



UDK: 336.748.5:336.711

DOI: 10.2478/jcbtp-2021-0025

*Journal of Central Banking Theory and Practice*, 2021, 3, pp. 79-97  
Received: 28 April 2020; accepted: 06 January 2021

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## **Output Losses from Currency Crises and the Role of Central Bank**

**Abstract:** Generally, one of the important issues related to currency crises is the output losses caused by these phenomena. In this study, determinants of output losses and particularly the role of the central bank will be evaluated during currency crises. Moreover, the paper tries to investigate the roles of macroeconomic variables and also monetary, fiscal and exchange rate policies on the output losses during currency crises. In this regard, an econometric model with panel data has been used for emerging market countries during 1980-2016. The results show that currency crises accruing have a positive and significant effect on output losses. While the successful defence of central bank has had the negative effects on the output losses, but it is positive for the unsuccessful defence and the non-intervention or immediate depreciation. However, the role of the macroeconomic condition is important where total foreign reserves can be considered as a buffer against the output losses, while inflation and deviation of the real exchange rate from its trend have had positive effects on the output losses. Finally, the output losses can be reduced by an active monetary, fiscal and exchange rate policies.

**Keywords:** Currency Crises, Output Losses, Successful and Unsuccessful Intervention

**JEL Classification:** C23, E52, E58, G01

### **1. Introduction**

Generally, episodes like the Latin American debt crises in the 1980s, the 1987 Black Monday, the 1992-1993 ERM crisis, the 1994-1995 Tequila crisis, the 1997-1998 South

East Asian meltdown, the 1998-1999 Brazilian and Russian crisis, the 2000-2001 Turkish crisis, the 2001 Argentine crisis and the 2007-2009 global financial crisis are important phenomena in the world financial market. Moreover, currency crises have had a typical role after the collapse of the Bretton Woods system of fixed exchange rates where overshooting of exchange rate is one of the repeatable events that mainly has monetary root and has been introduced in a monetary framework by Dornbusch (1976) (Yazdani, 2013; Yazdani, Dargahi, & Nikzad, 2017; Yazdani and Tayebi, 2013, Berthold and Stadtmann, 2018).

Moreover, economists mentioned that currency crisis is a phenomenon where more than 20 percent of the value of domestic currency suddenly drops against the foreign currency, and this phenomenon has occurred in various countries over the past three decades. However, currency crises have had different effects on output, including bust or boom. For example, Turkey experienced six currency crises during 1994-2006 which have had different effects on its economy. Although output had decreased strictly after the currency crises of 1994 and 2000, it did not change after the crisis of 1998, and it even enlarged in the aftermath of the currency crises of 2003, 2004 and 2006. Also, surveying the currency crisis shows that more than two-fifths of the occurred crises have had expansionary effects on the output in developing countries during 1970-1980, while they have had contractionary effects during recent two decades. For example, the crises in Brazil (1979), Colombia (1985), China (1994), Venezuela (1984) and Hungary (1993) were accompanied by the economic growth decreasing (Gupta, Mishra & Sahay, 2007; Erler, Bauer, & Herz, 2015).

According to the literature, a series of different factors could create and lead to a currency crisis and a period of several years is needed to eliminate these factors. Also, the intervention of central bank has a very important role during an occurred currency crisis. In other words, the monetary authority's response to currency crisis is critical and it can be considered a possible determinant for different outcomes of currency crisis, including output fluctuations. Generally, central bank has two choices to respond to a speculative attack. Monetary authorities can either have a passive role or intervene in the foreign exchange market to avoid depreciation. When the monetary authority intervenes, it is possible that it either succeeds or fails which depends on the monetary authority's actions, macroeconomic atmosphere, and the power of the speculative attacks. Hence, the monetary authority's action could have different outcomes including no attack, immediate depreciation, successful or unsuccessful defence. Based on the empirical literature such as Obstfeld (1994), Eichengreen, Rose, & Wyplosz, (1996), Jeanne (2000), central bank actions can be successful during the crisis, if GDP decreases less than three percent in the year following the crisis and when the central bank

intervention is unsuccessful, the economy will essentially experience a severe recession (Erler, Bauer, & Herz, 2015).

The main contribution of this paper is to analyse the role of central bank interventions to reduce the output losses from speculative attacks. In this regard, the paper distinguishes the various types of currency crises and identifies the three cases of (i) an immediate depreciation without any central bank interventions following a speculative attack, (ii) a successful defence, and (iii) an unsuccessful attempt to defend the exchange rate, i.e., interventions followed by depreciation. However, the decision of the central bank is risky to intervene or to stay passive. If the central bank intervention succeeds, the economic growth can achieve the better performance on average. But, the output losses can be particularly severe, if the interventions are not succeeded and the currency depreciates. This is while the empirical studies suggest that the non-intervention of central bank, and allowing an immediate depreciation, is accompanied by a relatively small drop in output. However, the risk aversion degree of the central bank is important (Erler, Bauer, & Herz, 2015).

In short, a currency crisis will have several outcomes and costs for a country where the output loss is one of the most important one that moves the country away from its actual growth trend. In this regard, the effective factors to reduce the output losses have particular importance. Meanwhile, the main institution to respond to the currency crisis is the central bank which could reduce the output losses by appropriate policies and decisions. This study tries to evaluate the determinants of output losses from currency crises and the role of central banks in their decrease in emerging market countries during 1980-2016 (The list of emerging market countries is represented in Appendix A.). Moreover, we will investigate the role of macroeconomic variables and environment to reduce the output losses in the selected countries.

The remainder of the paper is organized as follows: Section (2) introduces a brief on theoretical background and literature review, Section (3) discusses the model and methodology, in Section (4) we present the empirical results, and finally in Section (5) we end with conclusion and policy implications.

## 2. Literature review

Generally, there are different definitions of currency crisis in economic literature. Currency crisis generally refers to a situation where the value of a country's currency against other currencies severely drops. This devaluation is usually fol-

lowed by lack of agent's confidence towards the economic stability of a country and speculative attacks.

According to the previous currency crises around the world, three different generations were introduced. The first generation model of a currency crisis was introduced by Krugman (1979) and Flood and Garber (1984). This generation of currency crises point to inconsistent macroeconomic policies and considers the incompatibility of macroeconomic policies and the fixed exchange rate regime as a reason for a crisis. In other words, this model defines a speculative attack as the cause of devaluation of the national currency. This model claims that with symptoms such as monetization of government deficits, persistent inflation, etc., speculators will become aware of weaknesses of the national currency and demand sound currencies. In this situation, the support for national currency is related to the available resources of foreign reserves. Despite the strong theoretical background of the first generation model of a currency crisis as well as its ability to model the causes of this phenomenon, it is not able to respond to the question of how the crisis spreads to other countries. Also, capital controls and other government restrictions on the free mobility of capital have no place in this generation (Yazdani, 2013, Ezzahid and Maouhoub, 2020).

Hence, the second generation model of a currency crisis is introduced by Obstfeld (1994) after the currency crisis in Europe during 1994-1995 and extended by Eichengreen, Rose, & Wyplosz (1996), and Jeanne (2000). This model expressed that without any problem for macroeconomic variables, a currency crisis may occur just due to speculative attacks from traders' expectations about collapsing the fixed exchange rate regime. So it's possible that a currency has been attacked and loses its value, despite favourable conditions in the macroeconomy. The monetary authorities in this model evaluate the benefits and costs of protection and make a decision that they should support the national currency in the current situation or allow the exchange rate to move a new equilibrium, because it mentions that there are multiple equilibria in this model (Corsetti, Pesenti, Roubini, & Tille, 2000; Yazdani, 2013).

The third generation model was introduced due to the inability of the first and second generation models to explain some aspects of the currency crises and the reason for their occurrence in the past decades. This generation tries to pay more attention to financial market misalignments and the role of banking and insurance systems in currency crises where we consider these deviations as a reason for their occurrence. The currency crisis in East Asia can be introduced as the starting point for the expansion of this generation of the financial crisis that many researchers had focused due to its severe negative effects. Moreover, there

is no specific monetary policy suggestion for the central bank to confront with a currency crisis in the first and second generations. On the other hand, it was believed that currency crises are inevitable in the first and second generation model, but in the third generation model introduced by Krugman (1999) and some other economists, the effect of monetary policy on currency crises is considered (Dooley and Walsh, 2000; Yazdani, 2013).

In addition, a lot of costs that the currency crisis may impose on the economy were expressed in the economic literature. Although the long-term costs such as credit losses arise due to currency crisis for economies, generally the main cost is output losses (Bordo et al., 2001). However, the output's reaction during a currency crisis depends on several factors such as the current and future situation in financial sectors, external relations, and the condition of real sector in times of crisis, monetary and fiscal policies during the crisis, and the structural features of the economy (Gupta, Mishra, & Sahay, 2008). Hence, Milesi-Ferretti and Razin (1998) expressed that the boom and bust in output could occur after a currency crisis.

Moreover, according to the literature, the reaction of monetary authorities to crisis and the monetary authority's crisis decision are one of the possible determinants of these different crisis consequences. Generally, during a speculative attack on the exchange rate, the central bank is faced with two alternatives to respond. Based on Figure (1), the central bank can choose a passive behaviour and not intervene in the foreign exchange market or decide to intervene in order to stop depreciation. Depending on the monetary authority's actions and the severity of the speculative attack, the central bank intervention can be either successful or unsuccessful. Hence, four consequences including no attack and three different types of currency crises, namely, immediate depreciation, successful defence and unsuccessful defence can be considered in the interactions between monetary authority and speculative traders (Erler, Bauer, & Herz, 2015).

Generally, the theoretical and the empirical literature have not sufficiently considered the role of monetary authorities in speculative attacks and thus the differences between the three types of currency crises. However, Bauer and Herz (2010) and Daniëls, Jager, & Klaassen (2011) explicitly model the simultaneous interactions between policymakers and speculative traders. First-generation models introduce a speculative attack in terms of fundamentals, particularly a very expansionary fiscal policy with a central bank unsuccessfully attempting to defend the peg. In terms of the decision tree in Figure (1), the analysis is focused on the dichotomy no attack vs. unsuccessful defence. Second-generation models try to present the costs and benefits of exchange market interventions for a central bank

and emphasize on the role of self-fulfilling expectations and multiple equilibria. Implicitly these models introduce the situations of no attack vs. immediate depreciation. The third generation of currency crisis models includes very heterogeneous approaches and emphasizes on quite different issues, such as the fragility in the banking and financial system (Krugman, 1999; Chang and Velasco, 2001; Burnside, Eichenbaum, & Rebelo, 2004), or the role of private information (Morris and Shin, 1998; Heinemann, 2000). Again, a common feature of these studies is their dichotomic approach, i.e., they compare general crisis with no crisis scenarios and neglect the heterogeneity of currency crises.

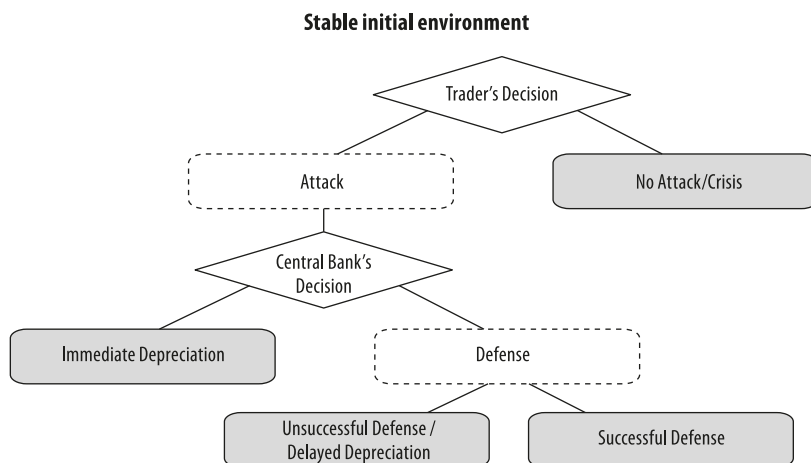
Moreover, empirical studies of currency crises, in a somewhat different way, use binary crisis variables (crisis vs no crisis). While the theoretical literature has usually focused on the pre-crisis periods to investigate the reasons of currency crises, two major approaches can be distinguished in the huge empirical literature on currency crises: (i) studies that focus on crisis prediction (Bussière and Fratzscher, 2006; Gerdesmeier, Reimers, & Roffia, 2009; Melvin and Taylor, 2009), and (ii) studies that consider the outcome of currency crises and particularly output effects (Gupta, Mishra, & Sahay, 2007; Cerra and Saxena, 2008). However, in order to determine crisis events, two basic approaches are usually used. The first approach tries to identify currency crises as considerable depreciation. According to Frankel and Rose (1996), Milesi-Ferretti and Razin (1998) and Bussière, Saxena, & Tovar (2010), the significant depreciation measure covers two types of crisis events: a speculative attack during which the central bank (i) does not undertake any defensive measures and lets the domestic currency depreciate immediately and (ii) an unsuccessful attempt of the central bank to defend the exchange rate. In terms of Figure (1), this crisis definition combines two types of crisis events, namely immediate depreciation and unsuccessful defence. A second popular way of proceeding is based on the so-called exchange market pressure index (EMPI) which was introduced by Eichengreen, Rose, & Wyplosz (1995), Bussière and Fratzscher (2006), Cerra and Saxena (2008), Klaassen and Jager (2011). This approach considers any significant action of central banks and/or speculative traders and is usually constructed as the weighted sum of depreciation rate, loss in reserves, and interest rate increase. Thus, it combines all three types of events, namely immediate depreciation, unsuccessful defence, and successful defence.

This study following Erlar, Bauer, & Herz (2015) tries to investigate the role of monetary policy by differentiating between the three types of currency crises introduced by Eichengreen and Rose (2003). By analysing the economic costs of successful attacks and successful defences, a successful attack is on average followed by a 3% loss of GDP in the following year. However, as the previous

studies combine immediate depreciation and unsuccessful defence to the successful attack scenario, their results do not provide any information regarding the important decision whether a central bank should intervene or not. Another noteworthy study is Gupta, Mishra, & Sahay (2007), as the output effects of currency crises are analysed in a more general approach. The authors adopt the crisis identification of other studies. In particular, they only treat those periods as crisis years that were already tagged by a majority of other studies, thereby intermingling different types of crisis definitions. Their empirical results indicate that crises can have very different economic outcomes and are typically more severe in the case of large capital inflows during pre-crisis periods, fewer capital market restrictions, lower trade openness and higher external long-term debt. Again, due to the encompassing crisis definition, it remains unclear what role central bank policies could have in explaining the diversity of crisis outcomes. Cerra and Saxena (2008) and Bussière, Saxena, & Tovar (2010) point out a new way to examine the persistence of output effects in the aftermath of currency crises. Their findings suggest that currency crises are accompanied by a persistent output loss of 2-6% of GDP relative to the no-crisis trend. Nevertheless, as both studies are based on aggregated crisis definitions, namely the EMPI in the study of Cerra and Saxena and the significant depreciation measure in the case of Bussière, Saxena, & Tovar they do not differentiate between the three types of crises. For this reason, the role of the central bank's crisis management cannot be assessed adequately.

Moreover, endogeneity is maybe a major issue in this framework. Generally, different economic fundamentals can be considered for countries that decide to let the exchange rate depreciate immediately than countries which successfully defend the domestic currency. For example, the monetary authority might explicitly consider how managing the exchange rate can affect the subsequent economic development, such as a loss of GDP or an increase in unemployment. A theoretical framework for this type of central bank behaviour can be modelled by the cost-benefit-approach of second-generation currency crisis models provided by Jeanne (2000). Thus, the economic environment is important for the decision of the central bank to give in to the speculative attack or to try to stabilize the exchange rate. So, it might not be the management by the monetary authority which determines the post-crisis macroeconomic development, but rather it could be the weak economic development that determines the success of the central bank's management. As a consequence, endogeneity problems might arise which could obscure the interpretation of the estimation results, including the differentiation between causal effects and pure correlations (Eichengreen and Rose, 2003; Erler, Bauer, & Herz 2015). This study tries to extensively explore and control the issue of endogeneity.

Figure 1: Central bank reaction during a speculative attack



Source: Bauer and Herz, (2010)

### 3. Model and Methodology

According to the literature, in addition to the effects of currency crisis on deviation of output from its long-run trend, and the role of various interventions of the central bank in this regard, this variable can be influenced by other factors such as inflation, exchange rate regime, budget deficit, the real money supply, trade openness, financial liberalization, exchange reserves and other economic variables. Following to Bordo et al. (2001), Erler, Bauer, & Herz (2015) and Yazdani, Dargahi, & Nikzad (2017), we can write the following equation to determine effective factors on the output losses caused by currency crisis:

$$OL_{it} = \beta_0 + \beta_1 CC_{it} + \beta_2 SSD_{it} + \beta_3 USC_{it} + \beta_4 IDD_{it} + \gamma X_{it} + \varepsilon_{it} \quad (1)$$

where  $OL_{it}$  is the output losses measure,  $CC_{it}$  is a dummy variable for currency crisis occurrence;  $SSD_{it}$  and  $USD_{it}$  are dummy variables indicating successful and unsuccessful intervention of the central bank at the year  $t$  in the country  $i$ ;  $IDD_{it}$  is a dummy variable for immediate depreciation at the year  $t$  in the country  $i$  where is employed for passive reaction of the central bank, and finally,  $X_{it}$  is a vector of the control variables. To estimate the model, the effects of currency crisis and central bank intervention indices will be evaluated on the output losses at the first stage and then other macro and policy variables are added to the model. Finally, interaction effects of the intervention (both successful and unsuccessful)



and non-intervention of the central bank with macroeconomic variables will be investigated on the output losses of currency crises.

### 3.1. Variables

Two indexes are employed for output losses in this study as follow:

**OL0 (Deviation of the output from its trend):** Some studies such as Bordo et al. (2001) have been used this measure and extracted the GDP cycles of countries over the long-run trend as a proxy for the output losses and evaluated the effects of other explanatory variables on it. Hence, in this study, variable OL0 represents the deviation of output from its long-run trend for the country  $i$  at the time  $t$  which is calculated by using the Hodrick-Prescott filter during 1980-2016. Using this variable, this fact could be shown whether currency crises cause the boom or bust of output and what is the role of the central bank actions to smooth and manage an economic cycle (Kapp and Vega, 2014).

**OL1 (Output Losses):** The other studies such as Gupta, Mishra, & Sahay (2007), Erler, Bauer, & Herz (2015) and Yazdani, Dargahi, & Nikzad (2017) believe that currency crises are only accompanied by recession, so they focused on the output losses. In these studies, at any year that the value of currency crisis index is equal to one, the trend of economic growth is calculated for ten years before the phenomenon using the Hodrick-Prescott filter. Then the GDP will be accelerated in the years after the currency crisis phenomenon by the value of the trend in the previous year, and it is determined as the potential GDP after the time of the currency crisis occurrence. Hence, the output losses are calculated using the difference between actual and potential GDP until the difference is equal to zero.

**Currency Crisis Index (CC):** In order to establish the data for a currency crisis, a method introduced by Frankel and Rose (1995) is employed. They focus on large exchange rate depreciation and consider their critical threshold as 25 percent per annum. According to Ilzetzaki, Reinhart, & Rogoff (2008) and Reinhart and Rogoff (2009), this definition is strict. They believe that financial systems in emerging markets economies are under heavy government supervision, so fluctuations in the exchange rate are not very high and 25 percent threshold that applies to data from the period after World War II would be too high for the earlier period. Therefore, they introduce a currency collapse whenever an annual devaluation is in excess of 15 percent. Therefore, data for currency crisis used in this study are from Reinhart and Rogoff. In their study, they have collected information about currency crises for developing and developed countries during the period 1800-

2010. Also, data is extended to include 2011. In this study, if annual depreciation of any currency versus the US dollar (or the relevant anchor currency – historically the UK pound, the French franc, or the German DM, and presently the Euro) be of 15 percent or more, the currency crisis occurred. So:

$$CC_{it} = \begin{cases} 1 & \text{if } \Delta ER > 15\% \\ 0 & \text{o.w.} \end{cases} \quad (2)$$

where  $\Delta ER$  are the changes in the nominal exchange rate for any country.

**Central Bank Intervention Index (IID, SSD, USD):** Generally, when a speculative attack occurred in an economy, a central bank has some options including adjusting interest rates ( $\Delta i_t$ ), intervention on the exchange market by its foreign reserves ( $\Delta TR_t$ ) and/or allowing the currency to depreciate ( $\Delta ER_t$ ). However, the central bank obviously has more policy tools in practice than the interest rate and foreign reserves. It should be mentioned that the realignments in exchange rate bands are also as other monetary tools, but it can classify as the exchange rate changes. In addition, exchange rate oriented open market operations should be considered as an interest rate adjustment (Calvo and Reinhart, 2002; Klaassen and Jager, 2011, p. 77; Kuncoro, 2020).

Following Erler, Bauer, & Herz (2015), this study tries to introduce the three types of crises, namely immediate depreciations (IID), successful interventions (SSD), and unsuccessful interventions (USD). Also following Bauer and Herz (2010), the central bank behaviour will be described by changes of the exchange rate ( $\Delta ER_t$ ) and using an intervention index (INTX). Based on Frankel and Rose (1996) and Erler, Bauer, & Herz, the intervention index is defined as the standard deviations weighted sum of interest rate changes and percentage changes in reserves ( $INTX = \Delta i_t / \sigma_{\Delta i_t} - \Delta TR_t / \sigma_{\Delta TR_t}$ ). Finally, Figure (1) including the subsequent set of rules is employed to identify specific crisis events:

- If the INTX index is more than the average value during the previous 12 months plus three standard deviations, then the intervention of the central bank is significant. The paper applies a more restrictive threshold than in the case of depreciation to account for central banks' adjustments of reserve holdings that are due to portfolio alignment only and are not due to intentional intervention in the foreign exchange market.
- A successful defence in year  $t$  is defined as a significant intervention in months of year  $t$  without a significant depreciation during the subsequent 12 months.

- An unsuccessful defence in year  $t$  is defined as a significant intervention in months of year  $t$  followed by a significant depreciation during the subsequent 12 months.
- An immediate depreciation in year  $t$  is defined as a significant depreciation without a significant intervention during the preceding 12 months. It should be mentioned that depreciation is significant if it is larger than the average of the exchange rate changes during the previous 12 months plus two times the standard deviation of these changes. Additionally, the exchange rate change must be greater than 5% (Ilzetzki, Reinhart, & Rogoff, 2008; Bauer and Herz, 2010; Erler, Bauer, & Herz, 2015).

According to the above definition, an unsuccessful defence might also be considered as a postponed depreciation. Generally, there are two reasons to end the intervention by the central bank and allow the currency to depreciate. The first is when the foreign reserves are finished, so the central bank is not able to intervene. The second is when the central bank has no incentives to protect the fixed exchange rate because the expected benefits of the intervention policy are not more than its expected costs.

The information for variables has been collected from the World Bank (WDI Database) and International Monetary Fund (IFS Database) for the emerging market countries during 1980-2016. Other data and their resources have been introduced in Table (2) in Appendix B.

## 4. Empirical Results

Although two measures for the output losses have been introduced in this study as  $OL0$  and  $OL1$ , in this section we will focus on  $OL0$  because, first of all, this variable is continuous unlike  $OL1$  that is a discrete variable and can be calculated only at the time of a currency crisis. Secondly, the literature mentions that some currency crises have had boom or bust effects on the output and  $OL0$  can consider this problem.

In this section, the empirical results for the estimated model of the output deviation from its trend ( $OL0$ ) are represented in Table (1) in the selected emerging markets economies during 1980-2016 and the role of currency crises and other explanatory variables will be considered in this regard. In *Eq.1*, the role of currency crises and the type of central bank intervention will be particularly emphasized. In the following specifications such as *Eq.2* and *Eq.3*, the paper tries to evaluate the role of macroeconomic variables and policies on the output losses.

Finally, in *Eq.4* and *Eq.5*, the interaction effects on the role of central bank intervention and macroeconomic variables will be investigated. Also, the diagnostic tests are represented in the same table.

**Table 1: Empirical Results for the Effects of Currency Crises on Output Diversions from its Trend**

Variables	Equations				
	Eq. (1)	Eq. (2)	Eq. (3)	Eq. (4)	Eq. (5)
CC	0.65** [0.20]	0.34* [0.23]	0.58** [0.26]	0.53** [0.27]	0.77*** [0.28]
SSD	-1.08 [0.89]	-1.16 [1.09]	-1.12 [1.14]	-1.29 [1.53]	-1.27 [1.12]
USD	2.39** [0.64]	3.59** [0.72]	5.1*** [0.76]	5.34*** [0.94]	3.87*** [0.97]
IDD	0.68** [0.25]	0.59* [0.31]	0.81** [0.34]	0.76** [0.35]	0.89*** [0.33]
LndTR		-0.57* [0.36]	-0.61* [0.36]	-0.73** [0.42]	-0.76** [0.37]
i		0.01 [0.18]	0.02 [0.02]	-0.001 [0.02]	0.02 [0.02]
dINF		0.09* [0.04]	0.09* [0.03]	0.13*** [0.05]	0.11*** [0.04]
HPLnRER		2.23*** [0.78]	2.23*** [0.81]	2.49*** [0.94]	2.12*** [0.79]
CAB		0.02 [0.03]	0.004 [0.03]	0.005 [0.03]	0.008 [0.03]
NFA		-0.08*** [0.02]	-0.069*** [0.02]	-0.07*** [0.02]	-0.066*** [0.02]
HPM2			0.025** [0.01]	0.026** [0.01]	0.027** [0.01]
BD			0.007 [0.01]	0.008 [0.01]	0.001 [0.12]
ERA			-0.09 [0.10]	-0.08 [0.11]	-0.005 [0.11]
INF*SSD				1.19 [5.64]	
INF*USD				-3.55** [1.87]	
INF*IID				0.07 [0.05]	
ERA*SSD					-0.05 [0.17]
ERA*USD					-0.32** [0.17]
ERA*IID					-0.23** [0.09]

\*\*\*, \*\* and \* are significance level at 99, 95 and 90 percent, respectively. The figures in parentheses indicate the probability of estimated coefficients and in the brackets are the standard deviation.

Source: Research Findings

Based on the results in Table 1, the currency crises (*CC*) have had a significant and positive effect on the deviation of output from its trend as a proxy for the output losses. The significant and positive effect of the unsuccessful intervention of the central bank (*USD*) indicates that if an intervention is not accompanied by fixing the exchange rate, it will lead to more output losses. Also, the coefficient of the exchange rate immediate depreciation (*IDD*) is positive and significant that shows the non-intervention of the central bank and a passive reaction from monetary authorities will increase the output losses.

By adding the macroeconomic variables in the *Eq.2*, the coefficient of changes in the foreign exchange reserves is significant and negative. Hence, a country with a high level of reserves can reduce the output losses when experiencing a currency crisis. The change in inflation (*INF*) is a positive and significant variable in the equations, which means that more inflationary environment leads to experiencing more losses in the currency crises phenomena. The coefficient of the log real exchange rate from its long-run trend (*HPLnRER*) is also positive and significant, so the real exchange rate gap will increase the output losses and monetary authorities should respond to this matter more seriously. Finally, the results show that the net financial account (*NFA*) has a significant and negative effect on the losses caused by currency crises and this variable is determined as a tool to control the output losses.

The effects of policy variables on the output losses are evaluated in the *Eq.3*. According to the results, the expansionary monetary policy (*HPM2*) has had a significant and positive effect on the output losses. Thus, it can intensify the deviation of output from its long-run trend which caused by currency crises, and it will divert the growth from its potential path. However, the effects of other policy variables, including the budget deficit (*BD*) and the exchange rate regime (*ERA*), are not significant on the output losses.

The interaction effects among macroeconomic and policy variables (e.g., *INF* and *ERA*) and the central bank responses (including *SSD*, *USD*, and *IID*) have been evaluated in the *Eq.4* and *Eq.5*. According to the results, the interaction effect of unsuccessful intervention and inflation (*INF\*USD*) is significant and negative, which reduces the positive effect of the unsuccessful intervention on the output losses. In addition, the interaction effects of unsuccessful intervention and non-intervention of central bank with the exchange rate regime (*ERA\*USD* and *ERA\*IID*) are significant and negative, which can reduce the positive effects of the variables on the output losses.

## 5. Conclusion and Policy Recommendations

Currency crises will have several outcomes and costs for a country and the output loss is one of the most important of them, which makes the country move away from its actual growth trend. In this regard, the effective factors to reduce the output losses are of particular importance. Meanwhile, the main institution to respond to the currency crisis is the central bank which could reduce the output losses by appropriate policies and decisions. The main aim of this paper was to examine the role of central bank interventions to reduce the output losses from speculative attacks in emerging market countries during 1980-2016. Hence, according to Bauer and Herz (2010), the study tries to differentiate the various types of currency crises and identifies the three cases of (i) an immediate depreciation without any central bank interventions following a speculative attack, (ii) a successful defence, and (iii) an unsuccessful attempt to defend the exchange rate. Moreover, the role of the macroeconomic environment to reduce the output losses has been investigated in the selected countries.

The estimated results of the output deviation from its long-run trend as a proxy for the output losses showed that the currency crises have had a positive effect on the output losses and made the economic growth move away from its potential path. Moreover, successful and unsuccessful defences of the central bank have had the negative and positive effects on the output losses of currency crises, respectively. On the other hand, the positive effect of non-intervention or immediate depreciation on the output losses has been confirmed. However, the role of the macroeconomic condition is important where total foreign reserves have had the negative effect on the output losses, while inflation and deviation of the real exchange rate from its trend have had positive effects on the output losses. Finally, the expansionary monetary policy (*HPM2*) has had a significant and positive effect on the output losses, while the effects of the budget deficit and the exchange rate regime are not significant.

Hence, the decision of the central bank to intervene or to remain passive is risky. If the central bank intervenes and succeeds, the growth performance on average can achieve the previous condition. But, if the interventions are not maintained and the currency depreciates, the subsequent output loss is particularly severe. Moreover, the output losses can be reduced by an active monetary, fiscal and exchange rate policies.

## Appendix A: List of the selected countries

The selected emerging markets economies are divided into two groups based on the indicators of the BBVA Research Institute. The first group is EAGLEs. In this group, emerging economies are looking for the goal of economic growth. In this group, based on the GDP index, two subgroups are defined. The first subgroup includes countries seeking economic growth above the G7 GDP average growth (excluding the US) over the next 10 years. The countries in the sub-group are China, India, Indonesia, Brazil, Mexico, Russia, Turkey, and the Islamic Republic of Iran. The second subgroup includes countries expected incremental GDP in the next decade to be lower than the average of the G6 economies (G7 excluding the US) but higher than Italy's. These countries are Argentina, Bangladesh, Chile, Colombia, Egypt, Malaysia, Nigeria, Pakistan, Peru, Philippines, Poland, Thailand, South Africa, Ukraine, and Vietnam. The second group is referred to as other countries. The other emerging nations include Bahrain, Bulgaria, the Czech Republic, Estonia, Hungary, Jordan, Kuwait, Latvia, Lithuania, Morocco, Oman, Qatar, Romania, Slovakia, Sri Lanka, Sudan, Tunisia, the UAE, and Venezuela.

However, it should be mentioned that the data for Slovakia and Lithuania is not available; hence, these two countries are not on the list of emerging markets economies in this study.

Also, since currency crisis is not experienced in Bahrain, Qatar, Kuwait and the United Arab Emirates, these countries are dropped from the sample, too.

## Appendix B

**Table 2: The Definition and Sources for Variables**

Variable	Symbol	Definition	Source
Output Losses	OLO	The country's production cycles around its long trend have been extracted by Hodrick-Prescott filter.	World Bank, Author Calculations
	OL1	At any year that the value of currency crisis index is equal to one, the trend of economic growth is calculated for ten years before the phenomenon using the Hodrick-Prescott filter. Then the GDP will be accelerated in the years after the currency crisis phenomenon by the trend figure at the previous year, and it is determined as the potential GDP at the time of the currency crisis occurrence. Hence, the output losses are calculated using the difference between actual and potential GDP until the difference is equal to zero.	World Bank, Author Calculations
Central Bank Intervention Index	INTX	According to the main text.	IMF, Author Calculations
Successful Intervention of Central Bank	SSD	According to the main text.	IMF, Author Calculations
Unsuccessful Intervention of Central Bank	USD	According to the main text.	IMF, Author Calculations
Immediate Depreciation of Domestic Currency	IDD	According to the main text.	IMF, Author Calculations
Currency Crisis	CC	Dummy variable takes the value 1 if a country experienced the currency crisis in the selected countries.	Reinhart and Rogoff (2009), World Bank, IMF
Current Account Balance	CAB	The current account balance in the selected countries.	World Bank, IMF
Inflation Rate	INF	The annual percentage change in the consumer price index in the selected countries.	World Bank, IMF
Cycles of Real Exchange Rate	HPLnRER	Cycles of log real exchange rate around its long-run trend obtained by the Hodrick-Prescott filter in the selected countries.	World Bank, IMF
Exchange Rate Regime	ERA	The annual report by International Monetary Fund about Exchange Rate Arrangement of Countries.	IMF
Monetary Policy	HPM2	Cycles of M2-to-GDP ratio around its long-run trend obtained by the Hodrick-Prescott in the selected countries.	World Bank, Author Calculations
Fiscal Policy	BD	The ratio of budget deficit to GDP in the selected countries.	World Bank
Net Financial Account	NFA	The net financial account in the selected countries.	World Bank, IMF
Interest Rate	i	Interest rate of deposit in the selected countries.	World Bank, IMF
Total Foreign Exchange Reserves	LnTR	Log of total foreign exchange reserves of the central bank in the selected countries.	World Bank, IMF



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