THE EFFICTEVENESS OF ICELAND CENTRAL BANK INTERVENTION THROUGH THE NOISE TRADING CHANNEL BEFORE AND DURING FINANCIAL CRISIS[1]

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Abstract

In this paper we explore the effectiveness of the sterilized central bank interventions through the noise trading channel. This study is conducted for the Central Bank of Iceland's case before and after the financial crisis. The noise trading channel assumes that noise traders must prevail the foreign exchange market and the exchange rate is determined by flow market equilibrium. Once these hypotheses are satisfied, the central bank should intervene in highly volatile market periods and keep its interventions secret. We used logit and probit model in order to test whether the high market volatility leads to a higher probability of normal response of the exchange rate upon the intervention. Our findings, during the period January-1999 through December-2008, are supporting the noise trading channel only for the period preceding the financial crisis and not during the financial crisis.

Keywords: *Central bank intervention; noise trading channel; logit and probit; microstrucutre; financial crisis*

JEL codes: *G01; E58; F31*

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1. Introduction

Central Banks often engage in individual or coordinated efforts in order to influence exchange rate dynamics, to strengthen or resist market momentum, to calm disorderly market conditions, to replenish previously depleted reserves, or to signal current or future economic policies. Thus the central bank intervention remain one an important

The effectiveness of sterilized interventions has been usually empirically studied on the basis of macroeconomic channels (.i.e. signaling channel and portfolio balance channel), since the emergence of microstructure theory of exchange rate (Lyons, 2001) new channels through which the central bank may work have been developed. These channel are the noise trading channel (Hung, 1997 and Huang, 2007), and the coordination channel (Taylor, 2004, 2005; Reitz and Taylor, 2008). In this study we shed the light on the noise trading channel.

To our knowledge none of empirical studies has investigated the effectiveness of central bank intervention during financial crisis. With the came out of the last financial crisis, in September and October, 2008, the foreign exchange market has been affect. The question that could be asked is how did the central bank intervene during the crisis if the exchange rate has been depreciated, and did it was successful? To answer these questions we have chosen to study the case of Central Bank of Iceland (CBI), in fact the ICK has known a great depreciation in the end of 2008. The entire economy and the financial system has been affected.

Our contributions in this paper are studying the effectiveness of central bank intervention trough a microstructure-base channel (i.e. the noise trading channel) and evaluating this effectiveness before and during financial crisis.

This paper is organized as follows. Section 2 examines the theoretical background of central bank intervention. Section 3 describes the empirical methodology. Section 4 includes a brief discussion of the data. Our main empirical results are reported in Section 5 before the final section concludes.

2. Theoretical background of central bank intervention

2.1 Sterilized and unsterilized intervention

An intervention occurs when a monetary authority buys (sells) foreign exchange, this action will affect the monetary base (by increasing for purchase or decreasing for sale), interest rates, market expectations and intimately the exchange rate. This type of intervention is called non-sterilized intervention. On the other hand, intervention is said sterilized if the monetary authority offsets or sterilizes the effect of the foreign exchange operation on the monetary base by selling or buying domestic bonds. This sterilization aims to keep the monetary policy unchanged.

2.2 Reported and secret intervention

Secret interventions are foreign exchange operations that are not disclosed to market participants. Beine and Bernal (2007) suggested several many reasons why central banks might keep their intervention secret: inconsistency with the exchange rate target, previous failure in intervention, inconsistency with macro fundamentals, and intervention contrary to recent trends. Neely (2008) found that the overall results of survey conducted for central banks of 23 countries are consistent with these factors.

Gnabo and Teiletche (2009) distinguished two basic strategies for intervention. The visible strategies, through signaling and coordination channels, and the hidden strategies through microstructure and noise trading channels. In their study for the Bank of Japan data case, they suggested that transparent policies (i.e.; oral[2] and public interventions) appear to be more effective for the Bank of Japan.

2.3 The effectiveness of sterilized intervention

Central bank intervention may work through many channels in order to influence the exchange rate and thus reaching the exchange rate target or reducing perturbation of the market. These channels, largely discussed in literature, may be classified in two types: traditional-macroeconomic channels (signaling channel and portfolio-balancing channel) and microstructure-based channels (noise trading channel and coordination channel).

The signaling channel or expectation channel may work through two hypotheses: the asymmetric information between central bank, which has superior information about

[2] Gnabo and Teiletche (2009) defined the oral intervention as a statement issued by an official to express his view on fundamentals (private information) or on possible actual intervention in the near future.

exchange rate fundamentals and other market participant; and the ability of central bank of conveying this information through actions. Once intervention's information is received by market participant, they will change their expectations and thereby conduct them to move the exchange rate to the desired target. The signaling channel was supported by many empirical studies (Payne and Vitale, 2003; Kim and Pham, 2006; Pasquariello, 2007), it is considered as the most important channel for central bank intervention.

The portfolio-balance channel may be explained through the Portfolio Balance model of the exchange rate in which trader's portfolio compositions is based on the expected return of domestic and foreign assets. Many studies on portfolio-balance channel (Edison, 1993; Payne and Vitale, 2003) have shown that its effect on exchange rates is either small or economically and statistically insignificant. However Evans and Lyons (2001) found strong evidence of temporary and persistent price effect. They developed a microstructure portfolio-balance model in which they incorporated the order flow variable. The later plays an important role for conveying information about shifts in trader's asset demands.

The noise trading channel was introduced by Hung (1997) based on the functioning and the microstructure of the foreign exchange market. According to Hung (1997), the noise trading channel assumes two hypotheses. The first is that noise traders[3] must prevail the foreign exchange market, at least, some times. The second, the exchange rate is determined by flow market equilibrium. Once these hypotheses are satisfied, the central bank should intervene in highly volatile market periods and keep its interventions secret. Reitz (2005) set up a generalization of the noise trading mechanism in order to test the effect of central bank intervention on exchange rates. The framework model proposed by Reitz (2005) has taken in account the heterogeneity of exchange rate expectations; traders are distinguished in chartists and fundamentalists. Using Markov regime-switching approach, he has found that Federal Reserve and Bundesbank interventions have enhanced the predictive power of chartists forecasting techniques in short run. Huang (2007) extended the work of Bhattacharya and Weller (1997) and suggested theoretical explanation for the noise trading channel hypothesis. He also conducted empirical study on daily interventions data of Federal Reserve, Bundsbank, and the Bank of Japan and found results supporting his theoretical prepositions. Besides Beine et *al.* (2009) used Markov switching approach for identifying the impact of central bank intervention in a noise trading channel model with chartists ad fundamentalists, found that

[3] Traders whose behavior and beliefs are influenced by market sentiment.

interventions increase the proportion of fundamentalists and hence exert stabilizing effect on the exchange rate.

The coordination channel was introduced by Sarno and Taylor (2001), Taylor (2004, 2005) and Reitz and Taylor (2008) in addition to the traditional channels: the signaling channel and the portfolio balance channel. In fact the exchange rate may be misaligned due to irrational speculative bubbles brought by traders like chartists and technical traders. Once the exchange rate is away from its fundamental equilibrium, it would be very difficult to other traders to revert the exchange rate. Moreover, due to this misalignment, smart speculators having important losses may be reluctant to trade into this uncoordinated fashion. The central bank, by its announced interventions operations, encourages smart money traders to enter the market in order to sell overevaluated currency and then, bringing the exchange rate to its fundamental level. This effect is called coordination channel. The central bank is not only revealing information about the fundamental exchange rate (like in the signaling channel) but also serving as focal point for market traders. Taylor (2004, 2005) provided evidence for supporting this coordination channel hypothesis by revealing that intervention has a stabilizing effect which grows with the degree of misalignment. Also Reitz and Taylor (2008) found results confirming the coordination channel through smooth transition regression model (STR-GARCH) for the Federal Reserve and the Bundesbank.

3. Empirical methodology

As mentioned in the previous part, Huang (2007) has proposed a theoretical explanation for the noise trading channel proposed by Hung (1997). Huang (2007) has suggested two propositions: «if the speculators have a high precision of the central bank's target information, the equilibrium exchange rate will tend to have a perverse response to the central bank's intervention» and «if the speculators have a high precision of the volume of liquidity trader, the equilibrium exchange rate is more likely to have a perverse response upon the central bank's intervention». Based on the hypothesis of Diebold and Nerlove (1989) we link these two prepositions to the market volatility. Indeed Dieblod and Nerlove (1989) suggested that when there is greater disagreement about meaning of incoming information, the exchange market volatility is likely to be high and when the information is unambiguously interpretable, then exchange rate volatility is likely to be low. So it is possible to assume when the exchange market volatility is low before intervention, the speculators will have high precision of central bank's target information and of the liquidity traders, therefore exchange rate is likely to have a perverse response to the central bank's intervention.

In our model each intervention is considered as an event. The event window includes the pre-event day (day-1), the event day (day 0), and the post event day (day+1). The event day is the day when the central bank intervenes in the market. The response of the exchange rate to the intervention is defined as $S_{t+1} - S_{t-1}$, where S_{t+1} and S_{t-1} are, respectively, the spot exchange rate on day +1 and day -1. The response of Iceland Central Bank is perverse if either:

$$\{Q^A > 0 \; and \; \Delta S_{t+1} > 0\} \quad or \quad \{Q^A < 0 \Delta S_{t+1} < 0\} \tag{1}$$

We used Logit and Probit model in order to test the hypothesis and determine the probability of the occurrence of a perverse response. The dependent variable, y_i, is a binary variable that takes 1 if the response is perverse and 0 otherwise:

$$p_i = prob(y_i = 1|x_i) = \frac{1}{1 + e^{-x_i\beta}} \tag{2}$$

$$p_i = prob(y_i = 1|x_i) = \int_{-\infty}^{x_i\beta} \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}} dz \tag{3}$$

Where $x_t = (x_i^1, ..., x_i^K)$ are the exogenous variables, $\beta = (\beta^1, ..., \beta^K)$ parameters to be estimated. The exogenous variables in our empirical model are: Q_t, the amount of intervention, positive sign for purchases, negative sign for sales; h_t, EGARCH volatility estimated; $Sdev$**,** the a Absolute deviation of the exchange rate from its 14 days moving average; $DumTow$, a dummy variable that takes 1 if they are two consecutive interventions before the event day.

4. Data description

4.1 CBI's intervention data

Table 1 report summary statistics for CBI's foreign exchange intervention transactions. The CBI's intervention data is measured as daily net market purchases of foreign currency, almost always the US Dollar (USD), by the CBI in terms of millions of ICK. A positive value represent a purchase of the USD (i.e. sale of the ICK), a negative value a sale of the USD (i.e. purchase of the ICK). Interventions have been conducted simultaneously with markets makers in order to avoid creating asymmetric information. Most of interventions have been usually done in the spot market; however, sometimes the central bank used forward contract and currency swap. Our sample can be divided into three periods:

Period I (January 1999- March 26, 2001): this period was characterized by large scale amounts of interventions (averaging 616.36 million of ICK). The main objective of the CBI was the maintenance of the exchange rate in a target zone band. This target band was passed from ±6% to ±9 on February 14, 2000. Out of 801 interventions, 725 involved purchases of ICK (i.e. sales of USD).

Figure 1 Daily ICK/USD rate and CBI's intervention transactions: January 1999–December 2008

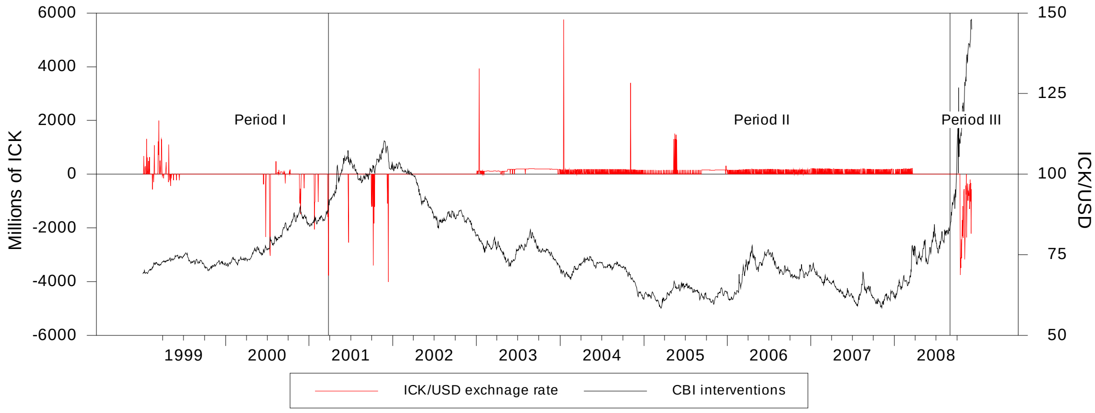


Table 1 Summary statistics for CBI's foreign exchange intervention transactions

	Full Period: January 1999 December 2008	***Period I : January 1999 March 2001***	***Period II: March 2001 August 2008***	***Period III September 2008 December 2008***
Size of int.				
Abs. average	317.8	616.36	226.86	1517.798
Average of buy	317.8	420.8	199.05	-
Average of sale	1333.828	868.68	2131.87	1517.798
Max buy	5756.10	1997.27	5756.1	-
Max sale	4017.09	3029.30	4017.09	3750
Number of days interventions				
Total int.	801	71	695	35
Buy	725	40	685	-
Sale	76	31	10	35
Min ICK/USD	58.45 (17/03/2005)	69.08 (05/01/1999)	58.45 (17/03/2005)	83.35 (1/9/2008)
Max ICK/USD	110.39 (23/11/2001)	90.04 (23/11/2000)	110.39 (23/11/2001)	147.98 (3/12/2008)

Period II (March, 27 2001 - August 2008): On March 27, 2001 there was the abandon of the target band and the ICK exchange rate was floated. Interventions were only purchases in order to support the ICK exchange rate.

Period III (September 2008- December 2008): This is the financial crisis period. The size of intervention was extremely increased averaging 1518 millions of ICK. Interventions were only purchases of ICK.

4.2 Exchange rate data

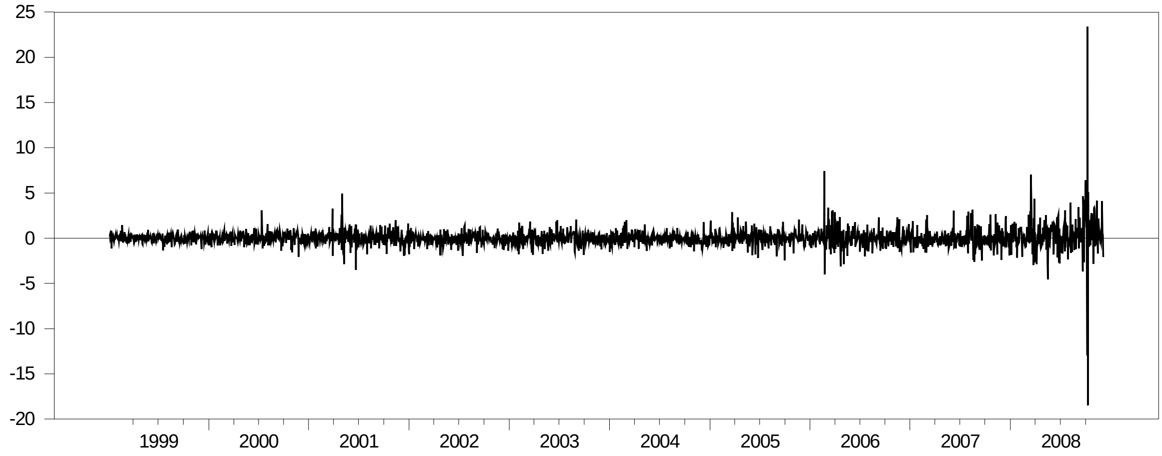
The exchange rate is defined as the number of foreign currency units per US dollars: ICK/USD, they are daily observations. Table 2 reports summery statistics of both daily exchange rate returns ($R_t = \log(S_t / S_{t-1}) \times 100$). This summary statistics are relative to two periods; the second period includes the financial crisis (period III): from September 2008 to December 2008.

Table 2 Summary statistics of daily ICK/USD returns

Panel B: Period I and Period II			
Mean	0.007692	$Q^2(12)$	25.909(0.011056)
Variance	0.65641	$Q(12)$	371.521 (0.0000)
Skeweness	0.81101	*ADF*	-23.60
Kurtosis	8.173084	$KPSS(\eta_\mu)$	0.192
J-B	7287.28(0.0000)		
Panel A: Full sample			
Mean	0.0286	$Q^2(12)$	258.057 (0.000)
Variance	1.16528	$Q(12)$	1337.730(0.000)
Skeweness	1.86645	*ADF*	-11.28
Kurtosis	128.121175	$KPSS(\eta_\mu)$	0.734
J-B	1770906 (0.0000)		

Table 2 shows that there is an increase in the average and the variance during the financial crisis. The ADF and KPSS tests show the stationarity of exchange returns. The Jarque-Bera test, the significant skewness and the excess kurtosis show the absence of normality and the leptokurtic distribution of returns. Also, there is evidence for the existence of significant serial correlation in the returns and conditional variance of the series.

Figure 2 The daily ICK/USD exchange rate return



5. Estimation and results

5.1 Volatility estimation

As shown in the previous part, there is evidence of heteroskedastic conditional volatility. In Table 3, Engel-LM and McLeod-Li tests confirm the ARCH effect of squared returns. In addition, the Engle and Ng (1993)'s sign bias tests show significant asymmetric volatility responses to unanticipated positive and negative shocks.

Table 3 ARCH effect and Asymmetric tests for conditional volatility

	P-value		***P-value***	
McLeod-Li test	0.0000(1129.371)	Engel-Ng test	0.01079(11.17)	
Engel LM test	0.0000(1403.1120)			
Calculated statistics are between parentheses				

One of the popular asymmetric formulations of conditional volatility is the exponential GARCH (EGARCH) proposed by Nelson (1991). It allows one to model not only an asymmetric behavior of volatility but also negative coefficients in the volatility equation. The EGARCH specification is given by:

$$R_t = \beta_0 + \sum_{i=1}^{n} \beta_i R_{t-i} + \varepsilon_t \qquad \varepsilon_t = z_t \sqrt{h_t} \quad z_t \approx GED \qquad (4)$$

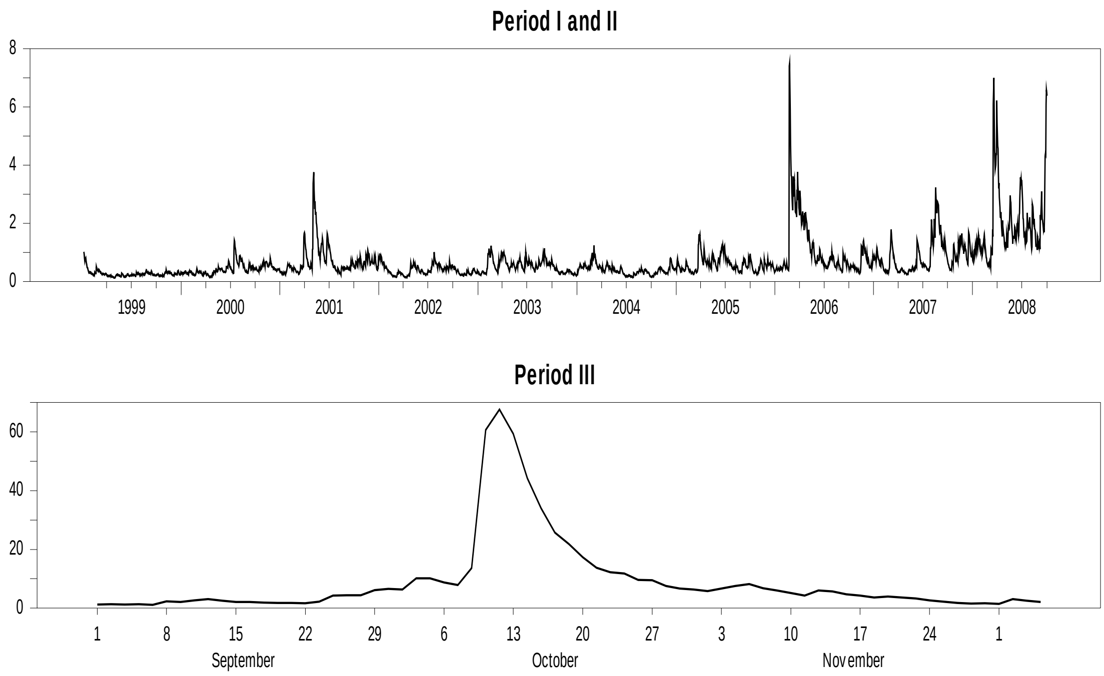
$$\log(h_t) = \alpha_0 + \alpha_1 \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \alpha_2 \log(h_{t-1}) + \alpha_3 \left[\frac{|\varepsilon_{t-1}|}{\sqrt{h_{t-1}}} - E\left(\frac{|\varepsilon_{t-1}|}{\sqrt{h_{t-1}}} \right) \right]$$

Since normal distribution for returns is not maintained through Jarque-Bera test, we use an alternative distribution to the normal distribution which is called GED (general error distribution). The GED family, introduced by Nelson (1991), includes both fat-tailed densities (shape>1) and thin-tailed densities (shape<1). Estimation coefficients of EGARCH volatility is reported in table 4.

Table 4 EGARCH volatility estimation

	Coefficient	***P-value***
α_0	-0.1830	0.0000
α_1	0.2239	0.0000
α_2	0.9717	0.0000
α_3	0.0523	0.0011
Shape (υ)	1.6150	0.0000
Diagnostic tests for standardized error		
Q(10)	11.978	0.0447
$Q^2(10)$	14.659	0.2606
McLeod-Li(20)	14.618	0.1465
Engel LM (5)	2.779	0.7339

Figure 3 Conditional volatility of daily ICK/USD returns



EGARCH estimated volatility of daily ICK/USD returns is shown in Figure 3. All coefficients are significant. The shaped parameter in upper one which confirm fat-tailed densities.

5.2 Logit and Probit estimation

The estimation results of the Eqs. (2) and (3) for the exchange rates response to interventions for all the sample periods are in Table 3.

Results, for logit and probit estimation, show that conditional variance has significant negative coefficient for the second period and significant positive coefficient for the third period (financial crisis period) and for full sample. One possible explanation to the insignificant coefficient for the first period may be explained by the fact that the exchange rate was maintaining in a target zone band and therefore expectation of interventions could be easier for markets participants.

Table 5 Logit and probit estimation

	Full Period: January 1991 December 2008		***Period I : January 1991 March 2001***		***Period II: March 2001 August 2008***		***Period III September 2008 December 2008***	
Probit	***Coef.***	***P-value***	***Coef.***	***P-value***	***Coef.***	***P-value***	***Coef.***	***P-value***
constant	0.1595	0.0393	0.13704	0.7292	0.3436	0.0009	0.6604	0.4115
a_h	0.1235	0.0037	-1.1612	0.2747	-0.1749	0.0803	0.1134	0.03179
a_Q	-5×10^{-5}	0.5370	-0.0004	0.0599	0.0002	0.0695	0.0002	0.4902
a_{SDEV}	-17.95	0.0075	28.8437	0.2202	-9.7477	0.0523	4.1931	0.7363
a_{DumTwo}	0.0257	0.7789	-0.6207	0.0881	-0.0342	0.7288	-	-
Log Lik	-547.458		-44.079		-478.306		-12.438	
LR test	15.72		10.82		14.94		1.55	
Sign. LR test	0.0034		0.0285		0.00482		0.6693	
Logit								
constant	0.2552	0.0397	0.2274	0.7273	0.5542	0.0012	1.1346	0.4220
a_h	0.2001	0.0037	-1.9679	0.2844	-0.2958	0.0860	0.1901	0.0196
a_Q	-9×10^{-5}	0.5368	-0.0008	0.0932	0.0003	0.0889	0.0004	0.5695
a_{SDEV}	-28.885	0.0073	46.0111	0.2283	-15.357	0.0573	5.7521	0.7907
a_{DumTwo}	0.0410	0.7798	-0.9819	0.1107	-0.055	0.7276	-	-
Log Lik	-547.458		-44.079		-478.3		-12.438	
***LR** test*	15.53		14.83		14.95		1.4129	
Sign. LR test	0.0037		0.0285		0.0047		0.7025	
Log Lik; is logarithm of likelihood function; LR *test*: likelihood ratio test*; Sign. LR test*: significance level of likelihood ratio test.								

The conditional variance negative sign for the second period show that high market volatility leads to a higher probability of normal response. This finding is supporting propositions suggested by Huang (2007) in his theoretical model for noise trading channel. However, in the financial crisis period, the high market volatility is associated with a perverse response of the exchange rate. In others words, interventions were not effective during high market volatility. As outlined by Barnett and Ozerturk (2007), interventions during currency crises may differ from the type of interventions considered by Huang (1997), Vitale (1999) and Huang (2007). In fact, financial crisis emerge when market participants think that a country is not able to maintain a fixed exchange rate. In these circumstances, the central bank's target rate is known by all market participants, consequently Diebold and Nerlove (1989) hypothesis (which say that if there is greater disagreement about meaning of incoming information, then the exchange market volatility is likely to be high) is not maintained in financial crisis. Therefore, in spite of high market volatility, the exchange rate target is known and hence the intervention may be ineffective.

The results also show that the size of the central bank interventions has a significant impact on the exchange rate for the first period and the second period. A large scale intervention may induce a normal response of exchange rate for the first period; however, for the second period intervention tends to be ineffective. A rational justification for this inconsistency between the first and the second period is that the first period was dominated by an absolute average amount of interventions larger than ones of the second period.

A high deviation (absolute) of the exchange rate from its moving average may avoid a perverse response of exchange rate and the central bank to success in its interventions. This finding was confirmed for the full sample and for the float exchange period (second period).

To sum up, we find that during the float exchange period the high market volatility leads to a higher probability of successful interventions (Payne and Vitale (2003) outlined that authority may choose to intervene when the market volatility is high). However during the financial crisis, when the volatility was extremely high, the noise trading channel was not supported. The latter is explained by the fact that the exchange rate target during financial crisis may be known by market participants.

6. Conclusion

This paper tests the Hung (1997) noise trading channel which has been then extended by Huang (2007) is his theoretical framework. The noise trading channel assumes that noise traders must prevail the foreign exchange market and the exchange rate is determined by flow market equilibrium. Once these hypotheses are satisfied, the central bank should intervene in highly volatile market periods and keep its interventions secret.

We empirically assess the effectiveness of interventions and focus on the operations carried out by the CBI (Central Bank of Iceland) before and during the financial crisis. We test the impact of market volatility on the reaction of exchange rate. The noise trading channel was supported for the float exchange period (second period) and not empirically confirmed during the financial crisis.

Financial crisis of Iceland was characterized by the failure of the CBI to maintain a fixed exchange rate, our empirical investigations show that secret interventions would not be the successful way. However, opting for the coordination channel (announced interventions operations by the CBI) may encourage traders to enter the market in order to bring the exchange rate to its fundamental level and thus stabilizing the foreign exchange market.

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