

EXCHANGE MARKET PRESSURE ON THE CROATIAN KUNA

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Abstract

Currency crises exert strong pressure on currencies often causing costly economic adjustment. A measure of exchange market pressure (EMP) gauges the severity of such tensions. Measuring EMP is important for monetary authorities that manage exchange rates. It is also relevant in academic research that studies currency crises. A precise EMP measure is therefore important and this paper re-examines the measurement of EMP on the Croatian kuna. It improves it by considering intervention data and thresholds that account for the EMP distribution. It also tests the robustness of weights. A discussion of the results demonstrates a modest improvement over the previous measure and concludes that the new EMP on the Croatian kuna should be used in future research.

Key words: exchange market pressure, currency crisis, Croatia

1 Introduction

In an era of increasing globalization and economic interdependence, fixed and pegged exchange rate regimes are ever more exposed to the danger of currency crises. Integrated financial markets have enabled speculators to execute attacks more swiftly and deliver devastating blows to individual economies. They occur when there is an abnormally large international excess supply of a currency which forces monetary authorities to take strong counter-measures (Weymark, 1998). The EMS crisis of 1992/93 and the Asian crisis of 1997/98 are prominent historical examples. Recently, though, the financial crisis has led to severe pressure on the Hungarian forint and the Icelandic kronor, demonstrating how pressure in the foreign exchange market may cause costly economic adjustment.

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The Croatian exchange rate regime is no exception. The Croatian kuna came under strong speculative pressure in 1999 at the end of a domestic banking crisis that resulted in the depreciation of the kuna and a contraction in output. In 2001, a combination of monetary relaxation and financial liberalization led to renewed pressure on the kuna. The kuna depreciated again although economic growth remained robust. Since 2001, the Croatian National Bank (CNB) has continued targeting the nominal exchange rate to anchor inflation expectations. It has consistently built up international reserves and has often intervened in the foreign exchange market to ward off appreciation pressure and maintain exchange rate stability. In the recent financial crisis, however, the CNB responded to strong speculative pressure and intervened to prevent kuna depreciation.

Such tensions in the foreign exchange market can be best explained by the concept of exchange market pressure (EMP). Pioneered by Girton and Roper (1977), EMP measures the exchange rate change that would have occurred in the absence of the authorities' intervention. In a freely floating regime all pressure is reflected in the exchange rate change. In intermediate and fixed regimes, however, pressure is only partially reflected in the exchange rate change as authorities intervene through buying or selling of foreign currency and use interest rates to offset pressure on the exchange rate. Thus, a measure of such activity gauges the severity of pressure in an exchange rate regime.

Measuring EMP is important for two reasons. Firstly, it is relevant for monetary authorities that pursue some form of exchange rate management. EMP on neighboring countries' currencies might indicate how much pressure monetary authorities could expect on their own currency due to contagion. In a similar vein, an EMP measure can be used in assessing whether specific policy instruments were successful in removing pressure. Furthermore, EMP is also relevant for a country's credit ratings especially if a large portion of the country's debt is foreign currency-denominated as was the case with Latvia's recent downgrading (Klaassen and Jager, 2008: 4). Secondly, a measure of EMP is relevant in research. Eichengreen et al. (1996) use it to study vulnerability to currency crises while Rose and Svensson (1994) employ EMP to test European exchange rate credibility before the EMS crisis of 92/93. Van Poeck et al. (2007) examine whether the new EU members' fundamentals are strong enough to participate in ERM II and Frankel and Wei (2008) use EMP to classify exchange rate regimes.

In Croatia, a small, open and highly euroized economy, EMP is definitely relevant. The EMP is useful to the CNB in its pursuit of exchange rate stability. Croatian research that aims to develop early warning indicators of a currency crisis such as Ahec-Šonje and Babić (2002) and Krznar (2004) uses EMP to identify crises. In this respect, it is paramount to capture EMP as precisely as possible. However, the measure of EMP on the Croatian kuna used in the literature has some drawbacks. This paper will, therefore, attempt to improve the measurement of EMP on the Croatian kuna. It will analyze EMP composition with respect to the latest theoretical advances and the structural aspects of the Croatian economy. The revised EMP measure will offer a new perspective on the last ten years of EMP on the kuna. It will also be empirically compared to the current measure and its impact on EMP measurement will be assessed.

To this end, Section II will review the relevant approaches to measuring EMP. Section III will then present and explain the measure especially in the context of Croatian mone-

tary policy. Section IV offers a new perspective on the last ten years and an empirical comparison with the current measure of EMP on the kuna. Section V will then conclude.

2 Approaches to measuring EMP

EMP measures the exchange rate change that would have occurred in the absence of involvement by the authorities. It is intuitive but inherently unobservable. Consequently, it must be approximated through a combination of variables. To derive and measure EMP, researchers have pursued a structural approach, an ad hoc approach and have recently proposed a model-free EMP measure.

Girton and Roper (1977) pioneered the EMP concept by using a structural monetary model while in a related theoretical article Roper and Turnovsky (1980) used an IS-LM framework to measure EMP. Weymark (1995; 1998) derived EMP through a small open economy model and established a model-free definition of EMP. Weymark defined EMP as:

“... the total excess demand for a currency in international markets as the exchange rate that would have been required to remove this excess demand in the absence of exchange market intervention, given the expectations generated by the exchange rate policy actually implemented”
(Weymark, 1995:278)

She stressed that EMP is not synonymous with the exchange rate that would have been observed under a pure float because “expectations associated with a pure float will differ than those held under the policy actually implemented” (p.280). Weymark further asserted that EMP is “therefore best viewed as a measure of the size of external balance, and, as such, is a useful measure of the magnitude of speculative attacks” (p.280). This model-free definition of EMP became generally adopted in the EMP literature. However, Weymark (1998) also concluded that structural EMP measures remain model specific and, thus, suffer from the limitations of the underlying model.

Eichengreen, Rose and Wyplosz (1996) developed an alternative ad hoc EMP approach. They constructed their composite EMP measure by using the exchange rate change, reserve changes and also the interest rate differential. They pointed to the “tenuous connection between the exchange rate and economic fundamentals” as a primary justification for the ad hoc measure (1996:16). However, a critique of their approach is that the choice of fundamental variables is arbitrary and subject to judgment. Eichengreen et al also mention the importance of accounting for capital controls but do not measure their influence due to a lack of satisfactory data and the inability to quantify it.

Klaassen and Jager (2008), reconcile the structural and ad hoc approaches by proving that their EMP can be derived under weak assumptions from any underlying exchange rate model. These assumptions are variable differentiability and constancy of weights. Thus, Klaassen and Jager’s EMP employs the change in the exchange rate, central bank’s foreign exchange rate demand scaled by foreign exchange turnover on that day and the real interest rate differential but in level form. Pressure is shown by the difference between the actual real interest rate and the one the central bank would set in the absence of ex-

change rate considerations. Authors approximate the desired real interest rate as the foreign real interest rate corrected for the inflation differential. While their proposed EMP measure is novel in many aspects, Klaassen and Jager do not address how to measure capital controls, a topic still unaddressed in the literature.

The specification of EMP has varied over the past few decades resulting in structural and ad hoc approaches. Recently, there has also been a proposal for a new model-free EMP measure. Nonetheless, consensus does not yet exist and each approach has its shortcomings. However, the theoretical advances of EMP do offer useful insights for its application on the Croatian kuna.

3 Measuring EMP on the Croatian kuna

3.1 The EMP Measure

EMP on the kuna can be measured using a structural, ad hoc, or Klaassen and Jager approach. Since no empirical model of Croatia's economy exists, EMP *à la* Weymark is not possible. EMP on the kuna could be approximated using the Eichengreen et al ad hoc approach but as Klaassen and Jager demonstrate their EMP can be derived using either method, this paper will therefore use their EMP measure to approximate pressure on the kuna. Their formula will be modified to reflect the properties of Croatia's economy but the final measure will not account for capital controls or the role of expectations. However, it should still capture most of the EMP on the kuna.

The EMP measure Klaassen and Jager propose is given by the formula below (2008):

$$IPDT_t = \Delta s_t + w_c c_t + w_r (i_t - i_t^d) \quad (1)$$

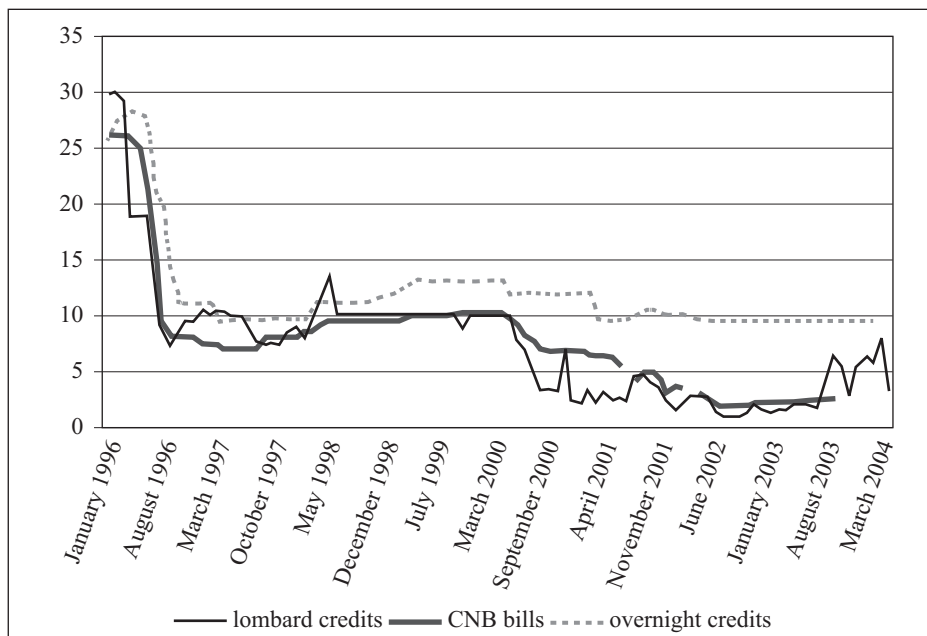
The first and foremost indicator of EMP is the percentage change in the nominal exchange rate, Δs_t . In a free floating exchange rate regime, Δs_t would represent the entire EMP because there is no intervention and $i_t = i_t^d$. In intermediate and fixed exchange rate regimes, however, such pressure is offset by responding policy variables. For example, central banks might intervene in the foreign exchange market to prevent large fluctuations. Such intervention is represented by c_t which is the magnitude of foreign exchange intervention on a particular day scaled by the magnitude of trading volume on the same day. Interest rates might also be used and the amount of pressure that is offset is represented by $i_t - i_t^d$. This is measured as the difference between the actual real interest rate and the desired real interest rate, where i_t^d is defined as $i_t^* - \pi_t^e + \pi_t^{*e}$ or the foreign real interest rate corrected for the difference in domestic and foreign inflation expectations. The desired interest rate is one the monetary authorities would have set in the absence of exchange rate considerations. Finally, Klaassen and Jager argue that EMP weights may well be constant but since they are unobservable they must be estimated. For this purpose they use volatility smoothing weights as adopted in Eichengreen et al. (1996) where w_c

and w_r are defined as $\frac{\sigma_{\Delta s_t}}{\sigma_{c_t}}$ and $\frac{\sigma_{\Delta s_t}}{\sigma_{i_t - i_t^d}}$ respectively.

In Croatia, the CNB pursued what can be described as a two pronged approach: a combination of foreign exchange market intervention and administrative measures. Therefore, the exchange rate change and CNB intervention definitely reflect a large part of EMP on the kuna. Foreign exchange market intervention, which is a primary CNB policy instrument in offsetting pressure on the kuna, removes excess kuna supply or demand while kuna value vis-à-vis the euro reflects the final balance of supply and demand in a given time period. These two components are therefore included.

On the other hand interest rates, often used by central banks to offset pressure, never played a significant role (Lang and Krznar, 2004:6). The CNB did not lead an interest-based monetary policy (ibid:1). This is due to the relative weakness of the interest rate channel and its ineffectiveness in affecting the real economy (Vizek, 2007:38). The purpose of the interest rate was rather to complement the reserve requirement tool in controlling domestic liquidity conditions. The CNB accomplished this through bills and repo auctions but focused more on the quantity of kuna issued rather than the interest rate. For example, in 2001 the auction interest rate varied from 4.64% to 7.23% (CNB, 2001:5). Moreover, Lang and Krznar (2004) note that the interest rate series suffered from structural breaks in the banking sector and had little influence on money market interest rates (pp.1-8). This is illustrated in Graph 1 below where a structural downward trend, lack of continuity of CNB bills and little correlation between Lombard and CNB bill interest rates on overnight interest rates can be observed.

Graph 1 Interest rates (%)



Source: Lang and Krznar, 2004

The CNB interest rates were not used to offset pressure and, consequently, they are excluded from the EMP measure.

This raises the question of other responding policy instruments. In this respect, reserve requirements have more often been used to offset pressure on the kuna, most notably in the 1999 and 2001 currency crises. However, they were mostly used to control domestic liquidity. For example, the CNB regularly used the mandatory reserve requirement for kuna-denominated deposits and loans and higher reserve requirement for indexed loans and foreign deposits. To control banks in their foreign borrowing the CNB required them to place 55% of amount borrowed in low-yielding CNB accounts. However, this was later avoided by Croatian client companies by borrowing abroad instead, rendering the measure somewhat ineffective. The CNB also occasionally used credit controls to limit credit growth. For example, banks are currently only allowed to increase their domestic loan portfolio by 12% per annum. Given such a dual motive it is difficult to pinpoint their precise influence on EMP. For this reason, they will not be included in the EMP measure.

A measure of EMP on the kuna should also account for the presence of capital controls but so far this has not been addressed in research. This paper has attempted quantitatively to measure capital controls intensity following the approach used in Edison and Warnock (2001). However, due to inadequate data only a qualitative discussion of the influence of capital controls on EMP is possible. In this regard, prior to 2001 the Foreign Exchange Act forbade enterprises to purchase and hold foreign currency, which would perhaps understate the EMP measure. Indeed, in 2001 the Act was liberalized which resulted in depreciation pressure as demand for foreign currency increased (Lang and Krznar, 2004:5). More importantly, though, Croatia signed the Stabilization and Association Agreement (SAA) with the European Union agreeing fully to liberalize its capital account by 2009. It only ratified the SAA in 2005 but in reality Croatia already had numerous bilateral treaties that precluded restrictions on foreign investment. The CNB only lifted the restrictions vis-à-vis the excluded countries in 2005. Currently, the capital account remains virtually liberalized only restricting foreign purchases of CNB bills. However, with foreign ownership of the banking sector this restriction is superfluous (Šošić and Kraft, 2006:12). Thus, the presence of capital controls may have significantly underestimated EMP in the late 1990s and early 2000s although this influence was quickly diminishing.

A further limitation of EMP in general is the inability to measure expectations. Market expectations are relevant because in a fixed or intermediate exchange rate regime they interact with foreign exchange interventions and interest rates. For example, if speculators perceive that a pegged exchange rate is not credible and expect a devaluation of the peg, they will sell the currency in large amounts. This will require a large intervention and an interest rate increase by the authorities as the currency experiences strong downward pressure. Conversely, if speculators believe this regime is credible, perhaps due to the size of foreign exchange reserves and willingness to increase interest rates, then they will not attack the currency. Interventions and EMP will be correspondingly smaller. However, due to the inability to measure expectations as well as their interaction with policy instruments, no EMP measure has included it so far and the EMP in this paper also excludes it.

Therefore, the final version of the EMP measure used in this paper albeit with a couple of limitations is:

$$IPDT_t = \Delta s_t - w_i c_t \quad (2)$$

The first limitation stems from the difficulty of measuring the response of other policy instruments such as reserve requirements and interest rates to offset pressure. This should not present a major limitation since foreign exchange interventions were the major policy instrument in exchange rate stabilization. Nonetheless, it renders the EMP measure incomplete. The second limitation is due to the presence of capital controls in the early period. The inability to quantify their influence should underestimate EMP at least in the early period. The third limitation is the inability to account for the role of expectations. However, despite its imperfections the measure should be able to capture most of the EMP on the kuna.

3.2 Data collection and manipulation

In this study, all the data were collected using the CNB Statistics database. This includes monthly data on the nominal exchange rate, foreign exchange interventions and foreign exchange market turnover for the period February 1997 to March 2008.

To calculate the nominal exchange rate percentage change, Δs_t , the end-of-month middle foreign exchange rate time series is used. For monthly EMP, end-of-month exchange rates accurately represent pressure on the currency. If monthly averages were used, the change in the nominal exchange rate might be over- or understated especially if the CNB was both buying and selling foreign currency within the same month. It is also important to note that over the period spanning 1997 to 2008 there were structural breaks in the reported values of the middle foreign exchange rate. The definition has been changed a couple of times and some foreign exchange trading markets, such as the inter-bank market, were initially not included in the calculation of the middle foreign exchange rate. The current rate also entails a two day lag (Galac, Burić and Huljak, 2006:32). However, this is not expected significantly to impact the monthly EMP.

The foreign exchange intervention data are reported on a daily basis but since this paper measures monthly EMP, the daily data are aggregated to show net monthly intervention. For example, if the CNB buys but also sells foreign currency within a given month, netting the different interventions will correctly indicate the direction and magnitude of pressure. Since in time series data components naturally grow over time, this is then scaled by monthly foreign exchange trading volume to ensure comparison across different periods. For example, CNB interventions in the last two years were the biggest so far but it would be erroneous to interpret them as indicating strong pressure since foreign exchange trading volume was relatively large as well.

The processed data was then used to calculate monthly EMP vis-a-vis the euro from February 1997 to March 2008 according to the modified formula given in equation (2).

4 An Analysis of EMP on the Croatian kuna: 1997-2008

The measure of exchange market pressure on the kuna presented in this section offers three useful analytical insights. Firstly, the properties of Croatian EMP require a different approach to calculating thresholds for determining currency crises. Secondly, the EMP over the ten year period clearly demonstrates the turbulent years surrounding the two currency crises and the relative stability during the last five years. Thirdly, the EMP in this paper marks an improvement, although a modest one, over the EMP measure employed by Krznar (2004).

EMP can be assessed for many purposes but its most prominent use is in studies of currency crises. In such studies thresholds of usually 1.5 to 3 standard deviations are set. If EMP exceeds the threshold within a given time period that period is deemed a crisis. However, this does not necessarily hold with emerging markets' EMP. Emerging market currencies often depreciate against major currencies due to the Balassa-Samuelson effect, which renders their EMP distributions non-normal due to fat tails (Bertoli et al, 2005: 7). In this case, using standard deviations to determine thresholds is no longer appropriate and percentiles should be taken directly instead. In Croatia's case the kuna has been appreciating against the euro for the last seven years. Using *Stata 8* a Wilk-Shapiro test for normality of the EMP distribution calculates a p-value of 0.00005, thus rejecting the null hypothesis at the 1% level. Therefore, to determine thresholds, the 2.5% and the 97.5% percentiles are calculated linearly, interpolating between closest data points. In non-normally distributed EMPs this is the appropriate method of calculating thresholds and determining currency crises.

The EMP on the kuna, with the appropriate thresholds, offers a new perspective as illustrated in Graphs 2-4. In the turbulent period, from September 1998 to around March 1999, the exchange rate depreciated almost 10% and the CNB intervened heavily through selling an equivalent of 6.5 billion euros. Furthermore, the CNB also raised reserve requirements to 40% of which a large portion had to be held in foreign currency. In addition, the Foreign Exchange Act did not allow enterprises to conduct foreign exchange transactions perhaps understating the EMP measure. This was the first currency crisis. At the height of the second currency crisis in 2001, the kuna first experienced an appreciation crisis in May followed by a depreciation crisis in August. However, in August the kuna had only depreciated by about 5% due to heavy CNB intervention, which had sold 3 billion of foreign currency in August 2001 alone. The CNB also increased reserve requirements for foreign-currency assets. Regarding the influence of capital controls, the Foreign Exchange Act was liberalized while some restrictions regarding security investment were still in place. However, the influence on EMP measurement was most likely minimal since it was domestic agents who were speculating on kuna depreciation. From 2003 onwards, the EMP on the kuna was markedly smaller in magnitude. In 2004 there was occasional appreciation pressure on the kuna, peaking in May; this constituted a crisis. It was perhaps due to a large increase of 28% in foreign direct investment in 2004. However, from 2004 till 2008 EMP was far from the thresholds, basically hovering around zero. Overall, the EMP clearly illustrates that 1997 to 2003 was quite a turbulent period while 2003 to 2008 was demonstrably more stable.

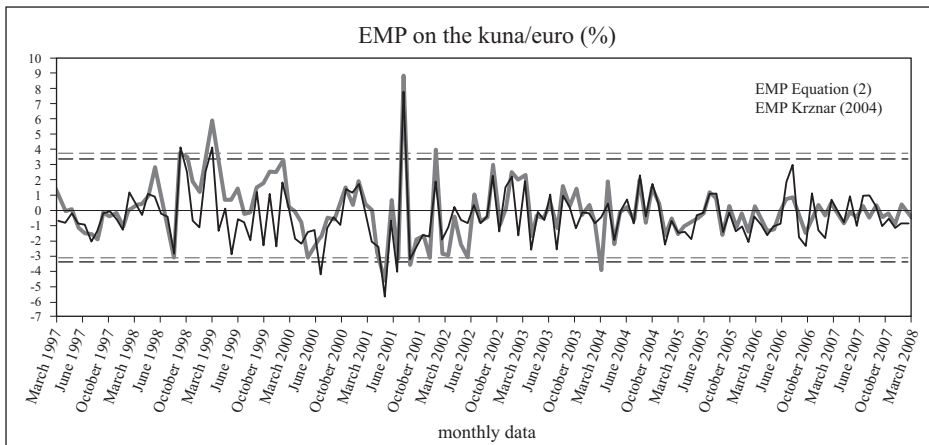
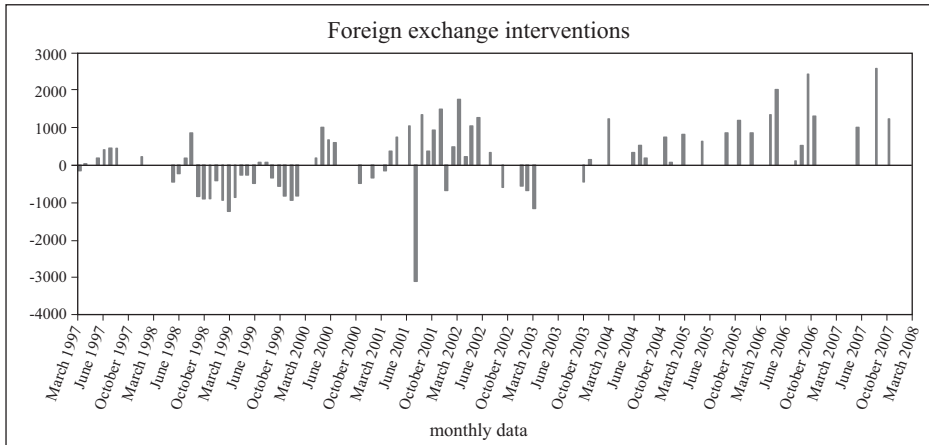
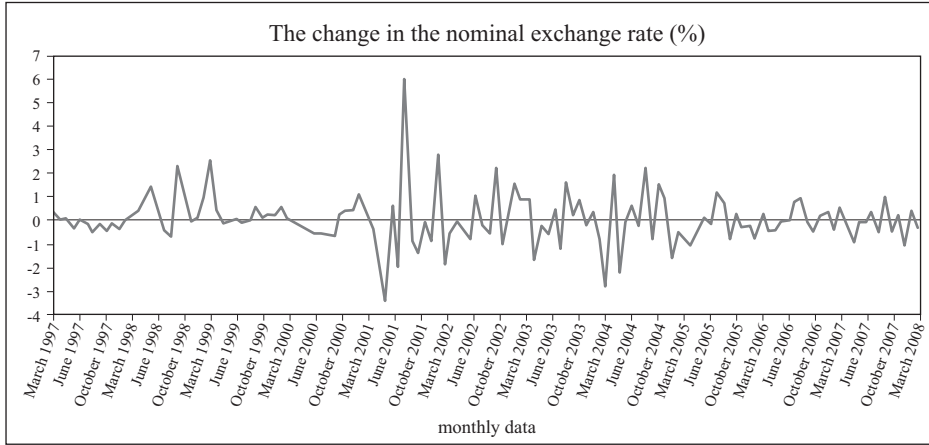
In comparison to Krznar's (2004) measure of EMP on the Croatian kuna, the version used in this paper marks an improvement. In his paper *Currency Crisis: theory and practice applied to Croatia*, Krznar (2004) follows Ahec-Sonje and Babic's (2002) approach and uses the nominal exchange rate change and the change in gross reserves to measure EMP. However, he more appropriately measures reserves in euros instead of dollars. The measure Krznar (2004) uses is:

$$IPDT_{Krznar(2004)} = \Delta s_t - \alpha \Delta r_t \quad (3)$$

Where Δs_t is the percentage change in the nominal exchange rate, Δr_t is the percentage change in gross reserves and α the weight calculated as $\frac{\sigma_{\Delta s_t}}{\sigma_{\Delta r_t}}$. Using this EMP measure

Krznar defines a currency crisis as any period in which EMP exceeds 2 standard deviations. However, Krznar's (2004) measure can be improved in at least two aspects. Firstly, EMP on the Croatian kuna is non-normally distributed, which means that using standard deviations to determine thresholds is inappropriate. Instead, percentiles should be taken directly from the EMP distribution. Secondly, Krznar's (2004) use of the percentage change in gross reserves to approximate CNB intervention introduces noise in the measure. Although the CNB foreign asset accounts contain relatively few items such as time deposits in foreign banks, foreign currency securities, SDRs, gold, etc., these items need not move in lock step. In fact, they do not and this under- or overestimates EMP. Alternatively, net reserves could be used to avoid this problem but even net reserves are subject to exogenous shocks in asset accounts. One such example is when the CNB received its share of Yugoslavia's gold in June to August 2001 (CNB Statistics). In this respect, foreign exchange interventions, where reported, always provide the exact amount of intervention thus avoiding the limitations of reserve accounting. EMP in this paper incorporates these two improvements.

The impact of these improvements on measuring EMP on the Croatian kuna can be assessed through a comparison of Krznar's (2004) and this paper's EMP as given by equation (2). In Graph 4 the two measures generally move together although on several occasions, they diverge. For example, at the height of the first currency crisis in February 1999 Krznar's EMP indicates 4% of pressure while the EMP in this paper indicates 6%. While the numbers have no economic interpretation, the comparison does indicate that the first currency crisis was more severe than previously thought as measured by the magnitude of EMP. Furthermore, from October 1999 till February 2000 Krznar's (2004) EMP displays both depreciation and appreciation pressure while the kuna was actually under pressure to depreciate in that period (CNB, 1999:14). Moreover, in March 2004 the EMP indicates -3.85% while Krznar's displays a negligible -0.46% grossly understating the magnitude of appreciation pressure the kuna experienced. Similarly, in September 2006 Krznar's (2004) EMP indicates strong depreciation pressure while, in fact, there was only slight pressure (CNB, 2006:39). When the correct thresholds are added to the EMP analysis, September 1998, February 1999, August 2001 and January 2002 constitute depreciation crises. May, July and September 2001 and March 2004 constitute appreciation crises. This paper's EMP identifies 8 crises in comparison to 6 using Krznar's (2004) EMP



capturing more precisely what happened in reality. Namely, the EMP in this paper does not recognize an appreciation crisis in July 2000 but identifies two additional appreciation crises in September 2001 and March 2004 (CNB, 2004:41). It also identifies an additional depreciation crisis in 2002 (CNB, 2002:33). Indeed, these results are robust to a range of weights that use different subperiod variances with the exception of the end periods 1997-1998 and 2006-2008. However, these periods are not representative of the whole ten-year period under study. Thus, the measure in this paper does have an impact on measurement of EMP on the Croatian kuna as it reveals the shortcomings of previous measurement.

The analysis of EMP in this section has shed new light on the last ten years. It has illustrated the relative turbulence in the foreign exchange market of the first 5 years and the relative stability during the second 5 years. Furthermore, it has demonstrated the improvement in EMP measurement and highlighted the shortcomings of the EMP used in Krznar (2004). Although the results show a modest improvement they do, however, support the use of the new measure.

5 Conclusion

Tensions in the foreign exchange markets can often produce severe pressure on currencies. Prominent historical examples are the EMS crisis of 92/93 and the Asian crisis of 97/98 although the recent financial crisis has produced incredible pressure on a number of currencies such as, for example, the Icelandic kronor. Croatia experienced strong pressure on the kuna in the currency crises of 1999 and 2001. To gauge the severity of such pressure one can measure EMP.

EMP is a concept that measures the exchange rate change that would have occurred in the absence of intervention by the authorities. In a free float all pressure is reflected in the exchange rate change. However, in a managed float monetary authorities intervene through foreign exchange intervention and interest rates to prevent large changes in the exchange rate. Thus, part of the pressure is absorbed by the authorities. For Croatia, exchange rate stability is synonymous with macroeconomic stability due to the small open and highly euroized nature of the economy. EMP, therefore, carries policy relevance as it helps CNB manage the exchange rate regime. Furthermore, in research it is used in studying currency crises and developing an early warning system. Thus, measuring EMP as precisely as possible is important but the latest measure in the literature used by Krznar (2004) has some drawbacks.

This paper revisits the question of measuring EMP on the Croatian kuna. Using the latest insights in the literature and considering the structural aspects of the Croatian economy, an improved EMP measure is developed. The improvements stem from using intervention data that avoid the limits of reserve accounting and from using thresholds that account for the non-normality of the EMP distribution. The improvement over the EMP employed in Krznar (2004) is modest as pressure is more precisely measured only in a few periods. Nonetheless, the improved measure is more in line with economic intuition and reality and should be used in future research and applications of EMP on the kuna.

The version of the EMP in this paper, however, contains some limitations. It does not quantitatively account for capital controls. Measuring their influence would be interesting for historical purposes although it bears little relevance now. Moreover, the EMP measure does not account for the role of expectations that affect the magnitude of the pressure. Further research should address these limitations.

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