95]
Number of lags	4	4	4	4
Number of observations	43	43	43	43

Notes: ρ_1 and ρ_2 denote the adjustment parameters; *p*-values presented in brackets; lag length chosen according to SBIC – Schwartz Bayesian Information Criterion; *** – null hypothesis rejected at 1 percent significance level; ** – null hypothesis rejected at 5 percent significance level; * – null hypothesis rejected at 10 percent significance level.

Source: calculation of the authors

the critical values tabulated in Wade, Gilbert, and Dibooglu (2004), we conclude that there is no evidence of threshold cointegration.[12] Thus, we conclude that the Johansen cointegration and VECM models of DE and CE are well specified and continue with testing threshold cointegration on more parsimonious models.

In the case of CE, we detected threshold cointegration in quintvariate cases, while in the case of DE threshold cointegration is present only in bivariate cases. *Table 4* summarizes the test results for the threshold CE models with five variables. Four models with CE as the dependent variable satisfy all the diagnostic tests and reject the null of no cointegration and the *F* test for symmetric adjustment at least at the 5% level. The threshold values are positive, similar, and very close to zero for all cases that demonstrate asymmetric adjustment of CE to changes in bank foreign debt, exchange rate volatility, either inflation or average past inflation, and either the nominal or the real effective exchange rate. We proceed by creating threshold error correction models of CE for the four cases exhibiting threshold cointegration.

The threshold error correction with the estimated coefficients and associated *p*-values of the constant term and the adjustment parameters, the block exclusion restriction test for lagged changes of the dependent and the explanatory variables with associated *F* statistics and *p*-values, together with diagnostic tests, are presented in *Table 5*.

[12] Tables with critical values can be found in *Table 2* of the *Appendix*. The results of the three models whose statistics are the closest to establishing threshold cointegration are presented in *Table 3* of the *Appendix*.

Table 5 Threshold EC Model (Quintvariate Cases) – Summary of Estimation Results

Dependent variable	Credit euroization			
Endogenous variables	Nominal exchange rate, exchange rate volatility, average past inflation, constant	Nominal exchange rate, exchange rate volatility, bank foreign debt, constant	Nominal exchange rate, exchange rate volatility, inflation, bank foreign debt	REER, exchange rate volatility, average past inflation, constant
	M-TAR	M-TAR	M-TAR	M-TAR
Threshold =	0.0054	0.0032	0.0067	0.0046
Constant	-0.001 [0.73]	-0.0004 [0.81]	-0.0006 [0.87]	-0.0013 [0.71]
ρ_1	-0.262 [0.01]**	-0.150 [0.088]*	-0.248 [0.01]**	-0.266 [0.007]***
ρ_2	-0.177 [0.03]**	-0.178 [0.021]**	-0.181 [0.03]**	-0.177 [0.03]**
$A_1(L)\Delta REER_{t\text{-}1}$#	-	-	-	2.27 [0.12]
$A_1(L)\Delta Exchange\_rate_{t\text{-}1}$	1.80 [0.18]	2.57 [0.09]*	1.19 [0.32]	-
$A_2(L)\Delta Exchange\_rate\_volatility_{t\text{-}1}$	1.88 [0.17]	0.36 [0.70]	0.72 [0.50]	2.47 [0.10]
$A_3(L)\Delta Average\_past\_inflation_{t\text{-}1}$	0.28 [0.60]	-	-	0.26 [0.62]
$A_4(L)\Delta Inflation_{t\text{-}1}$	-	-	0.61 [0.55]	-
$A_5(L)\Delta Bank\_foreign\_debt_{t\text{-}1}$	-	0.78 [0.47]	1.30 [0.29]	-
$A_6(L)\Delta Credit\_euroization_{t\text{-}1}$	23.11 [0.00]***	20.39 [0.00]***	22.95 [0.00]***	24.80 [0.00]***
R^2	0.68	0.60	0.75	0.71
Number of lags of explanatory variables	2	2	2	2
Number of observations	43	43	43	43
AR test	0.60 [0.62]	0.80 [0.50]	0.60 [0.62]	0.85 [0.48]
ARCH test	0.19 [0.90]	0.22 [0.88]	0.51 [0.68]	0.17 [0.91]

Notes: #numbers represent *F* statistics and the corresponding *p*-values of the Granger causality test for the respective variable; *p*-values are presented in brackets; lag length chosen according to SBIC – Schwartz Bayesian Information Criterion; *** – null hypothesis rejected at 1 percent significance level; ** – null hypothesis rejected at 5 percent significance level; * – null hypothesis rejected at 10 percent significance level.

Source: calculation of the authors

The first thing one notices is that the dependent variable is not weakly exogenous. Moreover, CE adjusts to discrepancies in both regimes, with the adjustment being faster when the disequilibrium is above the threshold (true in three out of four cases). The adjustment parameters range from -0.266 (in the case of the real effective exchange rate) to -0.150 (in the case of the nominal exchange rate), but even with the largest adjustment parameter (-0.266) it takes approximately four periods or one year to correct the discrepancies. The observed slow adjustment might be explained

Table 6 Threshold Cointegration for DE (Bivariate Cases) – Summary of Estimation Results

Dependent variable	Deposit euroization		
Explanatory variable	**Nominal exchange rate**	**REER**	**Exchange rate volatility**
Type of test	**M-TAR**	**M-TAR**	**TAR**
Threshold =	-0.0030	-0.0029	-0.1048
ρ_1 =	-0.017	-0.016	-0.048
ρ_2 =	0.043	0.038	-0.161
Tmax	3.05	2.78	-1.25
$\Phi(\rho_1 = \rho_2 = 0)$	8.133**	7.061*	7.970**
$W(\rho_1 = \rho_2)$	14.51 [0.00]***	12.39 [0.00]***	3.94 [0.047]**
AR test	0.68 [0.69]	0.59 [0.76]	1.51 [0.17]
Number of lags	4	4	1
Number of observations	161	161	161

Notes: ρ_1 and ρ_2 denote the adjustment parameters; *W* denotes the Wald test; *p*-values presented in brackets; lag length chosen according to SBIC – Schwartz Bayesian Information Criterion; *** – null hypothesis rejected at 1 percent significance level; ** – null hypothesis rejected at 5 percent significance level; * – null hypothesis rejected at 10 percent significance level.

Source: calculation of the authors

by persistence, the presence of which is indicated by the results of Granger causality tests for a lagged dependent variable. Since there is persistence in the adjustment process, fundamentals take a longer time to react, which in turn prevents the adjustment from unfolding more swiftly or completely. However, as in the case of the VECM, the persistence might also be a result of the stock definition of the dependent variable. Concerning the other CE determinants included in the threshold models, in the short run only the nominal exchange rate has an effect on CE, although this effect is marginally significant.

Table 6 summarizes the test results of the three bivariate DE models for which threshold effects were found. These models suggest that DE reacts in the long run to the nominal exchange rate, the REER, and exchange rate volatility. The threshold values in all three models are negative and very close to zero.

As a final step, we construct threshold error correction models for the three cases exhibiting threshold cointegration, with the results displayed in *Table 7*. DE responds to discrepancies from the equilibrium in all three models. In the model with the REER, DE adjusts to discrepancies in both regimes, but the adjustment is faster when the discrepancies are below the threshold. In the case with the nominal exchange rate, the adjustment occurs in one regime, when the discrepancies are above the threshold. Significant adjustment parameters are very small and range from -0.016 to 0.044, implying that it takes up to two years to correct long-run disequilibria.

Table 7 Threshold EC Model for DE (Bivariate Cases) – Summary of Estimation Results

Dependent variable	Deposit euroization		
Explanatory variable	Nominal exchange rate	REER	Exchange rate volatility
Type of test	M-TAR	M-TAR	TAR
Threshold	-0.0030	-0.0029	-0.1048
Constant	0.00007 [0.78]	0.0002 [0.53]	-0.0003 [0.43]
ρ_1	-0.016 [0.03]**	-0.020 [0.007]***	-0.007 [0.28]
ρ_2	0.024 [0.18]	0.044 [0.006]***	-0.007 [0.37]
$A_1(L)\Delta REER_{t-1}$#	-	0.99 [0.47]	-
$A_1(L)\Delta Exchange\_rate_{t-1}$	0.83 [0.62]	-	-
$A_2(L)\Delta Exchange\_rate\_volatility_{t-1}$	-	-	1.13 [0.35]
$A_4(L)\Delta Deposit\_euroization_{t-1}$	3.52 [0.0002]***	3.60 [0.0001]***	5.42 [0.0000]***
R^2	0.40	0.44	0.36
Number of lags of explanatory variables	12	12	10
Number of observations	161	161	161
AR test	1.20 [0.31]	2.04 [0.057]*	0.65 [0.72]
ARCH test	0.39 [0.91]	0.45 [0.87]	0.63 [0.73]

Notes: #numbers represent *F* statistics and the corresponding *p*-values of the Granger causality test for the respective variable; *p*-values are presented in brackets; lag length chosen according to SBIC – Schwartz Bayesian Information Criterion; *** – null hypothesis rejected at 1 percent significance level; ** – null hypothesis rejected at 5 percent significance level; * – null hypothesis rejected at 10 percent significance level.

Source: calculation of the authors

5. Concluding Remarks

In order to address FE with the appropriate policy measures, it is very important to understand its determinants. Namely, if policymakers aiming at de-euroization do not understand the process that led to equilibrium FE, with FE sometimes being an optimal outcome in an economy characterized by a set of frictions, policy measures aimed at de-euroization could result in failure and may even have detrimental effects on the stability of the financial system.

The results of the empirical analysis presented in this paper suggest that FE is an equilibrium outcome of several factors. Models nested in a linear framework suggest that the exchange rate, exchange rate volatility, inflation, and the tradeoff between inflation and real depreciation (suggested by the portfolio view of FE) are important for explaining the long-run behavior of both DE and CE. In addition, CE is affected in the long run by banks' behavior aimed at matching their foreign currency positions, which in effect implies that banks limit their exchange rate risk by shifting it to borrowers and by lending in foreign currency.

In the short run, DE and CE are characterized by a high degree of persistence that seems to prevent disequilibrium adjustment from taking place. Exchange rate and exchange rate volatility changes do not affect DE and CE in the short run, but inflation changes do, as does banks' behavior aimed at matching foreign currency positions.

Threshold effects that could only be detected in more parsimonious models of DE and CE suggest that the adjustment of disequilibrium from previous periods is discrete and asymmetric. In most cases, it is faster in regimes characterized by the FE level being lower than suggested by the fundamentals, and slower in regimes with the FE level being above equilibrium values. This finding might provide an explanation for the observed FE behavior not only in Croatia, but also elsewhere in the region. It took over a decade of stable economic performance for FE to very gradually subside, but after the unfavorable change in economic conditions in 2008 it swiftly shot up to its original higher levels.

As far as policy recommendations are concerned, tackling FE in Croatia is quite challenging and characterized by a high degree of uncertainty. The main dilemma faced by policy makers is whether to go ahead with across-the-board de-euroization of the financial system (ideally a symmetric one in order to avoid a build-up of currency mismatches) or to work toward swift euro adoption once Croatia joins the EU. However, the latter option is highly uncertain not only due to political and international economic factors, but also because Croatia is likely to have serious problems with fulfilling the Maastricht criteria related to fiscal deficits and public debt.[13] If, however, policy makers choose euro adoption, then they should accept euroization as a fact and manage its risks, primarily using regulation. In the opposite case, if euro adoption ceases to be a viable exit option, policy makers will have to address very high and persistent FE.

In order to reduce FE, Croatia and other post-transition European countries with high DE and CE first have to reform their macroeconomic policies and institutions in order to increase their credibility. Zettelmeyer, Nagy, and Jeffrey (2010) suggest that dollarization in Latin American countries only began to fall after countries introduced credible macroeconomic policies based on floating exchange rate and inflation targeting regimes. The importance of credible macroeconomic policies is confirmed in post-transition Europe, where the two countries with the oldest and most established floating exchange rate and inflation targeting regimes (Poland and the Czech Republic) have the lowest level of FE. Although credibility of macroeconomic policies and institutions was not controlled for in our empirical analysis, it is likely that it has to rise if policymakers want to reduce FE in Croatia.[14] Fiscal adjustment will also be necessary not just in order to increase fiscal credibility and meet the Maastricht debt and deficit criteria, but also to make inflation targets credible over the longer term.

Given that the empirical analysis results suggest that exchange rate developments and exchange rate volatility influence deposit and credit euroization in the long

[13] Public debt at the end of 2010 amounted to 45 percent of GDP. Projections based on the intertemporal budget constraint suggest that if no reforms of public spending are introduced, public debt could easily reach 60 percent of GDP by the end 2017, thus precluding adoption of the common currency.

[14] The eroded credibility of macroeconomic policies is obvious knowing that Croatia has a tightly managed float exchange rate system (which could also be defined as a quasi currency board), sustained for years because of fear of floating (Vizek, 2007).

run, it is essential that derivatives markets allowing borrowers to hedge against currency risk are developed. These markets would allow borrowers to hedge open foreign currency positions at affordable prices, thus reducing the overall sensitivity to exchange rate changes that promotes FE. The consequent elimination of exchange rate risk should matter especially for lowering borrowing in foreign currency generated by the corporate sector. Besides developing derivatives markets, the Croatian authorities should also consider further developing the local currency money market and promoting the local currency bond market. At the moment, the local currency money market is relatively shallow, while most of the corporate and government bonds issued on the domestic capital market are indexed to foreign currency.

APPENDIX

Data Description and Sources

Variable	Source	Description
Deposit euroization	Croatian National Bank	Share of foreign currency deposits in total deposits.
Credit euroization	Croatian National Bank	Share of foreign currency loans and loans indexed to a foreign currency in total loans.
Real effective exchange rate	Croatian National Bank	The index of the real effective exchange rate is a weighted geometric average of the index of bilateral exchange rates of the kuna adjusted for the relevant relative price indices. Producer price index is used as a deflator, (2005 = 100).
Exchange rate	Croatian National Bank	Average periods nominal HRK/EUR exchange rate.
Exchange rate volatility	Croatian National Bank	Monthly average of daily exchange rate volatility given by a ratio of standard deviation and average daily exchange rates in four months prior to the observed period.
M1	Croatian National Bank	Narrow money.
M4/M1	Croatian National Bank	Ratio of M4 over M1 monetary aggregate.
Inflation	Croatian National Bank	Croatian Consumer Price Index, (2005 = 100).
Average past inflation	Croatian National Bank	In each contemporaneous period calculated as an average of the Croatian Consumer Price Index (2005 = 100) two years prior to the contemporaneous period.
Minimum variance portfolio	Croatian National Bank	Minimum variance portfolio calculated as: $\frac{var(\Delta cpi)+cov(\Delta cpi,\Delta reer)}{var(\Delta cpi)+var(\Delta reer)+2cov(\Delta cpi,\Delta reer)}$ where *cpi* stands for Croatian Consumer Price Index and *reer* for Croatian real effective exchange rate.
Bank foreign debt	Croatian National Bank	Banks' gross external debt.
REER cycle	Croatian National Bank and Central Bureau of Statistics	Correlation between real effective exchange rate (*reer*) and the business cycle represented by industrial production (*ip*) calculated as: $correl[\text{12-month average}(\Delta ip), \text{12-month average}(\Delta reer)]$

Table A1 Summary Statistics for All Variables

	Observations	Mean	Standard deviation	Skewness	Excess kurtosis	Minimum	Maximum
Deposit euroization	161	0.79	0.08	-0.58145	-1.08497	0.65	0.88
Exchange rate	161	7.37	0.19	-0.56038	0.02827	6.90	7.70
REER	161	101.95	5.67	-0.26418	-0.43370	88.89	112.41
Exchange rate volatility	161	0.73	0.51	1.74767	3.43891	0.06	2.77
Inflation	161	96.28	11.75	0.07354	-0.87278	74.94	116.21
M1	161	31041.9	14673.3	0.09799	-1.41458	11274.95	55832.98
M4/M1	161	4.10	0.30	0.56749	0.45445	3.31	4.90
Average past inflation	161	92.98	11.72	-0.01836	-0.86856	71.97	114.86
Minimum variance portfolio	161	0.20	0.17	0.36107	-0.00834	-0.27	0.63
REER cycle	161	-0.10	0.27	0.11923	-0.16704	-0.77	0.56
Credit euroization	43	0.753	0.077	-0.35290	-0.82092	0.608	0.86
Bank foreign debt	43	6446.33	3201.34	-0.23897	-1.67814	2035.22	10724.16

Table A2 Critical Values of *F* Statistics Used for Testing TAR and M-TAR Threshold Cointegration (Null Hypothesis $\rho_1 = \rho_2 = 0$) with The Unknown Threshold

Number of observations	2-variable case						5-variable case		
	1 lag			4 lags			4 lags		
	0.90	**0.95**	**0.99**	**0.90**	**0.95**	**0.99**	**0.90**	**0.95**	**0.99**
TAR									
50	6.35	7.54	10.29	5.83	6.98	9.56	8.10	9.46	12.54
100	5.95	6.99	9.39	5.66	6.66	8.97	8.50	9.73	12.43
150	**5.94**	**6.98**	**9.29**	5.78	6.76	8.93	8.77	10.02	12.73
200	6.03	7.05	9.35	5.89	6.88	9.05	9.17	10.40	13.06
250	6.14	7.11	9.38	6.07	7.08	9.32	9.34	10.57	13.20
500	6.41	7.39	9.66	6.38	740	9.63	9.78	11.05	13.67
M-TAR									
50	7.22	8.49	11.55	6.54	7.76	10.50	**8.90**	**10.26**	**13.44**
100	6.97	8.15	10.67	6.61	7.73	10.14	9.52	10.81	13.72
150	**6.75**	**7.87**	**10.40**	**6.54**	**7.62**	**9.96**	9.66	10.99	13.74
200	6.62	7.72	10.04	6.46	7.51	9.85	9.75	11.05	13.83
250	6.61	7.76	10.15	6.41	7.44	9.71	9.84	11.12	13.82
500	6.52	7.55	9.93	6.42	7.47	9.72	10.05	11.31	14.07

Table A3 Threshold Cointegration

Model	Deposit euroization with real effective exchange rate		Credit euroization with nominal exchange rate
	TAR	M-TAR	TAR
	Threshold = 0.0081	Threshold = 0.0055	Threshold = -0.0126
$\rho_1 =$	-0.15	-0.0054	-0.297
$\rho_2 =$	-0.059	-0.13	-0.535
Tmax	-1.12	-0.067	-1.84
$\Phi(\rho_1 = \rho_2 = 0)$	5.50	5.51	5.16
$W(\rho_1 = \rho_2)$	0.67 [0.44]	1.03 [0.18]	0.85 [0.36]
AR test	1.22 [0.29]	1.10 [0.36]	0.61 [0.61]

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