

# Does Misaligned Currency Affect Economic Growth? – Evidence from Croatia

## **Tonći Svilokos**

University of Dubrovnik, Department of Economics and Business,  
Croatia  
tonci.svilokos@unidu.hr

## **Meri Šuman Tolić**

University of Dubrovnik, Department of Economics and Business,  
Croatia  
mstolic@unidu.hr

CroEconSur

Vol. 16

No. 2

December 2014

pp. 29-58

Received: September 16, 2014

Accepted: October 23, 2014

Research Article

doi:10.15179/ces.16.2.2

## **Abstract**

The main objective of this paper is to measure the currency misalignment of the Croatian kuna and to reveal whether it affects economic growth for the period 2001 (Q1) to 2013 (Q3). The estimate relies on recent cointegration techniques, VAR models and Granger causality tests. The findings show that there are two misalignment sub-periods for the Croatian kuna: undervaluation in the period from 2000Q1 to 2007Q4 and overvaluation in the period from 2008Q1 to 2013Q3. The evidence reveals that for the whole sample period, the Granger causality goes from misalignments (MISA) to GDP growth under the 10 percent significance level. However, for the two sub-periods no evidence of Granger causality from MISA to GDP growth or vice versa is found. The research also

reveals that the currency misalignments in the observed period are relatively small.

---

**Keywords:** Croatia, currency misalignment, economic growth, fundamental equilibrium exchange rate, Granger causality, VAR

---

**JEL classification:** E52, F31, G15

---

## 1 Introduction

The relationship between the exchange rate and economic growth often evokes many a discussion among economists. It is undisputed that the exchange rate plays an important role in international trade. Namely, if the domestic currency depreciates, it will increase the prices of foreign goods and services in terms of domestic currency, and reduce the price of domestic goods and services denominated in foreign currencies. Economic theory stipulates that this situation will lead to a reduction of the quantity of imports and to the increment of the quantity of exports, and, if the domestic demand for foreign products and the foreign demand for domestic products are relatively elastic, this will lead to a lower value of imports and a higher value of exports. The consequence of this will be the improvement of the current account in balance of payments and, finally, that will positively affect the growth of the domestic GDP. Moreover, depending on the selected exchange rate regime, the monetary authorities can more or less affect the nominal exchange rates. In this regard, the definition of the equilibrium exchange rate as well as the concept of undervalued and overvalued exchange rate are very important.

There are several approaches to defining an equilibrium exchange rate (EER). Perhaps the best-known approach is purchasing power parity (PPP), which was formalized and synthesized by Cassel (1918). PPP indicates that the nominal exchange rate is the domestic price level divided by the foreign price level. Cassel recognized that, in the short run, the nominal exchange rate prevailing

in the foreign exchange market may deviate from that suggested by PPP due to, for example, non-zero interest differentials and foreign exchange market intervention. In the short run, therefore, the extent of deviation from PPP might be thought of as an overvaluation or undervaluation of the home currency. This means that, if the actual nominal exchange rate is higher than that determined by PPP, the real and nominal exchange rates are undervalued, whereas in the opposite case they will be overvalued.

Equilibrium ER also refers to the theoretical ER that would prevail if an economy achieved simultaneously an internal and external balance. Internal balance refers to the economy operating at full employment with a “natural” rate of unemployment and at full capacity output with the continued control of inflation. External balance refers to sustainable current account position given a country’s desired capital position, as a net lender or borrower. An ER misalignment can then be defined as the deviation of the actual ER from this equilibrium ER (Collins and Razin, 1997).

The equilibrium ER is therefore an equilibrium concept. Its estimation is a complex matter, and not without controversy; but despite the inherent difficulties, equilibrium ER estimates are useful for providing a basis for estimating deviations of floating exchange rates from their equilibrium values (Parker, 1998). It has been said that the overvalued Croatian currency is the key problem of Croatian economy because it makes Croatian exports uncompetitive (Nikić, 2000; Zdunić, 2011). Whether the Croatian kuna is really overvalued or not, what the consequences of exchange rate misalignment are and whether it influences economic growth are the main questions of this research. In accordance with theory, a certain influence of currency misalignment on economic growth is expected: negative in a period of overvaluation and positive in a period of undervaluation.

The rest of the paper is organized as follows. Section 2 briefly outlines the previous findings related to the topic of this paper. The next section provides the literature-

based theoretical framework – the foundation for the subsequent research process, as well as the description of variables and econometric methodology. Section 4 contains data and an interpretation of the obtained results, and the final section contains concluding remarks.

## 2 Literature Review

There have been a number of studies that attempt to test the relationship between undervalued or overvalued exchange rate and economic growth. Edwards (1989a) provided the seminal work and, based on his model, he discovered a significant negative relationship between economic growth and overvaluation. Collins and Razin (1997) adapted Edwards's original model and they also found a significant negative impact, but discovered it was only significant among countries with very high degrees of overvaluation.

Rodrik (2008) provided evidence that undervaluation of the currency stimulates economic growth. He offered two categories of explanations as to why this may be so, focusing on institutional weaknesses and product-market failures. Levy-Yeyati, Sturzenegger and Gluzmann (2013) showed that undervalued exchange rates indeed lead to higher growth, but that the effect, rather than through import substitution or export booms, as argued by the mercantilist view, works largely through the deepening of domestic savings and capital accumulation.

Krugman (1990) dealt with the issue of assessing the equilibrium ER which was used in calculation of undervaluation and overvaluation exchange rates, as well as in establishing the exchange rate targets. In his paper he discussed the reasons why target rates might differ from the current market rates, examined the long-run trends of equilibrium ER and evaluated the different methods for calculations of the equilibrium ER. A similar comparative analysis can be found in the work of Égert, Halpern and MacDonald (2004), but on the sample of transition economies. They found that the trend appreciation usually observed for the exchange rates of these economies was affected by factors other than

the usual Balassa-Samuelson effect, such as the behavior of the real exchange rate of the open sector and regulated prices. They also considered three main sources of uncertainty regarding the implementation of an equilibrium exchange rate model. They concluded that the ensuing three-dimensional space of real misalignments is probably a useful tool in determining the direction of a possible misalignment rather than its precise size.

Using panel dynamic ordinary least squares (PDOLS) estimation to determine a measure of misalignment and employing standard growth regressions, Dubas (2012) found that exchange rate misalignment had asymmetric effects. Specifically, overvaluation significantly hurt growth while undervaluation had the opposite effect, though statistically insignificant. Misalignment affected the developed and developing countries differently because it seemed that developing countries were more sensitive to the growth effects of misalignment.

Regarding the real equilibrium exchange rates for advanced transition countries, Kim and Korhonen (2005) used a dynamic heterogeneous panel model. They concluded that exchange rates in the Czech Republic, Poland and Slovakia had converged in recent years with real equilibrium exchange rates expressed in US dollars. They found that the currencies of the analyzed transition countries, except Slovenia, were overvalued in 2002 based on real effective exchange rates. The largest extent of misalignment was found for the Hungarian forint.

While most empirical studies used panel data that included a cross-section sample with different countries and temporal data with different time periods (Darvas, 2011; Dubas, 2012; Freund and Pierola, 2008; Elbadawi, Kaltani and Soto, 2012; Rodrik, 2008), Yan and Yang (2012) investigated currency undervaluation and its effect on economic growth instead by focusing on the country-specific case of Taiwan. Although panel data analysis can result in a more general conclusion, an individual country study is able to catch the effect resulting from different political and economic environments that the country specifically faces. Firstly, they estimated the fundamental equilibrium exchange rate of Taiwan's currency

vis-à-vis the US dollar by employing the cointegration method and then the misalignment was determined by calculating the difference between the actual and the estimated equilibrium real exchange rates. They concluded that exchange rate misalignment affected GDP and it mainly came from the third sub-period when the Taiwan dollar was undervalued.

Tarawalie (2010) also tried to examine the effect of the exchange rate on economic growth with one country in focus, in the case of Sierra Leone. The empirical results of his research suggested that the real effective exchange rate correlated positively with economic growth, with a statistically significant coefficient. The results also indicated that monetary policy was relatively more effective than fiscal policy in the long run. Zakaria (2010) evaluated growth effects of real exchange rate misalignments in Pakistan for the flexible exchange rate period (1983Q1 to 2005Q4). He found that the actual real exchange rate in Pakistan remained undervalued and that undervaluation of the Pakistani rupee has improved output growth in Pakistan.

With regard to Croatian authors, Tica (2006) conducted an empirical and theoretical analysis of real exchange rate movements in transition countries. The final conclusion of this paper is that standard exchange rate economics was inadequate in explaining real exchange rate movements in transition countries. The author argues that it is necessary to start with surveying and classification of transition-specific exchange rate theories. The author expects the focus of research to be shifted toward investment demand theories, market efficiency theories, and covered and uncovered interest parities.

Additionally, the work of Belullo and Broz (2007) should also be mentioned. Their paper attempts to determine the relationship between fundamentals and real effective exchange rate in Croatia. The results indicate that relative effective terms of trade, relative effective price ratio of tradables to non-tradables and real interest rate differential are fundamentals that explain the behavior of the real effective exchange rate in Croatia. Furthermore, the real effective exchange rate

is very close in all the analyzed periods to the equilibrium exchange rate dictated by fundamentals in all analyzed periods.

Finally, Tkalec and Vizek (2011) in their work explored the validity of the purchasing power parity (PPP) hypothesis in the case of Croatia. Their results suggest that in the long run the absolute power parity condition holds when the exchange rate is aligned with the fundamentals and no depreciation is needed.

From this literature review it could be concluded that there has been a consensus regarding the negative effects of overvaluation on growth.

### 3 Conceptual Framework and Methodology

The usual procedure in investigating the impact of misaligned exchange rate on economic growth is as follows: (1) to estimate the fundamental equilibrium exchange rate (FEER) of domestic currency vis-à-vis one relevant currency or basket of currencies, (2) to calculate the difference between the actual and estimated equilibrium real exchange rates, and (3) to assess the influence of undervalued or overvalued currency on economic growth.

FEER is defined as the real effective exchange rate value which is compatible with the macroeconomic equilibrium. It is needed to distinguish the nominal and real exchange rate. The real exchange rate is the nominal exchange rate multiplied by the ratio of foreign and domestic price level:

$$Q_t = \frac{S_t \cdot P_t^*}{P_t}, \quad (1)$$

where  $Q_t$  is the real effective exchange rate, and  $S_t$ ,  $P_t$ , and  $P_t^*$  represent the nominal exchange rate, domestic price level, and foreign price level, respectively. Very often the Equation (1) is represented in log form:

$$q_t = s_t + p_t^* - p_t, \quad (2)$$

where,  $q_t$ ,  $s_t$ ,  $p_t$ , and  $p_t^*$  represent the same variables, but all in log form.

The fundamental equilibrium real exchange rate can be estimated by fundamental factors such as: productivity differential, commodity terms of trade, net foreign assets, government consumption, openness, etc. The literature on the determinants of real exchange rates is very extensive (Froot and Rogoff, 1995; Rogoff, 1996; and for developing countries Edwards, 1989b; Hinkle and Montiel, 1999; Edwards and Savastano, 2000; Kakkar and Yan, 2014). Empirical analyses differ in the choice of the aforementioned real exchange rate fundamentals, in part because of data availability considerations.

Factors that determine FEER can be represented by  $Z_t$  and Equation (2) can be written as:

$$q_t = \beta' Z_t + \varepsilon_t, \quad (3)$$

where  $Z_t$  is macro determinants matrix,  $\beta'$  is a coefficient vector, and  $\varepsilon_t$  is a random error vector. In order to calculate misalignment of exchange rate, Equation (4) was used:

$$m_t = q_t - \beta' \bar{Z}_t, \quad (4)$$

where  $\bar{Z}_t$  denotes the medium-term sustainable fundamentals (see MacDonald and Stein, 1999). If Equation (3) is introduced into Equation (4), later the rearrangement of Equation (5) can be expressed as:

$$m_t = \beta'(Z_t - \bar{Z}_t) + \varepsilon_t. \quad (5)$$

It is important to emphasize that in Equation (5) the term  $\beta'(Z_t - \bar{Z}_t)$  measures the deviation of the current exchange rate away from the economic fundamentals. In the following econometric analysis four determinant macroeconomic variables were used: productivity differential (PD), net foreign assets (NFA), terms of trade (TOT) and government consumption (GC).

## Productivity Differential (PD)

If productivity in the tradable sector grows faster than in the non-tradable sector, the resulting higher wages in the tradable sector will put upward pressure on wages in the non-tradable sector, resulting in a higher relative price of non-tradables, leading to real exchange rate appreciation (Balassa, 1964; Samuelson, 1964). This effect is well known as the Balassa-Samuelson effect, and it is ideally measured by productivity differentials in the tradable and non-tradable sectors. However, such data are not available for Croatia, so the GDP per capita relative to main Croatian trading partners (Italy, Germany, Austria and Slovenia) was used as the proxy, following Chudik and Mongardini (2007) and AlShehabi and Ding (2008). It is expected that PD should have a negative effect on the real exchange rate.

## Net Foreign Assets (NFA)

Standard intertemporal macroeconomic models predict that debtor countries will need a more depreciated real exchange rate to generate the trade surpluses necessary to service their external liabilities. Conversely, economies with relatively high NFA can “afford” more appreciated real exchange rates – and the associated trade deficits – while still remaining solvent. The net effect of investment income ensures that the creditor countries still run current account surpluses and the debtor countries current account deficits. Since Croatia had a negative NFA throughout the whole analyzed period (2001Q1–2013Q3) and since the usual econometric procedure is to use the log of series, in this research net foreign asset was calculated as the difference between the foreign investors’ holdings of domestic assets and the foreign assets held by domestic residents (not vice versa). This is very important because the increase in NFA now actually means the net increase of foreign assets in Croatia.

## Terms of Trade (TOT)

The ratio of export to import prices is included to capture exogenous changes in world prices that will affect the real exchange rate. An exogenous increase in export prices relative to import prices improves the country's terms of trade. TOT improvement generates an income effect, which increases domestic demand. To restore internal and external balances, non-tradable prices have to increase relative to tradable prices (real exchange rate appreciation) in order to switch the demand from non-tradable toward tradable goods. This effect, however, could be counterbalanced by a substitution effect where the demand for tradable goods increases from relatively lower import prices, and leads to an overall real depreciation. Thus, in theory, the relationship between the real exchange rate and TOT is ambiguous. However, a sizable amount of empirical literature has found that in developing countries, an improvement in TOT tends to cause appreciation in the real exchange rate because the income effect generally tends to overwhelm the substitution effect (Elbadawi, 1994). It also should be mentioned that according to Bobić (2010), Croatian trade flows are relatively price inelastic. Namely, the results of her research showed that the sensitivity of both exports and imports to prices was relatively low, while income effects were stronger. In this paper TOT was presented by the ratio of Croatian export price index (XPI) and import price index (MPI).

## Government Consumption (GC)

Higher government consumption (as a ratio to GDP) is likely to appreciate the real exchange rate to the extent that such consumption falls more on non-tradables than tradables, thereby raising the relative price of the former (Ostry, 1994). The pro-cyclical character of fiscal policy which certainly had appreciation and depreciation thrust on Croatian economy could be observed through government spending (Grdović Gnip, 2011; Švaljek, Vizek and Mervar, 2009). In this paper the government consumption in terms of GDP was used in order to capture the effect of government consumption on the real exchange rate.

After defining the variables and giving explanations of the theoretical foundations, the following model was set:

$$Q_t = f(PD, NFA, TOT, GC) \quad (6)$$

(-)   (+/-)   (+/-)   (+/-) .

All the variables are taken in their natural logarithms to avoid the problems of heteroscedasticity and denoted as  $Q$ ,  $PD$ ,  $NFA$ ,  $TOT$  and  $GC$ . The positive and negative signs in the parentheses underneath each variable are the expected signs.

To estimate FEER, Johansen cointegration estimation and vector autoregressive model (VAR) (Johansen, 1991) were employed. The model is based on the presumption of the stationarity of variables that can be determined by using the unit root test. In order to test the stationarity of series, augmented Dickey-Fuller test (ADF) (Dickey and Fuller, 1979) and modified Dickey-Fuller test by generalized least squares (DF-GLS) (Elliott, Rothenberg and Stock, 1992) were applied. ADF and DF-GLS tests require determining the number of lags ( $p$ ) of the dependent variable, and for that the Schwarz information criterion (SIC) (Schwarz, 1978) was applied. A vector autoregressive model of order  $k$  (VAR( $k$ )) has form:

$$y_t = \beta_1 + y_{t-1} + \beta_2 y_{t-2} + \dots + \beta_k y_{t-k} + u_t, \quad (7)$$

where  $y_t = (y_{1,t}, y_{2,t}, \dots, y_{g,t})'$  is multivariate stochastic time series in vector notation,  $\beta_i$ ,  $i=1, 2, \dots, p$  are deterministic  $g \times g$  matrices, and  $u_t = (u_{1,t}, u_{2,t}, \dots, u_{g,t})'$  is a multivariate white noise. Moreover, the Johansen test is performed on VAR that is turned into a vector error correction model (VECM) in the form:

$$\Delta y_t = \Pi y_{t-k} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + \dots + \Gamma_{k-1} \Delta y_{t-(k-1)} + u_t \quad (8)$$

Where,  $\Pi = \left( \sum_{i=1}^k \beta_i \right) - I_g$  and,  $\Gamma_i = \left( \sum_{j=1}^i \beta_j \right) - I_g$ .

$\Pi$  can be defined as a long-run coefficient matrix, since in equilibrium all the  $\Delta y_{t-i}$  will be zero. Also in the long run,  $u_t$  matrix should be equal to zero. The

Johansen test is based on an examination of a rank of the  $\Pi$  matrix via its eigenvalues. If time series variables are not cointegrated, the rank of  $\Pi$  matrix will not be significantly different from zero, i.e., the number of eigenvalues that are significantly different from zero will be less than the number of variables in the VAR model.

## 4 Results and Discussion

The data are adopted from the Croatian Bureau of Statistics, the Croatian National Bank (CNB), the World Bank database and the Eurostat database. The Appendix shows the data sources. The sample used in this research comprises quarterly data for the period 2000Q1 to 2013Q3. In calculating the productivity differential, it was taken into consideration that in 2012 Croatia's main trading partners were the following EMU countries: Italy (export 15.75 percent, import 16.44 percent), Germany (export 10.09 percent, import 12.59 percent), Austria (export 5.71 percent, import 4.46 percent) and Slovenia (export 5.34 percent, import 4.32 percent). Because of that, the productivity differential (PD) presents the ratio of per capita GDP of Croatia relative to per capita GDP of the mentioned countries weighted with the share of trade that Croatia exercised with each particular country.

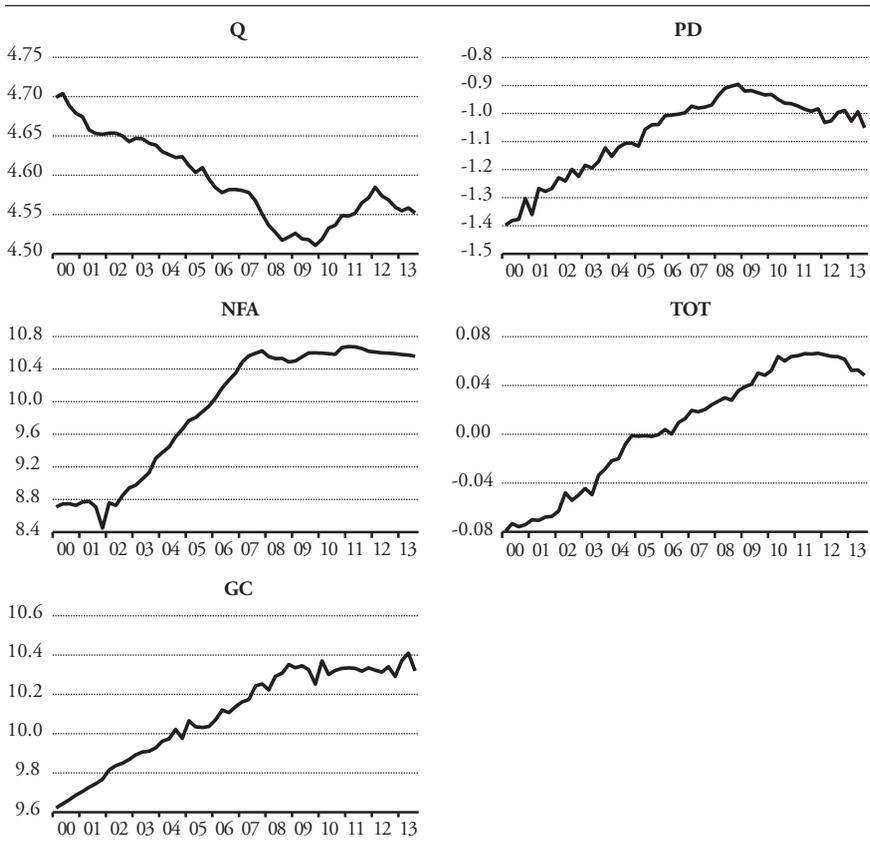
It should be noted that, until recently, Croatia had managed to attract, during a long period of time, noteworthy foreign direct investments which extensively surpassed the investments that Croatia had abroad, and that, among other things, allowed deficits in Croatian balance of payments. Namely, in 2012 Croatia received EUR 1.07 billion of FDI which was EUR 31.75 million less (-2.87 percent) than in the previous year, and Croatian citizens placed investments of only EUR 28 million abroad during the same year.

In the period 2000–2010 average government consumption grew at a rate of 5.95 percent. In 2011 it slightly decreased (-0.13 percent), while during 2012 this decline was somewhat more significant (-1.22 percent). This could be the result

of recession and government incompetence to implement needed reforms in the public sector.

Figure 1 shows the obtained time series after the usual procedure of data transformation by natural log and seasonal adjustment (the Census X-12 quarterly seasonal adjustment method was used).

*Figure 1: Movement of Seasonally Adjusted Logs of Variables*



Source: Authors' calculations.

Table 2 contains the correlation coefficients of the five variables. It indicates that there is a negative correlation between real exchange rate (Q) and: net foreign assets (NFA), productivity differential (PD), terms of trade (TOT) and government consumption (GC). This is in accordance with theoretical expectations (Bussière et al., 2010; Lee et al., 2008; Ostry, 1988; 1994).

If the VAR model and cointegration regression are going to be employed, stationarity of variables should be checked first. In order to determine whether the time series are stationary, the ADF and DF-GLS tests have been employed.

Table 3 shows the results of the ADF and DF-GLS stationary tests. The null hypothesis of the test is that the series is non-stationary (has a unit root). If calculated ADF or DF-GLS value is greater than the critical value, the null at conventional significance levels cannot be rejected. As shown in the table, the ADF and DF-GLS tests with lags specified by the Schwarz information criterion (SIC) suggest that for all variables the null hypothesis with a significance level of 1 percent should be accepted. After differentiation all variables became stationary. The results clearly show that the first differences of all time series are stationary, i.e., that they are I(1).

Johansen cointegration tests are presented in Table 4. Trace statistic indicates that five variables have at most two cointegrated vectors, and max-eigen statistic shows only one cointegrated vector. Johansen (1991) suggested the use of max-eigen statistic when there are different results between the trace statistic and max-eigen statistic. Based on Q this vector is normalized and shown in (9).

In Equation (9) the numbers presented in parentheses are the standard error, and below is the *t*-value inside the brackets. The estimated coefficient of PD (-0.407874) is negative and this is according to our expectation. This means that in Croatia higher productivity is accompanied by appreciating currency. The estimated coefficient of NFA (-0.0189) indicates that net increase in foreign assets in Croatia is accompanied by currency appreciation. For a net debtor country such as Croatia it is possible that a short-term increase in capital

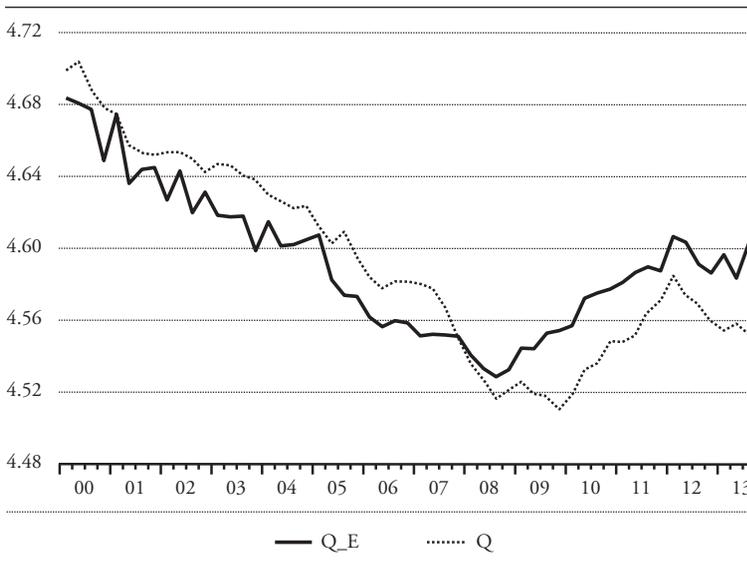
inflow leads to currency appreciation (AlShehabi and Ding, 2008). The positive estimated coefficients of TOT (0.712468) and GC (0.007787) mean that the relative increase in export prices in relation to import prices, as well as the increase in government consumption are accompanied by Croatian exchange rate depreciation.

$$Q = 4.2594 - 0.4079 \cdot PD - 0.0189 \cdot NFA + 0.7125 \cdot TOT + 0.0078 \cdot GC \quad (9)$$

(0.0919)	(0.0064)	(0.2512)	(0.0083)
[-4.4400]	[-2.9393]	[2.8328]	[0.9337]

Using Equation (9) fundamental equilibrium exchange rate (Q<sub>E</sub>) is estimated and compared with actual real exchange rate (Q). Figure 2 shows their misalignment.

**Figure 2:** Actual and Estimated Equilibrium Real Exchange Rates



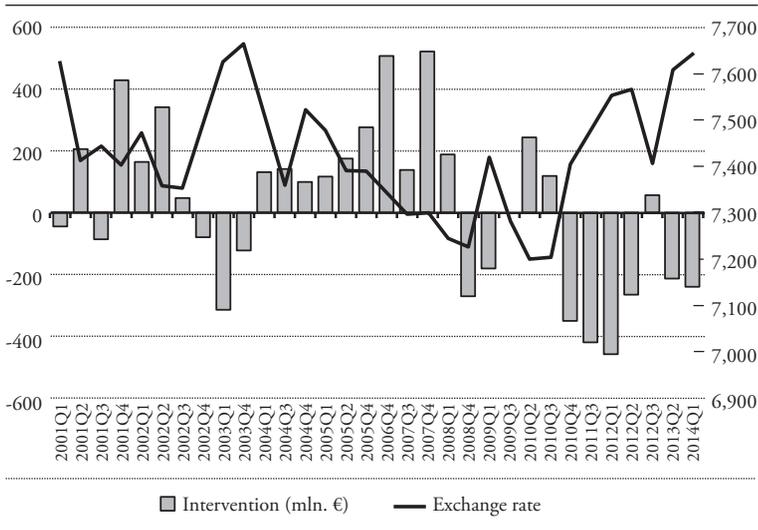
Note: A rise in the exchange rate implies depreciation, while a fall indicates appreciation.  
 Source: Authors' calculations.

Two sub-periods can be identified according to the direction of misalignment. The first sub-period, from 2000Q1 to 2007Q4, is a period with currency undervaluation (real ER is higher than FEER, and that means that it is undervalued). The average undervaluation is rather small (0.44 percent) and the highest undervaluation is in 2003Q4 (0.86 percent). This is in accordance with the results of Égert, Halpern and MacDonald (2004). They found that the real exchange rates of the selected transition economies (including Croatia) were undervalued. As a result, the real exchange rate of the open sector (i.e., the relative price of traded goods), and consequently, that of the whole economy, tends to appreciate at the beginning of the systemic transformation process, reflecting an adjustment towards equilibrium. In such a case, policy-makers may aim to fix the exchange rate at an undervalued rate (undershooting) so that the real appreciation, which takes place during the post-stabilization period, does not lead to overvaluation and that the credibility of the monetary authorities becomes restored in the meantime, which is seen as a crucial element in controlling inflation in the future (Bruno, 1993).

The second sub-period, from 2008Q1 to 2013Q3, is a period with currency overvaluation. The average overvaluation is 0.58 percent, and the highest overvaluation is in the last quarter (2013Q3: 1.13 percent). These two exchange rate misalignment periods correspond with Croatian economic development. During the nineties, with the adoption of the stabilization program that strived to stop hyperinflation and help the country to pull out of the economic crisis, Croatia opted for an open economy and a floating exchange rate regime with an implicitly defined range of floating. After successful completion of the first phase of the stabilization program which included the expansion of domestic consumption, strong development of the banking sector, rapid growth of bank loans, foreign debt and current account deficit, Croatia created preconditions for the intensification of foreign capital inflow. Factors that contributed to the growth of capital inflows to Croatia were privatization, financial deregulation, improvement of macroeconomic stability, favorable macroeconomic outlook,

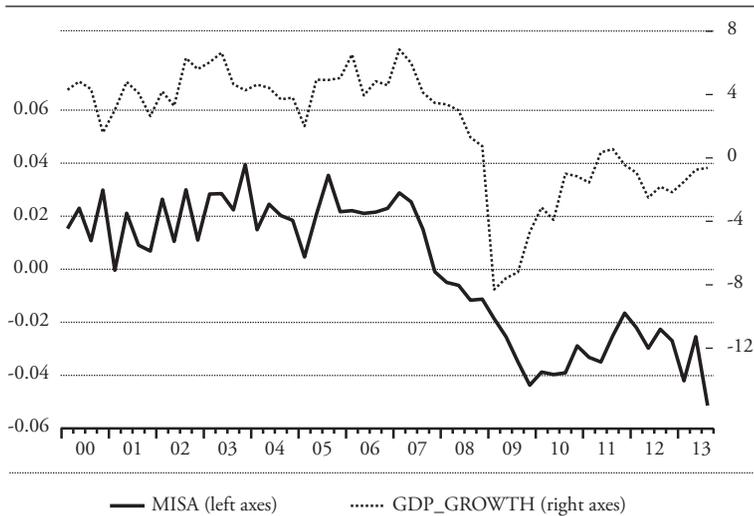


**Figure 3:** Exchange Rate and CNB Foreign Exchange Rate



Note: Chart contains only quarters when the CNB intervened on the foreign exchange market.  
 Source: Authors' adaption of data provided from the CNB.

**Figure 4:** MISA and GDP\_GROWTH



Source: Authors' calculations.

According to the graph, it seems that both variables MISA and GDP\_GROWTH are not stationary in levels. If a time series is a stationary process, the Granger causality test is performed using the level values of two (or more) variables. If the variables are non-stationary, then the test is done using first (or higher) differences. The number of lags to be included has usually been chosen based on an information criterion, such as the Akaike information criterion or the Schwarz information criterion. Accordingly, the stationary test was applied on MISA and GDP\_GROWTH. The test results are provided in Table 5. The test showed that these series were I(1) and because of that, in the Granger test the first differences (D\_MISA and D\_GDP\_GROWTH) were used instead of the original series.

First of all, the Granger causality test was conducted on the whole sample period. Since there are two sub-periods: from 2000Q1 to 2007Q4 with currency undervaluation, and from 2008Q1 to 2013Q3 with currency overvaluation, the Granger causality test for each sub-period was also implemented to investigate whether there is a different causal relationship between the undervalued and overvalued currency periods. The Granger tests with 1 lag were chosen, according to the majority of lag order selection criteria provided in Table 6. The results of the Granger causality tests are shown in Table 7.

For the whole sample period it has been detected that there is Granger causality from D\_MISA to D\_GDP\_GROWTH under the 10 percent significance level. However, for both sub-periods no evidence of Granger causality from D\_MISA to D\_GDP\_GROWTH or vice versa was found. The results of partial Granger causality tests for the two sub-periods should be taken with caution due to the relatively small sample size. The results can be explained by the fact that the misalignment of the Croatian exchange rate was relatively too small to have a significant influence on GDP growth. This could be regarded as the research limitation of this paper because the main goal was to examine whether exchange rate misalignment (MISA) had affected economic growth (GDP\_GROWTH). Hence, a suggestion for further research could be the employment of a broader

VAR model, which, apart from the misalignment variable MISA and GDP\_GROWTH could include some additional variables: e.g., exports, investment, etc. Additionally, some improvements in empirical analysis could be achieved by applying a robustness test, in which case the regressors could be defined as deviation from long-term trend estimated by H-P filter.

## 5 Conclusion and Policy Implication

The attitude of many Croatian citizens and also some professionals and scientists is that the Croatian kuna is constantly overvalued. This opinion is based primarily on the evidence of the Croatian current account deficit. It is also interesting that, despite the recent Croatian current account improvement and nominal as well as real currency depreciation, the mentioned attitudes are still held by many. But the fact is that between 2000 and the beginning of 2008 the Croatian monetary authority had actually struggled to restrain the appreciation of the Croatian kuna (see Figure 3). Without monetary intervention the kuna would be even more appreciated. The reason can be found in the inflow of foreign currencies resulting from foreign direct investments and in the rapid growth of loans from abroad. Namely, the CNB imposed several obstacles that were supposed to discourage the practice of commercial banks to borrow from their parent banks and to route that money into relatively expensive loans in Croatia. Furthermore, from the beginning of 2008 until today, the monetary authority has conducted numerous interventions on the foreign exchange market in order to prevent further nominal depreciation of the Croatian kuna (see Figure 3). Considering all that, the obtained empirical results are not surprising. This research revealed two sub-periods of currency misalignment. The first sub-period, from 2000Q1 to 2007Q4, is a period with currency undervaluation, and the second sub-period, from 2008Q1 to 2013Q3, is a period with currency overvaluation.

The misalignments of the Croatian exchange rate could be explained as follows: the period of nominal exchange appreciation (see Figure 3) may come to life if

the expected future productivity gains are realized. For example, capital inflows related to productive foreign investments might trigger future productivity gains and an increase in future export revenues that could counterbalance the current deterioration of the current account. Most importantly, this kind of nominal appreciation will be an *ex post* equilibrium phenomenon only if productivity advances materialize and export revenues actually increase. In the opposite case, if productivity gains do not materialize (which is the case in Croatia), an expectations-driven nominal appreciation, viewed *ex ante* as an equilibrium phenomenon, may lead to an *ex post* overvaluation of the real exchange rate.

Further research provides evidence that exchange rate misalignment (D\_MISA) does Granger cause the GDP growth (D\_GDP\_GROWTH) for the whole sample period under the 10 percent significance level. However, no evidence of Granger causality from D\_MISA to D\_GDP\_GROWTH or vice versa was found for either of the analyzed sub-periods. This could be explained by the fact that the misalignments for both sub-periods were not substantial.

The fact that Croatia became a member of the European Union on July 1, 2013, and may join ERM-II in the coming years, has given added importance to the issue of what the correct equilibrium exchange rate is for Croatia. Getting the rate wrong could have very serious implications regarding the degree of recovery that Croatia still has to achieve. Establishing proper values is very important, because if Croatia overvalues its currency, it would make the Croatian economy uncompetitive initially, and undervaluing it would damage the wealth of Croatian citizens and cause potential social problems.

## Appendix

**Table 1: Data Sources**

Variables	Data sources	Unit
GDP per capita in Croatia	Eurostat	Euro per inhabitant
GDP per capita in Italy	Eurostat	Euro per inhabitant
GDP per capita in Germany	Eurostat	Euro per inhabitant
GDP per capita in Austria	Eurostat	Euro per inhabitant
GDP per capita in Slovenia	Eurostat	Euro per inhabitant
Share of trade in 2012	Croatian Bureau of Statistics	Percentage
PD: productivity differential	Calculated: ratio of per capita GDP of Croatia relative to per capita GDP of Italy, Germany, Austria, Slovenia (weighted with the share of trade)	
NFA: net foreign assets	CNB – table H16: International Investment Position - summary	EUR million
XPI: export price index	Croatian Bureau of Statistics	Index
MPI: import price index	Croatian Bureau of Statistics	Index
TOT: terms of trade	Calculated: ratio of XPI and MPI	
GC: government consumption	Eurostat, World Bank	HRK million
Q: real effective exchange rate	CNB	Index
Q_E: fundamental equilibrium exchange rate	Calculated using equation (9)	
MISA	Calculated using equation (10)	
GDP_GROWTH	Croatian Bureau of Statistics	Percentage

Source: Authors.

**Table 2: Correlation Coefficient**

	Q	PD	NFA	TOT	GC
Q	1.0000				
PD	-0.9611	1.0000			
NFA	-0.9320	0.9382	1.0000		
TOT	-0.9062	0.8991	0.9656	1.0000	
GC	-0.9492	0.9382	0.9661	0.9763	1.0000

Source: Authors' calculations.

**Table 3:** ADF and DF-GLS Tests of Variables in Levels and First Differences

Variable	Levels		First differences	
	ADF	DF-GLS	ADF	DF-GLS
Q	-2.3385 (1)	-0.3356 (1)	-5.1853 (0)***	-4.5608 (0)***
NFA	-1.5495 (1)	-0.2352 (1)	-6.6433 (0)***	-6.7052 (0)***
PD	-1.4935 (1)	-0.5372 (0)	-11.0862 (0)***	-11.1951 (0)***
TOT	-1.9768 (0)	-0.6588 (3)	-2.2132 (2)***	-2.9019 (2)***
GC	-2.9043 (2)	-0.6850 (1)	-11.1544 (0)***	-11.1417 (0)***

Notes:

- 1) The lags are in parentheses;
- 2) H0 – series is non-stationary – has a unit root;
- 3) \*\*\* H0 cannot be rejected at the 1% level;
- 4) \*\* H0 cannot be rejected at the 5% level;
- 5) \* H0 cannot be rejected at the 10% level;
- 6) ADF and DF-GLS tests were carried out including the intercept in test equation. The results of the tests that include both, trend and intercept, as well as the tests that do not include either of them, are not presented here. However, they also suggest the same conclusions.

Source: Authors' calculations.

**Table 4:** Testing the Cointegration between Variables  
 Series: Q, PD, NFA, TOT, GC, lags interval (in first differences): 1 to 3

Unrestricted cointegration rank test (trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical value	Prob.**
None *	0.4945	83.4305	69.8189	0.0028
At most 1 *	0.3644	48.6402	47.8561	0.0421
At most 2	0.2085	25.5295	29.7971	0.1434
At most 3	0.1797	13.6017	15.4947	0.0945
At most 4	0.0663	3.4989	3.8415	0.0614

Unrestricted cointegration rank test (maximum eigenvalue)				
Hypothesized		Max eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical value	Prob.**
None *	0.4945	34.7904	33.8769	0.0388
At most 1	0.3644	23.1107	27.5843	0.1688
At most 2	0.2085	11.9277	21.1316	0.5548
At most 3	0.1797	10.1028	14.2646	0.2053
At most 4	0.0663	3.4989	3.8415	0.0614

Notes: 1) \* rejection of the hypothesis at the 0.05 level; 2) \*\* MacKinnon-Haug-Michelis (1999) p-values; 3) Trace test indicates 2 cointegrating eqns at the 0.05 level. Max-eigenvalue test indicates 1 cointegrating eqn at the 0.05 level.  
 Source: Authors' calculations.

**Table 5: ADF and DF-GLS Tests of Variables in Levels and First Differences**

Variable	Levels		First differences	
	ADF	DF-GLS	ADF	DF-GLS
MISA	-1.9732 (1)	-1.4328 (0)	-5.9031 (0)***	-4.5526 (0)***
GDP_GROWTH	-2.1813 (0)	-1.8409 (0)	-4.5670 (0)***	-4.4832 (0)***

Notes:

- 1) The lags are in parentheses;
- 2) H0 – series is non-stationary – has a unit root;
- 3) \*\*\* H0 cannot be rejected at the 1% level;
- 4) \*\* H0 cannot be rejected at the 5% level;
- 5) \* H0 cannot be rejected at the 10% level;
- 6) ADF and DF-GLS tests were carried out including the intercept in test equation. The results of the tests that include both, trend and intercept, as well as the tests that do not include either of them, are not presented here. However, they also suggest the same conclusions.

Source: Authors' calculations.

**Table 6: Lag Order Selection Criteria**

Endogenous variables: D_GDP_GROWTH, D_MISA						
Exogenous variables: C						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	54.2618	NA	0.00040	-2.13313	-2.05591*	-2.10383
1	61.7875	14.1302*	0.00035*	-2.27704*	-2.04539	-2.18915*
2	63.3521	2.8098	0.00039	-2.17764	-1.79155	-2.03115
3	65.3786	3.4739	0.00042	-2.09709	-1.55656	-1.89201
4	67.0580	2.7414	0.00047	-2.00237	-1.30741	-1.73870
5	69.7502	4.1757	0.00049	-1.94899	-1.09959	-1.62673

- Notes: \* indicates lag order selected by the criterion;  
 LR: sequential modified LR test statistic (each test at 5% level);  
 FPE: final prediction error;  
 AIC: Akaike information criterion;  
 SC: Schwarz information criterion;  
 HQ: Hannan-Quinn information criterion.

Source: Authors' calculations.

**Table 7: Pairwise Granger Causality Test**

<i>Sample 2000Q1–2013Q3</i>		
<b>Null hypothesis:</b>	<b>F-statistic</b>	<b>Probability</b>
D_GDP_GROWTH does not Granger cause D_MISA	1.2814	0.2630
D_MISA does not Granger cause D_GDP_GROWTH	3.1272*	0.0831

<i>Sample 2000Q1–2007Q4</i>		
<b>Null hypothesis:</b>	<b>F-statistic</b>	<b>Probability</b>
D_GDP_GROWTH does not Granger cause D_MISA	1.1032	0.3029
D_MISA does not Granger cause D_GDP_GROWTH	0.2487	0.6220

<i>Sample 2008Q1–2013Q3</i>		
<b>Null hypothesis:</b>	<b>F-statistic</b>	<b>Probability</b>
D_GDP_GROWTH does not Granger cause D_MISA	2.0833	0.1695
D_MISA does not Granger cause GDP_GROWTH	0.7802	0.3035

Note: \* denotes the null hypotheses that are rejected according to F-statistic (significance level 10%).  
 Source: Authors' calculations.

## Literature

AlShehabi, Omar and Shuang Ding, 2008, “Estimating Equilibrium Exchange Rates for Armenia and Georgia”, International Monetary Fund Working Papers, No. 08/110, April, Washington, DC: IMF.

Balassa, Bela, 1964, “The Purchasing-Power Parity Doctrine: A Reappraisal”, *The Journal of Political Economy*, 72(6), pp. 584-596. <http://dx.doi.org/10.1086/258965>

Belullo, Alen and Tanja Broz, 2007, “Do Fundamentals Explain the Behaviour of the Real Effective Exchange Rate in Croatia?”, *Proceedings of the 28th International Conference on Organisational Science Development*, pp. 109-130, Kranj: Fakultet za organizacijske vede, Maribor.

Bobić, Vida, 2010, “Income and Price Elasticities of Croatian Trade – A Panel Data Approach”, Croatian National Bank Working Papers, W-25, April, Zagreb: CNB.

Bruno, Michael, 1993, *Crisis, Stabilization, and Economic Reform: Therapy by Consensus*, Oxford: Oxford University Press.

Bussière, Matthieu, Michele Ca’Zorzi, Alexander Chudík and Alistair Dieppe, 2010, “Methodological Advances in the Assessment of Equilibrium Exchange Rates”, European Central Bank Working Paper, No. 1151, January, Frankfurt: ECB.

Cassel, Gustav, 1918, “Abnormal Deviations in International Exchanges”, *Economic Journal*, 28(112), pp. 413-415. <http://dx.doi.org/10.2307/2223329>

Chudik, Alexander and Joannes Mongardini, 2007, “In Search of Equilibrium: Estimating Equilibrium Real Exchange Rates in Sub-Saharan African Countries”, International Monetary Fund Working Papers, WP/07/90, April, Washington, DC: IMF.

Collins, Susan and Ofair Razin, 1997, “Real Exchange Rate Misalignments and Growth”, National Bureau of Economic Research Working Paper Series, No. 6174, September, Cambridge: NBER.



Elliott, Graham, Thomas J. Rothenberg and James H. Stock, 1992, “Efficient Tests for an Autoregressive Unit Root”, NBER Technical Working Paper, No. 130, Cambridge, MA: National Bureau of Economic Research, <http://www.nber.org/papers/t0130> (accessed April 15, 2014).

Freund, Caroline and Martha Denisse Pierola, 2008, “Export Surges: The Power of a Competitive Currency”, World Bank Policy Research Working Paper, No. 4750, October, Washington, DC: World Bank.

Froot, Kenneth A. and Kenneth Rogoff, 1995, “Perspectives on PPP and Long-Run Real Exchange Rates”, *Handbook of International Economics*, Vol. 3, pp. 1647-1688. [http://dx.doi.org/10.1016/S1573-4404\(05\)80012-7](http://dx.doi.org/10.1016/S1573-4404(05)80012-7)

Grdović Gnip, Ana, 2011, “Discretionary Measures and Automatic Stabilizers in Croatian Fiscal Policy”, *Ekonomika istraživanja*, 24(3), pp. 44-74.

Hinkle, Lawrence and Peter J. Montiel, 1999, *Exchange Rate Misalignment: Concepts and Measurement for Developing Countries*, New York, NY: Oxford University Press.

Johansen, Søren, 1991, “Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models,” *Econometrica: Journal of the Econometric Society*, 59(6), pp. 1551-1580. <http://dx.doi.org/10.2307/2938278>

Kakkar, Vikas and Isabel Yan, 2014, “Determinants of Real Exchange Rates: An Empirical Investigation”, Bank of Finland, Institute for Economies in Transition Discussion Papers, No. 1/2014, January, Helsinki: BOFIT.

Kim, Byung-Yeon and Likka Korhonen, 2005, “Equilibrium Exchange Rates in Transition Countries: Evidence from Dynamic Heterogeneous Panel Models”, *Economic Systems*, 29(2), pp. 144-162. <http://dx.doi.org/10.1016/j.ecosys.2005.03.005>

Krugman, Paul R., 1990, “Equilibrium Exchange Rates” in William H. Branson, Jacob A. Frenkel and Morris Goldstein, eds., *International Policy Coordination and Exchange Rate Fluctuations*, pp. 159-196, Chicago, IL: University of Chicago Press.

Lee, Jaewoo, Jonathan Ostry, Gian Maria Milesi-Ferretti, Luca Antonio Ricci and Alessandro Prati, 2008, “Exchange Rate Assessments: CGER Methodologies”, Washington, DC: IMF, <https://www.imf.org/external/np/pp/eng/2006/110806.pdf> (accessed March 1, 2014).

Levy-Yeyati, Eduardo, Federico Sturzenegger and Pablo Gluzmann, 2013, “Fear of Appreciation”, *Journal of Development Economics*, 101(C), pp. 233-247. <http://dx.doi.org/10.1016/j.jdeveco.2012.11.008>

Ljubaj, Igor, Ana Martinis and Marko Mrkalj, 2010, “Capital Inflows and Efficiency of Sterilisation-Estimation of Sterilization and Offset Coefficients”, Croatian National Bank Working Papers, W-24, Zagreb: CNB.

MacDonald, Ronald and Jerome L. Stein, eds., 1999, *Equilibrium Exchange Rates*, New York, NY: Springer. <http://dx.doi.org/10.1007/978-94-011-4411-7>

MacKinnon, James G., Alfred A. Haug and Leo Michelis, 1999, “Numerical Distribution Functions of Likelihood Ratio Tests for Cointegration”, *Journal of Applied Econometrics*, 14(5), pp. 563-577. [http://dx.doi.org/10.1002/\(SICI\)1099-1255\(199909/10\)14:5<563::AID-JAE530>3.0.CO;2-R](http://dx.doi.org/10.1002/(SICI)1099-1255(199909/10)14:5<563::AID-JAE530>3.0.CO;2-R)

Nikić, Gorazd, 2000, “Kontroverze tečajne politike”, *Ekonomski pregled*, 51(9-10), pp. 1102-1122.

Ostry, Jonathan David, 1988, “The Balance of Trade, Terms of Trade, and Real Exchange Rate: An Intertemporal Optimizing Framework”, *Staff Papers-International Monetary Fund*, 35(4), pp. 541-573.

Ostry, Jonathan David, 1994, “Government Purchases and Relative Prices in a Two-Country World”, *Economic Record*, 70(209), pp.149-161. <http://dx.doi.org/10.1111/j.1475-4932.1994.tb01834.x>

Ötker-Robe, İnci, Zbigniew Polański and Barry Topf, 2007, “Coping with Capital Inflows: Experiences of Selected European Countries”, International Monetary Fund Working Paper, No. 07/190, July, Washington, DC: IMF.

Parker, Simon C., 1998, “Exchange Rate Misalignments and Adjustments: Implications for Floating and Fixed Parity Systems”, *Manchester School*, 66(1), pp. 44-58. <http://dx.doi.org/10.1111/1467-9957.00088>

Rodrik, Dani, 2008, “The Real Exchange Rate and Economic Growth”, *Brookings Papers on Economic Activity*, 39(2), pp. 365-439.

Rogoff, Kenneth, 1996, “The Purchasing Power Parity Puzzle”, *Journal of Economic Literature*, 34(2), pp. 647-668.

Samuelson, Paul Anthony, 1964, “Theoretical Notes on Trade Problems”, *The Review of Economics and Statistics*, 46(2), pp. 145-154. <http://dx.doi.org/10.2307/1928178>

Schwarz, Gideon, 1978, “Estimating the Dimension of a Model”, *The Annals of Statistics*, 6(2), pp. 461-464. <http://dx.doi.org/10.1214/aos/1176344136>

Švaljek, Sandra, Maruška Vizek and Andrea Mervar, 2009, “Ciklički prilagođeni proračunski saldo: primjer Hrvatske”, *Privredna kretanja i ekonomska politika*, 18(120), pp. 49-81.

Tarawalie, Abu, 2010, “Real Exchange Rate Behaviour and Economic Growth: Evidence from Sierra Leone”, *South African Journal of Economic and Management Sciences*, 13(1), pp. 8-25.

Tica, Josip, 2006, “Exchange Rate Economics in Transition Economies”, *International Review of Economics and Business*, 9(2), pp. 155-170.

Tkalec, Marina and Maruška Vizek, 2011, “Purchasing Power Parity in a Transition Country: The Case of Croatia”, *Comparative Economic Studies*, 53(2), pp. 223-238. <http://dx.doi.org/10.1057/ces.2011.3>

Yan, Ho-don and Cheng-lang Yang, 2012, “Does an Undervalued Currency Merit Economic Growth – Evidence from Taiwan”, *Panoeconomicus*, 59(1), pp. 37-57.

Zakaria, Muhammad, 2010, “Exchange Rate Misalignment and Economic Growth: Evidence from Pakistan’s Recent Float”, *Singapore Economic Review*, 55(3), pp. 471-489. <http://dx.doi.org/10.1142/S0217590810003857>

Zdunić, Stjepan, 2011, “From the Impossible Monetary Trinity towards Economic Depression”, *Zbornik radova Ekonomskog fakulteta u Rijeci*, 29(2), pp. 395-422.