The determinants of exchange rate in Croatia

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Abstract

The dilemma for every country with an independent monetary policy is which kind of exchange rate arrangement should be applied. Through the exchange rate policy, countries can influence their economies, i.e. price stability and export competiveness. Croatia is a new EU member state, it has its own monetary policy and currency but it is on the way to euro introduction. Regarding the experiences from the beginning of the 1990s when Croatia was faced with serious monetary instabilities and hyperinflation, the goal of Croatian National Bank (CNB) is to ensure price stability and one way to do so is through exchange rate policy. Croatia, as a small and open economy, has applied a managed floating exchange rate regime. The exchange rate is determined primarily by the foreign exchange supply and demand on the foreign exchange market, with occasional market interventions by the CNB. Therefore, in order to maintain exchange rate stability, policymakers must be able to recognize how changes in these factors affect changes in the exchange rate. This research aims to find a relationship among the main sources of foreign currency inflow and outflow and the level of exchange rate in Croatia. The analysis is carried out by using the bounds testing (ARDL) approach for co-integration. The results indicate the existence of a stable co-integration relationship between the observed variables, whereby an increase in the majority of variables leads to an exchange rate appreciation.

Keywords: exchange rate, co-integration, ARDL approach, Croatia

1. Introduction

There are several exchange rate regimes that countries can apply, from fixed (the extreme is a regime without the domestic currency in circulation – dollarization; currency board etc.) to completely flexible[1]. Although countries tend to have one

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[1] According to the International Monetary Fund (IMF) classification, there are six intermediate regimes (IMF 2009).

formal system, they in fact apply some intermediate systems. For example, one country can officially have a flexible exchange rate, but in reality its exchange rate moves in very narrow boundaries (which would mean that it is actually applying a fixed exchange rate regime). The choice of exchange rate depends on the goals that the country wants to achieve (Krugman and Obstfeld 2006).

A flexible exchange rate system is convenient for large "closed" countries with a diversified production (export) structure that is highly involved in international financial flows, and has an inflation rate different from that of its trade partners. On the other hand, the fixed exchange rate system is suitable for small countries with the opposite characteristics (Babić and Babić 2003). Calvo and Reinhart (2002) warn that countries that want to allow their exchange rate to float, mostly fail to do so because of the "fear of floating" that results from foreign exchange reserves and interest rates. The new EU member states used to apply different exchange rate systems before EU entrance (from currency board to floating), but even now, after obtaining full membership status, there are differences among them. Some of them were oriented toward the euro introduction (small states). Slovenia, Slovakia, Cyprus, Malta, Estonia, Latvia and Lithuania are already in Eurozone while others apply different policies: managed floating (Bulgaria, Croatia), free floating (Poland, Romania and Czech Republic, Hungary).

Since gaining its independence, Croatia has applied two exchange rate regimes: a fixed regime toward the Deutsche mark from 1991 to 1993, and a regime of managed floating from September 1993 until now. The Croatian National Bank (CNB) occasionally makes interventions on the foreign exchange market through foreign exchange auctions, whereby the central bank purchases or sells foreign currency to commercial banks[2]. In that way, excessive exchange rate fluctuations were prevented. Croatia formally applies a flexible exchange rate system. However, Nikić (2003) warns that the changes in the exchange rate were in the narrow limits of deviation (in the period 1993-2001). According to CNB data, these deviations are +/- 6%.

Such an exchange rate policy is successful in lowering inflation and achieving the goal of price stability. However, a longer application of this policy is not recommended, as it may reduce the competitiveness of domestic economy due to the appreciation of the local currency. Long-term overvaluation of domestic

[2] The CNB can apply other measures and instruments for regulation of money supply and the exchange rate of the domestic currency (i.e., policy of sterilization and determination of obligatory reserves). Until 2008, most CNB interventions regarded the buying of foreign currencies, because the kuna tended to appreciate (the highest amount of buying was in July 2007, 71.2 million EUR). After the beginning of the economic crisis in 2008, most interventions were on the supply side: the CNB sold euros to business banks because the kuna tends to depreciate (the highest intervention was in October 2008: 270.6 EUR million) (CNB 2013b).

currency tends to decrease exports, increase job losses, further widen the current account deficit, and increase foreign debt. The negative effects of quasi "fixing" the exchange rate must compensate monetary and fiscal policies. Santini (2006) warns that the exchange rate in Croatia is determined by the supply side of foreign currency in the foreign exchange market, which originates in the credit borrowing abroad. The consequence is a high level of debt. Such a situation is not sustainable, because it does not stem from the real terms of trade. Rather, it depends on foreign creditors that increase the cost of capital. As foreign exchange reserves in Croatia are higher than the money supply, at this moment, the CNB can defend any level of the exchange rate.

In the system of floating, all exchange rate determinants that create supply and demand for foreign exchange may influence the exchange rate.

The goal of this paper is to find the determinants that can influence the exchange rate movement in Croatia and to quantify their significance in both the long and the short run. Identifying these variables is very important for managing exchange rates and for perceiving the consequences of changes in chosen variables, since exchange rate stability is important for the maintenance of price stability and for the prospective introduction of the euro (one of Maastricht criteria regards the stability of the exchange rate of the national currency toward the euro). We proceed with the analysis of determinants of the exchange rate in Croatia where we perform a combination of theoretical approaches, select the relevant variables from them and follow the findings of Hinkle and Montiel (1999), MacDonald (1997 and 2000), Driver and Westway (2003) and Egert (2003).

Croatia is a small country with a GDP of 43.9 billion euro or 10.295 euro per capita in 2012 (CNB, 2013a). It is an open economy, with the share of exports (or imports) in GDP of about 42%. It is faced with a deficit in its current account, which reached the highest level of 8.9% of GDP in 2008 and has since been decreasing (in 2012, there was a small surplus of 0.1% of GDP). According to WIIW (2012) Croatia received 23.9 billion euro of foreign direct investments (FDI) in the period from 1993 until the end of 2011, which is a very large amount in per capita terms – 5,787 euros. The Croatian foreign debt was 44.8 EUR billion at the end of 2012 (or 102% of GDP). Croatia also has a high level of euroisation (savings in euros and credits with clause in foreign currencies, i.e., about 83% of deposits are in euro or other currencies, and about 70% of credits are in kuna with clause in foreign currencies). About 90% of the banking sector is in foreign ownership. The high level of foreign debt and the large amount of credits with a foreign exchange clause are the main constraints of the possible depreciation of the kuna, because the depreciation would result in increasing the rate of loans in kuna and would have major negative social consequences (reducing the living standards). The other constraint of depreciation is that import dependence of domestic production and depreciation will increase the price of products with high share of foreign inputs. The open economy trilemma ("impossible trinity") shows

that it is impossible to reach three goals simultaneously: monetary independence, stable exchange rate, and financial integration. A country should sacrifice one of the mentioned goals (Krugman and Obstfeld, 2006). This means that Croatia (with a high level of euroisation and openness) can achieve financial integration and a stable exchange rate, but it should lose the independent monetary policy. This is proven in papers that deal with research monetary transmission mechanism that show a stronger exchange rate channel while interest rate channel is not relevant or is very weak (Vizek, 2006; Benazić, 2009; Doležal, 2011).

The research applies the Autoregressive Distributed Lag (ARDL) econometric method and this paper aims to contribute to the existing literature in several ways. There are some papers about the exchange rate policy, but most of them remain at the level of exchange rate examination and explain trends with statistical data from the balance of payments (Nikić, 2003; Santini, 2006). There is scarce literature about the determinants of the Croatian exchange rate. Papers that explore the influence of exchange rate policy on the monetary policy or on foreign trade are a lot more frequent (Stučka, 2003; Sošić and Kraft, 2006; Sorić, 2007; Koški, 2009, Josifidis et al. 2013; Tkalec and Verlič, 2013). There are no papers that research greater number of determinants (not volatilities) of exchange rates in Croatia. The innovation also consists in applying the ARDL methodology as well as in the analysed period – we have included the period 1998:4 to 2013:1 (all available data).

The paper is organized as follows: Section 2 is focused on literature review. Section 3 presents the empirical analysis and results, while Section 4 deals with conclusions.

2. Literature review

This paper analyses the determinants of exchange rate in Croatia (not volatility) and regarding the fact the euro is most present foreign currency in Croatia (unofficial euroisation- loans with a currency clause, a large share of savings in euros, the prices in the housing market are reported in euros) and also has domination in the index of the real effective exchange rate, we decide to explore the factors affecting the changes in the euro exchange rate in Croatia. [3]

[3] Considering that Croatia introduced its own currency in 1993 and that beginning with this period, it was characterized by huge macroeconomic instability (hyperinflation, industrial decrease, unemployment resulting from the transition process and war), the available data on the relevant variables that we should include in the analysis were available for the short period (from 1998 on). In order to measure volatility it is necessary to have a longer period and more observations. The data about foreign debt on a quarterly basis are available from 1998. Because of this we started analysis with this year. For other variables, earlier data are also available.

Exchange rate volatility problems are associated with flexible exchange rate regimes and monetary authorities were blamed for fluctuations in exchange rates. Dornbusch (1979) showed that unanticipated monetary policy shocks might disproportionately generate large fluctuations in exchange rates (overshooting effect). The speed of adjustment in the goods markets is then lower in financial markets. This is a mechanism through which the exchange rate disproportionately absorbed the unanticipated monetary shock in the short run. However, do monetary developments have an impact on exchange rates? Inflation rates in developed countries are very low; however, there is volatility in major world currencies (Rogoff, 1999). Therefore, the impact of monetary trends may be considered overpriced, and that it is just one of the factors that affect the volatility of exchange rates.

Hacche (1983) synthesized the possible determinants of the exchange rate (and researches): flows in the balance of payments, flow-equilibrium in asset market, and relative price levels, interest rates, and money supply. Branson (1981) created a model (with static and rational expectation) that integrates money, relative prices, and the current account balance as factors explaining movements in nominal (effective) exchange rates since 1973. He found that those theoretical models that integrate money, the balance on current account, and relative prices are consistent with movements in these variables since 1973 in the United States, the United Kingdom, Germany, and Japan.

In addition to monetary developments, new open-economy macroeconomics points to the importance of non-monetary variables on the exchange rate and thus includes productivity, terms of trade, and government spending. Aguirre and Calderon (2005), Prasad et al. (2003), and Caporale et al. (2009) estimated the influence of financial integration on exchange rate volatility in emerging countries and found out that the higher financial openness and the stronger the financial integration, the smaller volatility of exchange rates will be.

Edwards (1988) developed a dynamic model of real exchange rate behaviour in 12 developing countries for the period 1960-1985 considering a three-goods economy (exportables, importables, and nontradables). Macroeconomic disequilibria affect the real exchange rate in the short run; the long run equilibrium-real exchange rate responds to changes in fundamentals (external terms of trade, level and composition of government consumption, import tariffs and capital flows).

MacDonald (1997) estimated the influence of different variables on the long-run exchange rate and he found that productivity, terms of trade, fiscal balances, net foreign assets and real interest rates are key fundamental determinants. Hinkle and Montiel (1999) provide a complex overview of the exchange rate misalignment in developing countries and also point out the approaches to define the long-term equilibrium of exchange rate. Egert (2003) differentiates few approaches of defining equilibrium exchange rate: the

fundamental equilibrium exchange rate, the natural equilibrium exchange rate, behavioral exchange rate, and shows their efficiency in the long and short run. The purchasing power parities (and Balasa-Samuelson effect) is more suitable for the long run, while other approaches are more efficient in the short and medium term. After the literature review, he concludes that it is very difficult to predict the future exchange rate equilibrium and that it is necessary to combine findings and variables that come from above mentioned approaches. Driver and Westaway (2003) examine the concept of equilibrium exchange rate in relation to the discussion on the different strengths and weaknesses of alternative empirical measures of equilibrium exchange rates. They connect approaches with their effectiveness in the short/long-run. MacDonald (2000) discusses the internal-external balance model in defining the equilibrium exchange rate as compared with behavioral equilibrium model. He found that in the medium-run, the current account imbalance should be sustainable.

More comprehensive and systematic literature review is given by Rosi (2013) who tries to determine a set of variables that influence the forecast of exchange rates. She concluded that predictability depends on the choice of predictor, forecast horizon, sample period, model, and forecast evaluation method. She warns that a theoretical model such as the random walk is frequently found to generate better exchange rate forecasts than economic models ("the Meese and Rogoff puzzle"). The paper combines different approaches (theories) of exchange rate and provides a discussion on the various variables than can be applied as exchange rate predictor: interest rate differentials, inflation differentials, money and output differentials, productivity differentials, portfolio balance, the Taylor rule, external imbalance measures.

Regarding European countries, we emphasize the following researches.

Égert and Halpern (2005) conducted a meta-regression analysis in new EU member states and looked at the most common explanatory variables for the real exchange rate: productivity, net foreign assets, and openness. They found that the real misalignments reported in the literature are systematically influenced, inter alia, by the underlying theoretical concepts and by the econometric estimation methods. Stančik (2006) researched the exchange rate volatility in six new EU member states during the period 1999-2004 and used TARCH methodology. He found that openness has a negative effect on exchange rate volatility and that there is a significant effect of "news" (unpredictable circumstances) on exchange rate volatility. Holzner (2006) researched the distortion of the real exchange rate in the seven Southeast European countries and applied panel data analysis. The results show that the West Balkan countries have overvalued real exchange rates, while other transition countries' exchange rates are rather undervalued. The main determinants of the real exchange rate distortion are related to the inflow of FDI.

Josifidis et al. (2013) has researched the real exchange rate as an adjustment mechanism variable; crisis transmission to the real economy, and foreign

exchange intervention as a way of exchange rate management/defence. The research is conducted on six new EU members during the financial crisis. Nedeljković and Urošević (2012) studied the drivers of the nominal dinar-euro exchange rate from September 2006 to June 2010. They applied a novel semiparametric and showed that the relevance of several factors varies in time. In the period preceding the financial crisis in 2008, information on past returns, changes in the foreign currency savings of households, and net purchases of foreign currency by banks were the most significant factors. From September 2008 onwards, other factors related to changes in the country's risk and information processing in the market gained importance.

The exchange rate policy and movements in Croatia have been researched, among others, by Ahec Šonje and Babić (2002), Nikić (2003), Sošić and Kraft (2006), Benazić (2008), Erjavec et al. (2012) and Benazić and Barbaro (2012).

Ahec Šonje and Babić (2002) tried to find out the indicators of currency disturbances in Croatia, with a special concern on two cases, 1999 and 2001, and to create an effective system of early warning indicators heralding currency disturbances through "signal" approach (combination of banking and macroeconomic indicators). Sošić and Kraft (2006) analysed the Croatian exchange rate policy in the framework of dollarization and warn that monetary and exchange rate policies focus on exchange rate smoothing to safeguard financial stability. Dollarization has prevented the use of monetary policy to stabilize output. The high level of dollarization in Croatia has had an impact on monetary policy (Kraft, 2002), i.e., exchange rates fluctuation can create credit quality shocks and also influence the structure of deposits (savings). Depreciation leads to high dollarization.

Benazić (2008) examined the long-run and short-run relationship between stock prices represented by CROBEX[4] and the real effective exchange rate of the Croatian kuna in the Republic of Croatia. Applying a vector error correction (VEC) model, forecast error variance decomposition (FEVD), and impulse response analysis, he found the existence of a long-run relationship between variables, i.e., an increase in share prices will lead to an appreciation of the exchange rate. In the short-run, changes in share prices are almost statistically insignificant.

Ljubaj, Martinis, and Mrkalj (2010) assessed the CNB's policy of sterilization (of capital inflow) in the 2000-2009 period. By applying econometric analysis (2SLS), they found that CNB implemented a policy of strong but incomplete sterilization of capital inflows from abroad. At the same time, the CNB indirectly contributed to additional inflow of capital by applying monetary policy instruments.

[4] CROBEX is the official share index of the Zagreb Stock Exchange.

Productivity differs in the tradable and non-tradable sectors, and can influence inflation and exchange rates. However, Funda et al. (2007) found that the Balassa-Samuelson effect in Croatia was not statistically significant, so it should not constitute a barrier to meeting convergence criteria. Thus, we did not include the data about productivity in the basket of the variables that can influence the exchange rate.

By using structural vector autoregression (SVAR), Erjavec et al. (2012) analysed the changes in the real exchange rate due to three structural shocks: supply, demand, and monetary in the 1998-2008 period. They found that the fluctuations in the real exchange rate are mostly due to real demand shocks (more than 80%) while supply shocks account for a small proportion of the variation in real exchange rates. Thus, the Croatian real exchange rate acts as a shock absorber.

Since Croatia has a trade deficit in manufactured products and a surplus in the service balance sheet (because of tourism), an appreciation of the Croatian kuna during the summer and depreciation during the fall and winter could be expected (Benazić and Barbaro, 2012). Exchange rate movements show that the exchange rate of the kuna really behaves according to this trend. At times, however kuna went through appreciation in other periods of the year. This indicates the importance of other determinants that affect the inflow or outflow of foreign exchange in Croatia (e.g., external borrowing and FDI inflows).

3. Empirical analysis and results

The main goal of this paper is to analyse the effects of changes in consumer prices, the ratio between foreign currency deposits and total time and saving deposits, the ratio between kuna loans indexed to foreign currency and total loans, international reserves of the CNB, the export/import coverage, foreign direct investments and external debt on nominal exchange rate of kuna against the euro in Croatia. For this purpose, the autoregressive distributed lag (ARDL) modelling approach is used[5]. Data are analysed on a quarterly basis from December 1998 until March 2013[6]. Figure 1 shows their movements. All data are obtained from the CNB and the International Financial Statistics (IFS).

It is visible that consumer prices (CPI), international reserves (INTRES), FDI, and external debt (EXTDEBT) achieve strong upward trend mainly throughout the whole observed period, while the exchange rate (HRK/EUR), the ratio between foreign currency deposits and total time and saving deposits (DEP_fc), the ratio between kuna loans indexed to foreign currency and total loans

[5] For the time series analysis *Gretl* and *Microfit* econometric software are used.

[6] The main reason why the data in the model start from 1998 is due to the external debt data. Specifically, CNB publishes data on external debt since 1998. Furthermore, the external debt is a very important determinant of the foreign exchange rate movements, particularly in small and open economies such as the Croatian.

(LOAN_fc), and the export/import coverage (COVER) achieve a downward trend until 2008, after which they start to rise due to a spillover effect of the global crisis on the Croatian economy.

To estimate the exchange rate equation, the ARDL modelling approach is used. Due to its advantages, the approach was popularized with the works of Pesaran, Shin, and Smith (1996) and Pesaran and Shin (1999). The main advantage of this approach is that it can be applied irrespective of whether the regressors are I(0) or I(1) and can avoid the pre-testing problems associated with the standard co-integration analysis that requires the identification of the order of integration. Therefore, and in contrast to other approaches of co-integration, this method has the advantage of rendering unnecessary pre-stage unit root tests, which are known for their poor confirmation power. Another advantage is that the ARDL approach does not require symmetry of lag lengths.

According to Pesaran, Shin, and Smith (1996) and Pesaran and Shin (1999) the ARDL model is performed in two steps. The first step starts with conducting the bounds test for co-integration. In the second step, when co-integration is found, the long-run relationship and the associated error correction model (ECM) are estimated.

Before proceeding with the bounds test, it is necessary to examine the properties of the time series, i.e., the degree of integration, because it is very important to determine whether the variables are integrated of order $n = 0, 1, 2$ as to avoid spurious results. In the presence of I(2) variables, the computed *F*-statistics is not valid, because the bounds test is based on the assumption that the variables are I(0) or I(1). To do so, the Augmented Dickey-Fuller ADF test (Dickey and Fuller, 1979), the Phillips and Perron PP test (Phillips and Perron, 1988), and the KPSS test (Kwiatkowski, Phillips, Schmidt and Shin, 1992) are considered. To eliminate the influence of seasonal factors, all series were seasonally adjusted[7]. Furthermore, all variables are expressed in their logarithmic form. Table 1 shows the results of the unit root tests.

Although some results in Table 1 indicate that international reserves and FDI are stationary in levels, insight into Figure 1 and the results of KPSS test confirm that all the variables are integrated of order I(1), i.e., they are stationary in their first differences.

As stated before, the first step of the ARDL approach starts with conducting the bounds test for co-integration. Therefore, the long-run relationship between the variables is tested by computing the *F*-statistic to test the significance of the lagged levels of the variables in the error correction form of the underlying ARDL model.

[7] Using the Arima X12 method.

Table 1. Unit root tests

Variable and test	*Level*		*First difference*	
	Constant	*Constant and trend*	*Constant*	*Constant and trend*
ADF test	*t-stat.*			
LHRK/EUR	-2.316566	-2.648627	-8.490229	-8.427158
LCPI	-0.884024	-2.367436	-5.546803	-5.522273
LDEP_fc	-1.812320	-0.863639	-4.230473	-4.500034
LLOAN_fc	-2.202321	-2.512819	-4.846812	-5.008408
LINTRES	-4.029183	-3.233909	-8.310674	-9.167506
LCOVER	-2.165528	-1.733979	-10.69652	-10.84541
LFDI	-3.263900	-2.658381	-3.194741	-4.185991
LEXTDEBT	-2.070897	0.185226	-3.450301	-4.146332
PP test	*Adj. t-stat.*			
LHRK/EUR	-2.474173	-2.934443	-8.507097	-8.457705
LCPI	-0.764638	-2.407806	-5.630176	-5.612733
LDEP_fc	-1.458528	-0.805771	-4.337277	-4.594069
LLOAN_fc	-1.870587	-1.970604	-4.826693	-4.991450
LINTRES	-4.961587	-3.437320	-8.237352	-9.211417
LCOVER	-1.925117	-2.317703	-10.80428	-11.50547
LFDI	-5.821024	-2.798638	-2.983517	-4.197777
LEXTDEBT	-2.644342	0.857900	-3.494237	-4.228369
KPSS test	*LM-stat.*			
LHRK/EUR	0.428620	0.144387	0.084571	0.084423
LCPI	0.941337	0.072262	0.080699	0.064378
LDEP_fc	0.421971	0.194103	0.289821	0.106389
LLOAN_fc	0.214569	0.176860	0.186464	0.053040
LINTRES	0.883756	0.230021	0.716348	0.099684
LCOVER	0.269158	0.206276	0.284257	0.071069
LFDI	0.915552	0.229246	0.699578	0.105757
LEXTDEBT	0.917990	0.221474	0.530796	0.120396

Source: Authors' calculations[8]

[8] Note: L indicates logarithm of the variable. For the implementation of ADF test the Schwarz Bayesian criterion has been implemented. ADF test critical values (MacKinnon, 1996); constant: 1% level (-3.49), 5% level (-2.89), 10% level (-2.58); constant and trend: 1% level (-4.04), 5% level (-3.45), 10% level (-3.15). PP test critical values (MacKinnon, 1996): constant: 1% level (-3.49), 5% level (-2.89), 10% level (-2.58); constant and trend: 1% level (-4.04), 5% level (-3.45), 10% level (-3.15). KPSS asymptotic critical values (Kwiatkowski-Phillips-Schmidt-Shin, 1992); constant: 1% level (0.739), 5% level (0.463), 10% level (0.347); constant and trend: 1% level (0.216), 5% level (0.146), 10% level (0.119)

For these purposes, Pesaran, Shin, and Smith (1996) tabulated the critical values for different number of regressors (k) considering the model could include an intercept and/or trend. The testing procedure starts with conducting the bounds test for the null hypothesis of no co-integration. Since the observations are quarterly given, the maximum order of lags in the ARDL model is 4. Furthermore, the trend is included[9]. The error correction version of the ARDL model is defined as follows:

$$\begin{aligned}\Delta LHRK/EUR_t = {} & \alpha_0 + t + \sum_{i=1}^{4}\psi_i \Delta LHRK/EUR_{t-i} + \sum_{i=1}^{4}\varphi_{i1}\Delta LCPI_{t-i} + \sum_{i=1}^{4}\varphi_{i2}\Delta LDEP\_fc_{t-i} \\ & + \sum_{i=1}^{4}\varphi_{i3}\Delta LLOAN\_fc_{t-i} + \sum_{i=1}^{4}\varphi_{i4}\Delta LINTRES_{t-i} + \sum_{i=1}^{4}\varphi_{i5}\Delta LCOVER_{t-i} \\ & + \sum_{i=1}^{4}\varphi_{i6}\Delta LFDI_{t-i} + \sum_{i=1}^{4}\varphi_{i7}\Delta LEXTDEBT_{t-i} \\ & + \delta_1 LHRK/EUR_{t-1} + \delta_2 LCPI_{t-1} + \delta_3 LDEP\_fc_{t-1} + \delta_4 LLOAN\_fc_{t-1} \\ & + \delta_5 LINTRES_{t-1} + \delta_6 LCOVER_{t-1} + \delta_7 LFDI_{t-1} + \delta_8 LEXTDEBT_{t-1} + u_t \end{aligned} \quad (1)$$

where δ_1, δ_2, δ_3, δ_4, δ_5, δ_6, δ_7 and δ_8 are the long-run multipliers, ψ_i and φ_i are the short-run dynamic coefficients, a_0 is the intercept term, t is a deterministic time trend while u_t are serially uncorrelated residuals with zero mean. The current values of DLCPI, DLDEP_fc, DLLOAN_fc, DLINTRES, DLCOVER, DLFDI, and DLEXTDEBT are excluded, since it is not possible to know *a priori* whether LCPI, LDEP_fc, LLOAN_fc, LINTRES, LCOVER, LFDI, and LEXTDEBT are the "long-run forcing" variables for exchange rate (LHRK/EUR).

The F-test is conducted for the joint hypothesis that the lagged levels of the variables in Equation (1) are zero:

$$H_0 : \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7 = \delta_8 = 0 \quad (2)$$

against the alternative hypothesis that at least one lagged level variable is non-zero:

$$H_1 : \delta_1 \neq 0, \delta_2 \neq 0, \delta_3 \neq 0, \delta_4 \neq 0, \delta_5 \neq 0, \delta_6 \neq 0, \delta_7 \neq 0, \delta_8 \neq 0 \quad (3)$$

Computed F-statistic should be compared with the critical values in Pesaran, Smith, and Shin (1996). Two sets of asymptotic critical values are provided: one set assuming that all the regressors are I(1) and another set assuming that they are all I(0). If the computed F-statistic exceeds the upper critical value, the null hypothesis of no long-run relationship can be rejected and if it falls below the lower critical value, the null hypothesis of no long-run relationship can be accepted. Finally, if it falls between these two critical values, the result is inconclusive. Table 2 summarizes the result of the computed F-statistic with the exchange rate as dependent variable.

[9] Subsequent comparison of the model information criteria (AIC and SBC) showed that a higher value of the information criterion achieves models that include a trend.

Table 2. ARDL bounds test

F-statistic	*p-value*	*95% I(0) bound*	*95% I(1) bound*
5.8129	0.00456806*	2.752	3.883

Source: Authors calculations[10]

Since the computed *F*-statistic exceed the upper bound, the null hypothesis of no long-run relationship between variables can be rejected irrespective of the order of their integration. The results also suggest that LCPI, LDEP_fc, LLOAN_fc, LINTRES, LCOVER, LFDI, and LEXTDEBT can be treated as the "long-run forcing" variables for the explanation of nominal exchange rate.

In the second step, the long-run ARDL model is estimated. The appropriate number of lags for each variable in the model is detected automatically by the program procedure using the SBC[11]. The automated program procedure leaves only significant lags while the insignificant ones are removed. Table 3 summarizes the diagnostic tests of the selected ARDL (2, 4, 3, 4, 2, 2, 4, 3) exchange rate equation.

Table 3. Diagnostic tests of the ARDL (2, 4, 3, 4, 2, 2, 4, 3) exchange rate equation

Serial correlation	LM test: LMF = 1.237190, p-value = P(F(4.17) > 1.23719) = 0.332 Alternative statistic: TR^2 = 12.175315, p-value = P(Chi-square(4) > 12.1753) = 0.0161 Ljung-Box test: Q' = 4.78265, p-value = P(Chi-square(4) > 4.78265) = 0.31
Normality	Chi-square(2) = 2.835, p-value = 0.24234
Heteroscedasticity	Breusch-Pagan test: LM = 45.397158, p-value = P(Chi-square(32) > 45.397158) = 0.058645 Koenker test: LM = 35.559383, p-value = P(Chi-square(32) > 35.559383) = 0.304279
ARCH	LM = 6.3424, p-value = P(Chi-square(4) > 6.3424) = 0.174995
Parameter stability	CUSUM test: Harvey-Collier t(20) = 0.644853, p-value = 0.5264
Non-linearity	Ramsey's RESET test:

[10] Note: lags = 4, k = 7. The bounds are given for Case II (intercept and trend). (*) indicates statistical significance at the 1% level.

[11] Also, the model using the AIC was estimated but the results were very similar, including the estimated standard errors. Furthermore, the SBC is more suitable for this kind of analysis due to a relatively short estimation period and because it penalizes models with a larger number of independent variables more than the AIC does. In other words, the SBC, being the more restrictive one, is used.

	(squares and cubes) F = 2.895874, p-value = P(F(2.19) > 2.89587) = 0.0798 (squares only) F = 1.682614, p-value = P(F(1.20) > 1.68261) = 0.209 (cubes only) F = 1,676140, p-value = P(F(1.20) > 1,.7614) = 0.21

Source: Authors' calculations

Diagnostic tests suggest that the model is adequately estimated and that the conclusions of the model are acceptable. Furthermore, CUSUM and CUSUMQ plots are presented in the appendix and do not show significant breaks of the estimated ARDL (2, 4, 3, 4, 2, 2, 4, 3) model, indicating that there exists a stable exchange rate function over the sample period.

Table 4 presents the level relationship, i.e., the long-run ARDL (2, 4, 3, 4, 2, 2, 4, 3) exchange rate equation.

Table 4. Estimated long-run coefficients of the ARDL (2, 4, 3, 4, 2, 2, 4, 3) exchange rate equation

Dependent variable: LHRK/EUR				
	Coefficient	*Std. Error*	*t-ratio*	*p-value*
Const	10.1151	1.7217	5.8751	0.000***
LCPI	-0.71325	0.31543	-2.2612	0.034**
LDEP_fc	-0.090915	0.097909	-0.92857	0.364
LLOAN_fc	-0.27288	0.081026	-3.3679	0.003***
LINTRES	-0.064513	0.065410	-0.98629	0.335
LCOVER	0.25820	0.14209	1.8172	0.083*
LFDI	-0.22332	0.092773	-2.4072	0.025**
LEXTDEBT	-0.25247	0.13988	-1.8049	0.085*
Trend	0.024664	0.0057617	4.2808	0.000***

Source: Authors' calculations[12]

Most of the estimated coefficients in the long-run are statistically significant and have expected signs. Calculated *t*-ratios suggest that the ratio between kuna loans indexed to foreign currency and total loans, FDI, and consumer prices are the most significant factors in determining the exchange rate equation, which are followed by the export/import coverage and external debt. On the other side, the ratio between foreign currency deposits and total time and savings deposits and international reserves are insignificant in the long run. It is

[12] Note: L indicates logarithm of the variable. (***) indicates the statistical significance at the 1% level; (**) indicates the significance between 1% and 5%; (*) indicates the significance between the 5% and 10% levels.

evident that an increase in all variables in the long-run, except the export/import coverage, leads to a decrease (i.e., appreciation) in the exchange rate.

The stated relations between variables are logical, since the rise in international reserves, FDI, and external debt at the same time increases the supply of foreign currency (mainly euros) and the demand for domestic currency (kuna), which is then reflected as an exchange rate appreciation. Furthermore, an increase in consumer prices would also lead to an exchange rate appreciation. In the past, the CNB was very successful in maintaining price stability by keeping the exchange rate stable, which was common to all small and open countries with large capital inflows, such as Croatia. Capital inflows normally create inflationary pressures, because they increase the amount of money in circulation that may be neutralized by the exchange rate appreciation.

We can also notice that the effects of the ratio between kuna loans indexed to foreign currency and total loans and external debt on the exchange rate are very similar. This is closely related to the ways of financing loans, which, in the past, were largely financed by foreign borrowing, i.e., through external debt. An increase in the export/import coverage leads to an increase (i.e., depreciation) in the exchange rate, although this coefficient is marginally significant. Commonly, an increase in the export/import coverage leads to exchange rate appreciation, since exports (income) grow more than imports (expenditures) and since the foreign currency supply (in relation to the demand for foreign currency) on domestic market rises, which in turn raises the demand for domestic currency. Additionally, an increase in the export/import coverage can occur, when exports stagnate and imports decrease or when imports decrease faster than exports. Thus, we can say that the export/import coverage in Croatia is currently rising because exports are stagnating and imports are decreasing due to the financial crisis. In such a situation, appreciation pressures are absent, since the supply of foreign currency does not increase, while at the same time, due to the crisis, the demand for foreign currency rises (e.g., due to the existing debt repayments) which creates depreciation pressure on the exchange rate wherein this effect is stronger than the effect of the increase in the export/import coverage. This is also supported by the fact that Croatian export/import coverage indicator is very low, that is, imports are continuously much larger than exports. Therefore, it is common that the demand for foreign currency, due to the large imports (which is reflected as depreciation pressure on the exchange rate), is continuously present.

The error correction representation of the ARDL (2, 4, 3, 4, 2, 2, 4, 3) model is presented in Table 5.

It is evident that changes in consumer prices, including lags, have a statistically negative effect on the exchange rate change, indicating that the rise in consumer prices in the short run causes an exchange rate appreciation. A change in the first lag of the ratio between foreign currency deposits and total time and savings deposits has a statistically negative effect on the change in exchange rate,

indicating that the rise in the ratio between foreign currency deposits and total time and saving deposits in the short run causes an exchange rate appreciation. In relation to the long run, in the short run, the link between the named variables is confirmed.

Table 5. Error correction representation of the ARDL (2, 4, 3, 4, 2, 2, 4, 3) exchange rate equation

Dependent variable: DLHRK/EUR				
	Coefficient	*Std. Error*	*t-ratio*	*p-value*
DConst	5.4074	1.2459	4.3400	0.000***
DLHRK/EUR_1	-0.36091	0.11151	-3.2364	0.003***
DLCPI	-0.93648	0.21400	-4.3761	0.000***
DLCPI_1	-0.77554	0.26545	-2.9216	0.007***
DLCPI_2	-0.39184	0.22942	-1.7079	0.099*
DLCPI_3	-0.93564	0.24175	-3.8703	0.001***
DLDEP_fc	-0.089236	0.078448	-1.1375	0.265
DLDEP_fc_1	-0.20193	0.074011	-2.7283	0.011**
DLDEP_fc_2	-0.10185	0.070899	-1.4365	0.162
DLLOAN_fc	-0.010420	0.018733	-0.55623	0.582
DLLOAN_fc_1	0.16929	0.026456	6.3988	0.000***
DLLOAN_fc_2	0.080009	0.021058	3.7994	0.001***
DLLOAN_fc_3	0.086782	0.021159	4.1014	0.000***
DLINTRES	0.097427	0.043552	2.2371	0.033**
DLINTRES_1	0.18571	0.043014	4.3175	0.000***
DLCOVER	0.051305	0.031564	1.6254	0.115
DLCOVER_1	-0.034773	0.022335	-1.5569	0.131
DLFDI	-0.076852	0.072635	-1.0581	0.299
DLFDI_1	-0.061858	0.048448	-1.2768	0.212
DLFDI_2	0.13057	0.042767	3.0531	0.005***
DLFDI_3	-0.074061	0.039111	-1.8936	0.069**
DLEXTDEBT	0.25477	0.057053	4.4655	0.000***
DLEXTDEBT_1	0.29201	0.074995	3.8937	0.001***
DLEXTDEBT_2	0.087943	0.068750	1.2792	0.211
DTrend	0.013185	0.0022092	5.9684	0.000***
ECM_1	-0.53459	0.15092	-3.5423	0.001***

Source: Authors' calculations[13]

It is evident that changes in consumer prices, including lags, have a statistically negative effect on the exchange rate change, indicating that the rise in

[13] Note: D indicates the first difference, while L indicates logarithm of the variable. (***) indicates the statistical significance at the 1% level; (**) indicates significance between 1% and 5%; (*) indicates significance between the 5% and 10% levels.

consumer prices in the short run causes an exchange rate appreciation. A change in the first lag of the ratio between foreign currency deposits and total time and savings deposits has a statistically negative effect on the change in exchange rate, indicating that the rise in the ratio between foreign currency deposits and total time and saving deposits in the short run causes an exchange rate appreciation. In relation to the long run, in the short run, the link between the named variables is confirmed.

Changes in lags of the ratio between kuna loans indexed to foreign currency and total loans have a statistically significant and positive effect on the change in the exchange rate, indicating that the rise in the ratio between kuna loans indexed to foreign currency and total loans in the short-run causes an exchange rate depreciation, although the coefficients are relatively small. Changes in the international reserves, including their first lag, have a statistically significant and positive effect on the change in the exchange rate. This indicates that the rise in international reserves in the short run causes an exchange rate depreciation. In relation to the long run, in the short run, the link between named variables is confirmed. The changes in the export/import coverage have no statistical effect on the change in the exchange rate in the short run. A change in the second lag of FDI has a statistically positive effect on the change in the exchange rate while a change in the third lag of FDI has a statistically negative effect on the change in the exchange rate, although the coefficient is relatively small. Finally, changes in the external debt, including its first lag, have a statistically positive effect on the change in the exchange rate. This indicates that the rise in the external debt in the short run causes exchange rate depreciation.

The ECM is found to be negative (i.e., has the correct negative sign) and highly significant, indicating a relatively strong adjustment to the long-run equilibrium. Nearly 54% of the disequilibria of the previous quarter's shock adjust back to the long-run equilibrium in the current quarter.

We can notice that, in the short-run, the rise of the ratio between kuna loans indexed to foreign currency and total loans, international reserves and external debt causes exchange rate depreciation. The increase of loans in Croatia is closely linked to the increase in external debt. Since the kuna is legal and a definitive means of payment in Croatia, external debt (which is mainly in euros) must be converted into kuna. This instantaneously increases the amount of domestic currency in circulation (thus causing exchange rate depreciation), which consequently increases international reserves (the euros bought by the CNB). The excess amount of kuna is then sterilized by the CNB monetary policy instruments.

Empirical analysis confirms theoretical assumptions, and it is evident that the obtained results support other work in this area as previously discussed in the literature review, where Edwards (1988), Holzner (2006), and Carrera and Restout (2008) found positive influence of foreign capital inflow on the exchange rates in different analysed countries. Nedeljković and Urošević (2008) found an impact of

savings in foreign currency and foreign debt on the exchange rate in Serbia. Santini (2006) pointed out that exchange rate in Croatia is determined by the supply side of foreign currency.

4. Conclusions

Croatia is a small, open economy that is highly euroized, focused on maintaining price stability by managing the exchange rate and avoiding higher fluctuations. This policy creates a framework of limited room for independent monetary policy. Croatia has chosen to reach financial integration (openness to foreign capital) and a stable exchange rate (as a guarantee for price stability). Such circumstances, with additional further participation in Economy and Monetary Union in the EU, require continued management of stable exchange rate policy. To achieve this, it is necessary to determine the variables and their influence on the exchange rate of kuna against the euro.

This paper analyses the determinants of the nominal exchange rate in Croatia by using the bounds testing (ARDL) approach to co-integration. The results indicate the existence of a stable co-integration relationship between the chosen variables. In the long run, an increase in all variables (ratio between kuna loans indexed in foreign currency and total loans, FDI inflows, consumer prices, and external debt), except for the export/import coverage, leads to an exchange rate appreciation wherein the ratio between foreign currency deposits and total time and savings deposits and international reserves are insignificant. In the short run, positive changes in consumer prices, the ratio between foreign currency deposits and total time and savings deposits and FDI cause an exchange rate appreciation wherein the positive changes in the ratio between kuna loans indexed to foreign currency and total loans, international reserves and external debt cause exchange rate depreciation, while changes in the export/import coverage are insignificant.

Empirical analysis confirms the relationship between the chosen macroeconomic variables and the nominal exchange rate in Croatia. Therefore, by influencing and controlling these variables using monetary policy instruments, Croatian monetary authorities can successfully preserve the nominal exchange rate stability, which is a necessary condition to maintain price (i.e. macroeconomic) stability in a small, open, highly euroised, and import-dependent economy such as Croatia. Thus, the determination of the nominal exchange rate in Croatia primarily depends on the external factors that affect domestic economy.

The identification of these variables is very important for managing the exchange rates and for perceiving the consequences of changes in chosen variables, since exchange rate stability is important not only for the maintenance of price stability but also for the prospective introduction of the euro (one of Maastricht criteria regards the stability of the national currency toward euro exchange rate).

This analysis provides a comprehensive framework of typical determinants of exchange rate movement in small dollarized / euroised countries and can be useful for policymakers regarding the expectation of exchange rate appreciation/depreciation and conducting monetary policy measures.

In the end, it is necessary to mention that our analysis has some limitations. For example, it does not take into account all (or other) variables that affect the exchange rate. Furthermore, it is assumed the existence of only one co-integrating vector which may not be the case since the model includes eight variables. However, obtained results can be useful to policymakers in making monetary policy decisions, i.e. in trying to keep the exchange rate stable. Future research may be extended by using some other methodology able to overcome these limitations.

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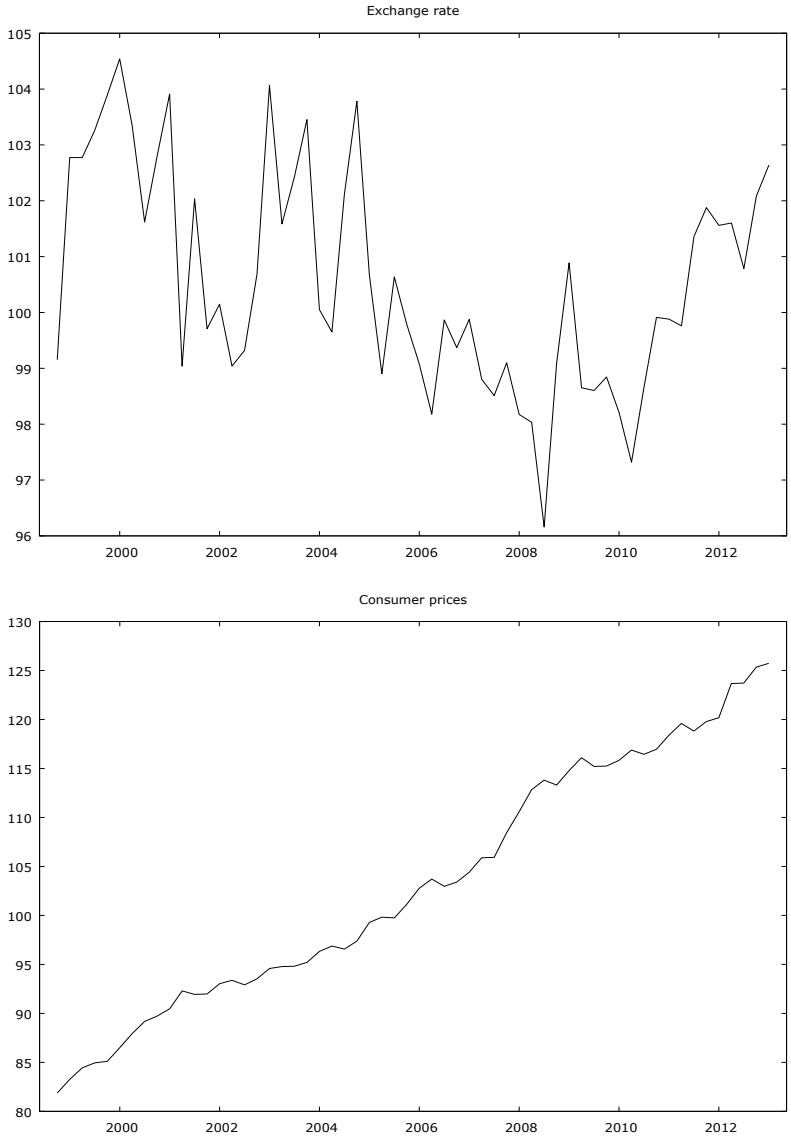
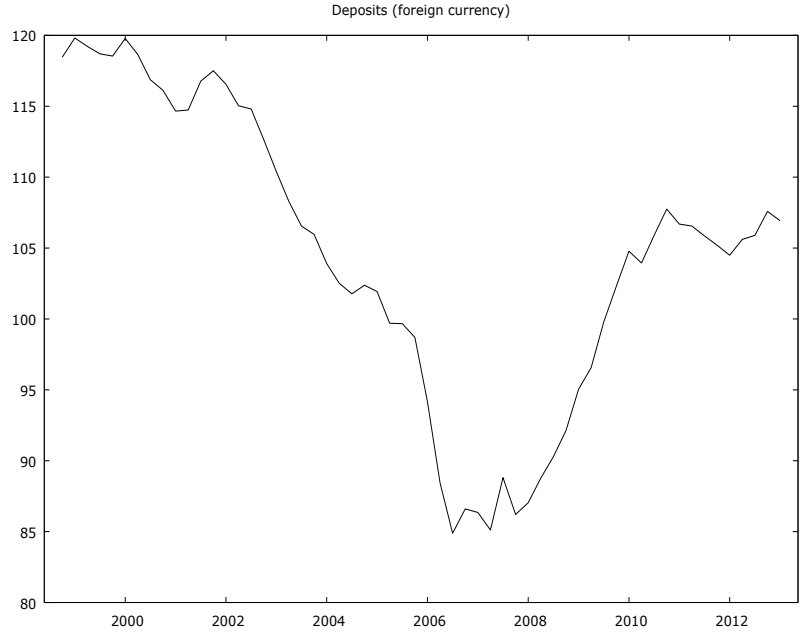
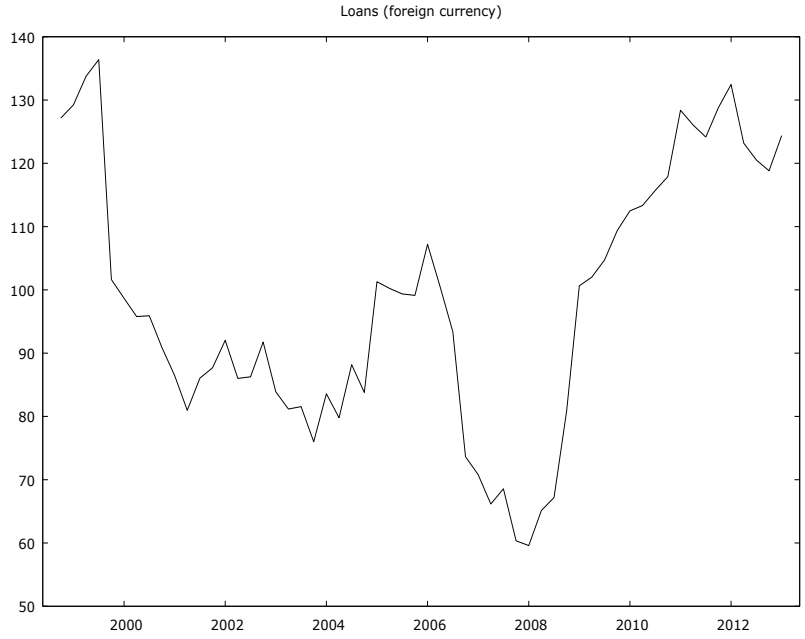
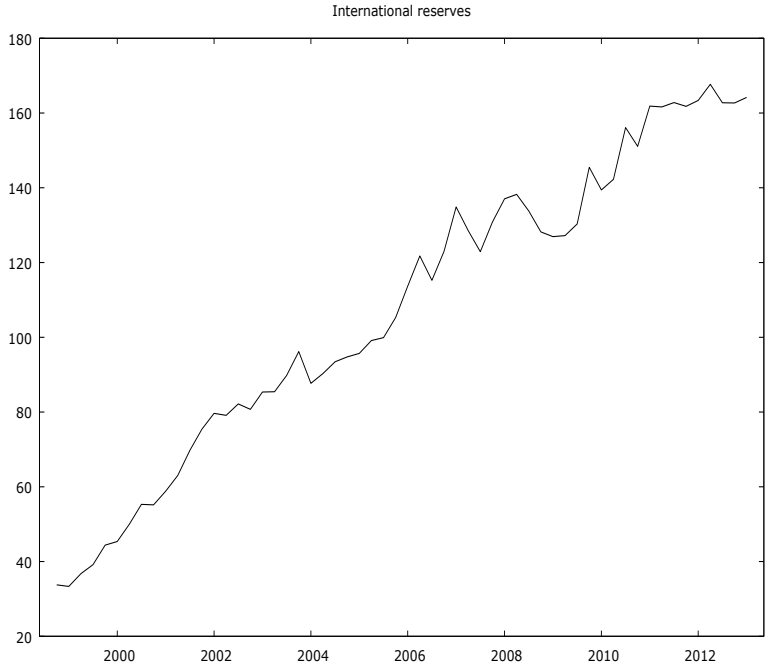
APPENDIX

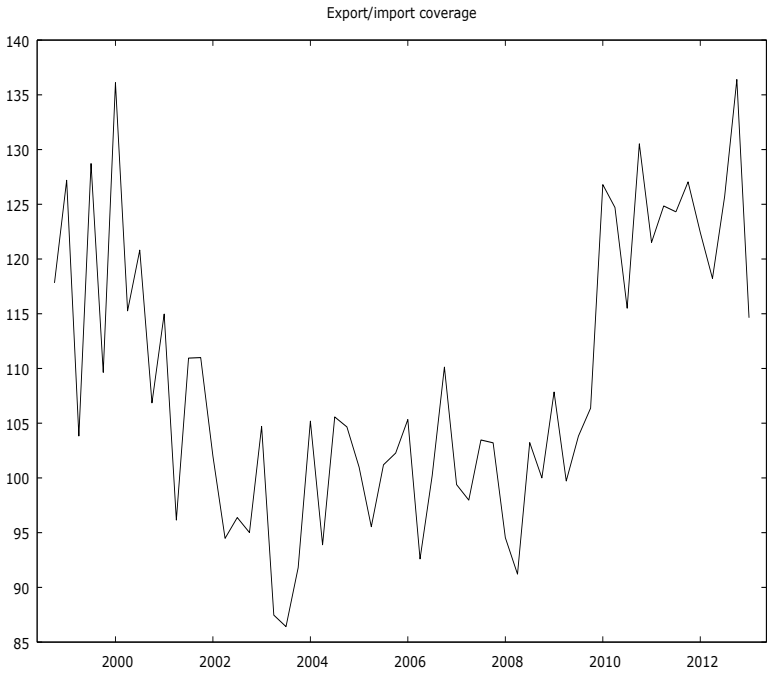
Figure 1: The nominal exchange rate of the kuna against the euro, consumer prices, the ratio between foreign currency deposits and total time and saving deposits, the ratio between kuna loans indexed to foreign currency and total loans, international reserves of the CNB, the export/import coverage, foreign direct investments and external debt (all variables are expressed in indices 2005=100)

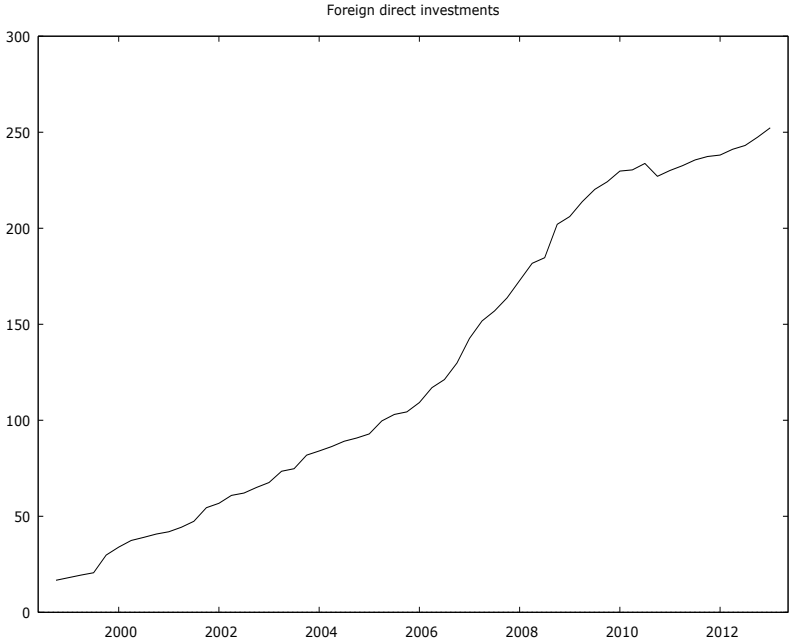


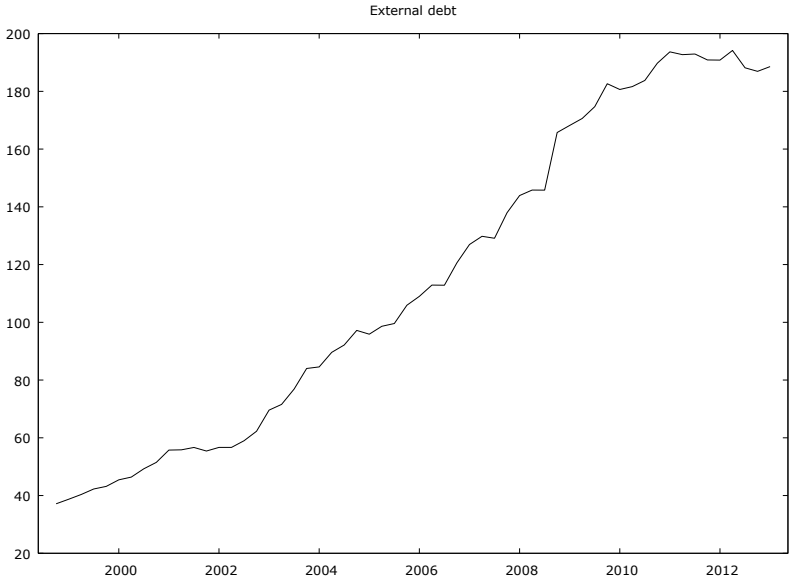

Deposits (foreign currency)
120
115
110
105
100
95
90
85
80
2000
2002
2004
2006
2008
2010
2012


Loans (foreign currency)
140
130
120
110
100
90
80
70
60
50
2000
2002
2004
2006
2008
2010
2012


International reserves
180
160
140
120
100
80
60
40
20
2000
2002
2004
2006
2008
2010
2012

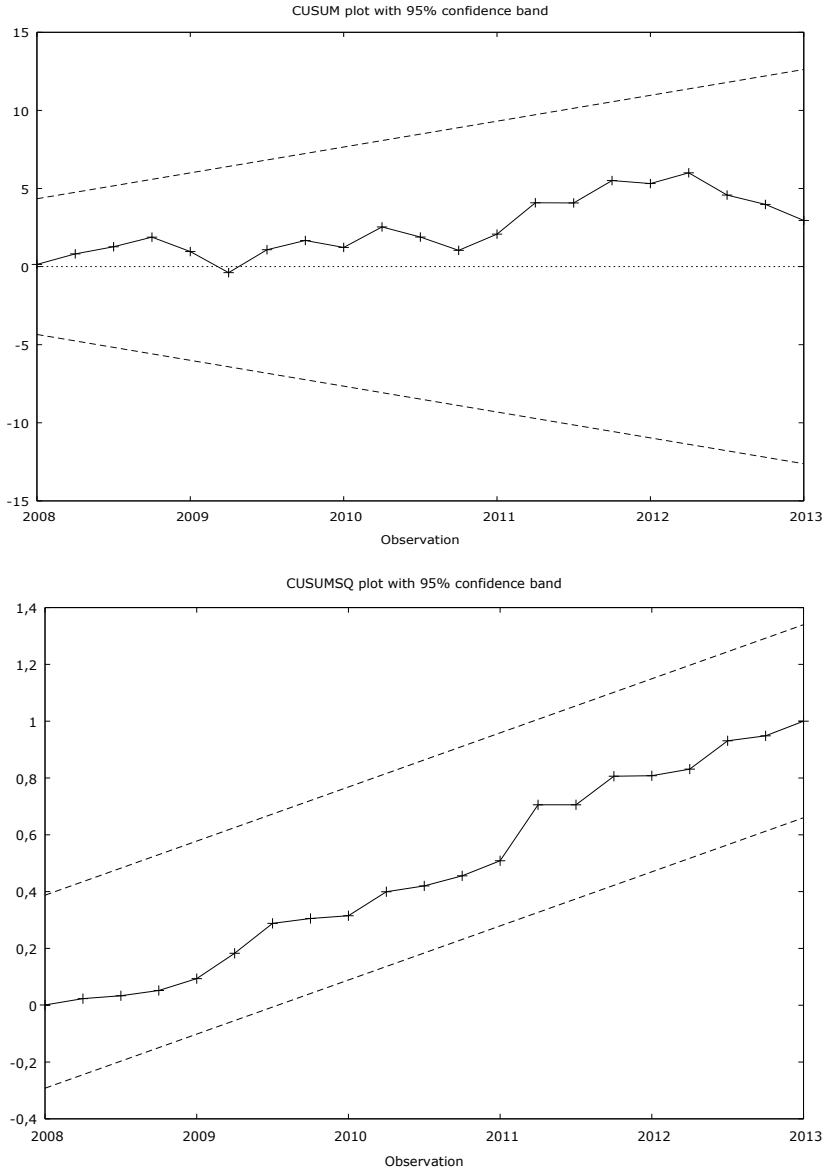

Export/import coverage
140
135
130
125
120
115
110
105
100
95
90
85
2000
2002
2004
2006
2008
2010
2012





Source: CNB and IFS

Figure 2. Plot of CUSUM and CUSUMQ (stability test) with 95% confidence intervals



Source: Author's calculations