TALKS, FINANCIAL OPERATIONS OR BOTH? GENERALIZING CENTRAL BANKS’ FX REACTION FUNCTIONS.

Oscar BERNAL
Jean-Yves GNABO
Talks, financial operations or both?

Generalizing central banks’ FX reaction functions∗

Oscar BERNAL† Jean-Yves GNABO‡

February 1, 2007

Abstract

This paper generalizes central banks’ FX interventions reaction functions to include oral interventions alongside actual ones. Using Japanese data for the 1991-2004 period, we estimate an ordered probit explaining the occurrence of each type of intervention and evaluating the extent to which oral and actual interventions are substitutes or complements. Our results indicate that monetary authorities tend to adopt progressively stronger measures as the exchange rate behaves in an increasingly unfavorable way. This suggests that words and acts are used as complements only in extreme cases.

JEL Classification: E58; F31; G15

Keywords: Central banks; Foreign exchange market; Interventions; Communication policy

∗Financial support from the Belgian National Fund for Scientific Research (FRFC funding) is gratefully acknowledged. We thank Michel Beine, Marcel Fratzscher, David-Jan Jansen, Christelle Lecourt, Kim Oosterlinck, Franz Palm and Ariane Szafarz as well as the participants of the DULBEA’s internal seminar and the Fifth Econometrics day in University of Paris-Nanterre for useful comments and suggestions. We are also indebted with Agnès Bénassy-Quéré for providing us with estimates of the fundamental exchange rate. Of course, all remaining mistakes are the responsibility of the authors.

†DULBEA, Free University of Brussels (Belgium); obernal@ulb.ac.be

‡CEREFIM, University of Namur (Belgium); jean-yves.gnabo@fundp.ac.be
1 Introduction

“The Japanese authorities have so far limited themselves to verbal [oral] intervention, with Vice-Finance Minister Koji Tanami warning overnight that Japan will take appropriate measures in the event of drastic currency market fluctuations. But traders said the Bank of Japan would have to spend money intervening to convince the market that Japan was resolute about halting the yen’s rally” (Reuters, January 11, 1999).

Although monetary authorities intervene in the foreign exchange (FX) market to influence exchange rates, different types of interventions can be distinguished. Actual interventions involve financial transactions (i.e. currency sales or buys) whereas oral interventions do not (i.e. they are mere oral announcements). While evidence on major economies (e.g. the United States, the Euro Zone and Japan) indicates a clear shift toward lesser actual interventions, oral interventions continue to be frequently used. Understanding why one type of intervention is used rather than another is then an important issue.

Researchers have concentrated on actual interventions largely focusing on their determinants and effects for various countries and periods (Domínguez and Frankel, 1993; Almekinders and Eijffinger, 1996; Domínguez, 1998; Beine et al., 2002 and Ito and Yabu, 2004 among many others). It is just recently that they have become interested in the authorities’ communication policy and particularly in the role played by oral interventions as substitute for or as complement to actual interventions (see Beine et al., 2004 and Fratzscher, 2004).

This paper aims at providing useful elements to facilitate the understanding of the occurrence of each type of intervention. We propose to analyze the FX intervention topography in the light of the signaling theory (Mussa, 1981) which supposes that actual and oral interventions share the ability of influencing market agents’ expectations by conveying central banks’ private information. According to Domínguez (1998) it is the nature of interventions (i.e. their signal strength) which determines their effects on the exchange rate dynamics. We thus need to classify interventions following the strength of the signal they convey.

As secret interventions (i.e. actual interventions not contemporaneously detected by the market) do not carry an explicit or visible signal, they cannot be distinguished from private trades (Evans and Lyons, 2001). Secret-interventions-days can thus hardly be differentiated from no-interventions-days. By contrast, interventions that are perceived by market participants naturally convey a stronger and explicit signal that must be assessed. For this, as the total cost supported by authorities depends on the type of operation carried out, we assume the cost associated to the different types of visible interventions to be an indicator of their signal strength and we classify them accordingly. In other words, we infer the authorities’ determination to correct a bad exchange rate dynamics to be given by the burden cost related to the operation.

To understand the occurrence of the different types of interventions, we estimate an extended inter-
vention reaction function on traditional determinants (i.e. deviations of the exchange rate from some target, the exchange rate volatility and the general conjuncture of the economy). We use an ordered probit specification which is convenient to model naturally ordered variables and to obtain thresholds estimates determining unbalance levels leading to the use of increasingly stronger interventions. Moreover, these thresholds also determine whether oral interventions play a role of substitute for or of complement to actual ones.

The paper is organized as follows. The theoretical discussion of the different types of interventions and the way they have been studied in the literature is presented in section two. A discussion on the transmission channels of sterilized interventions as well as the method used to classify interventions according to the strength of the signal they convey is in section three. The econometric model and the data are described in section four. Our empirical results are discussed in section five. Section six concludes.

2 Interventions on foreign exchange markets

According to Dominguez and Frankel (1993), interventions can be broadly defined as “any transaction or announcement by an official agent of a government that is intended to influence the value of an exchange rate”. Countries intervene in the FX market when they perceive that the exchange rate dynamics is not consistent with their objectives. That is, they intervene when the exchange rate level is not adequate or when the exchange rate volatility is excessive (for a recent review of central banks interventions practices see Neely, 2006).

From Dominguez and Frankel (1993)’s definition, different types of interventions can be distinguished. Actual interventions involve central bank’s transactions (i.e. currency buys or sales) designed to appropriately influence the exchange rate dynamics. They are generally leaning-against-the-wind operations. That is, operations that try to reverse the exchange rate trend. Another type of intervention mentioned by the definition are so-called oral interventions. They are pure announcements that does not involve any currency transaction. Therefore, they are official speeches or communications that are intended to influence the exchange rate by providing the market with explicit relevant (private) information. A third type of intervention corresponds to confirmed interventions. They are actual interventions accompanied by an announcement directly related to it (i.e. whether by confirming the occurrence of the actual intervention or by clarifying its purpose). From this description, the topography of FX interventions can be represented by three subsets respectively corresponding to the three kinds of interventions evoked. It is illustrated in figure 1.

\footnote{In several countries specific political authorities (e.g. the Treasury in the United States, the Ministry of Finance in Japan and the European Council in the Euro Zone) are in charge of the FX policy. Central banks remain independent to conduct the monetary policy. They only implement transactions orders in the FX market. In this paper, for the sake of clarity, we neglect the interactions existing between the different actors involved in the intervention process (for a discussion}
Figure 1: FX interventions topography

Note: Several types of interventions can be distinguished according to whether they involve financial transactions or not. Oral interventions are speeches or communications by officials and do not involve any transaction. Actual interventions are currency buys or sales. Confirmed interventions are actual interventions accompanied by a confirming or clarifying announcement.

The literature on interventions has generally put the focus on the study of the determinants and effects of actual interventions. Main results on actual interventions determinants suggest that large deviations of the exchange rate from its past values and the fundamental equilibrium level cause corrective measures. Furthermore, the leaning-against-the-wind strategy has been generally confirmed (Dominguez and Frankel, 1993; Almekinders and Eijffinger, 1996; Baillie and Osterberg, 1997; Sarno and Taylor, 2001; Ito, 2003; Ito and Yabu, 2004 and Bernal, 2006). The role of the exchange rate volatility as determinant to actual interventions is less clear. Although, recent advances in the way it is measured may improve the situation (Andersen et al., 2005; Beine et al., 2006 and Gnabo et al., 2006). In particular, Gnabo et al. (2006) show that more interventions are expected by market participants when some components of the realized volatility increase. Empirical works on the effects of actual interventions on the exchange rate level most often indicate that they are effective over short periods (Dominguez, 2004 and Fatum and Hutchinson, 2004, 2006). Furthermore, their impact on the volatility deeply depends on the market’s overall situation (Bosser-Neal and Tanner, 1996; Dominguez, 1998, 2003; Beine and Laurent, 2003; Beine et al., 2002, 2003 and Gnabo et al., 2006).

The interest in the authorities’ communication policy and more precisely in oral interventions is rather recent. It takes its roots in the shift of major economies’ policy (i.e. the United States, the Euro Zone and to a certain extent Japan) toward the use of this type of intervention and the abandon of actual ones. As a matter of fact, after not having conducted any actual intervention since 1995, the United States intervened once in 2000. It has not entered the market since. In Europe, authorities only actually intervened on four occasions since the introduction of the euro in 1999. The case of Japan is particular as it maintained a policy of frequent actual interventions until march 2004 where it ended an episode of massive interventions.² Nevertheless, it has not intervened since that time and seems to follow the path

---

²Note that according to Beine and Lecourt (2004) and Beine and Bernal (2006), about 80% of actual interventions
of the United States and the Euro Zone (an updated analyze of the Japanese case is proposed by Ito, 2006).

The role of oral interventions of substitute for or complement to actual ones is a crucial question that has been addressed. Particularly, Fratzscher (2004, 2006) finds that oral interventions are good substitutes for actual operations. He shows that oral interventions may influence exchange rates without raising the market’s uncertainty independently from the general stance of the monetary policy and the occurrence of actual interventions.\(^3\) However, in his analysis of the determinants to oral and actual interventions, Fratzscher (2005) indicates that both types of interventions tend to be coordinated domestically in practice. This suggests that they are used on the same periods and denotes the ability of authorities to switch from one type of measure to another rapidly depending on the market conditions. On the other hand, Beine et al. (2004) find that oral interventions clarify the signal conveyed by actual ones. They highlight the complementary relationship existing between these types of economic policy measures. More generally, Gnabo and Tieteltche (2006) analyze the impact on market expectations of a large set of strategies of interventions. They confirm the virtuous effect of transparent measures (i.e. oral, actual and confirmed interventions) against opaque ones (i.e. secret interventions). Besides, these measures appear to be the most effective when the degree of authorities involvement is high. Therefore, while it is clear that several corrective policies are at the disposal of responsible authorities, they could hardly be considered as being perfectly substitutable.

Interestingly, to the best of our knowledge, no holistic study has been conducted to understand what are the elements inducing authorities to use one type of intervention rather than another (Fratzscher, 2005 considers separate logit specifications, one for oral and one for actual interventions, to identify their determinants). Furthermore, no rationale has been provided to the shift in the intervention strategy observed in major economies. To address these questions appropriately, it is important to understand how interventions work. We examine this point below with a particular focus on the signaling channel theory.

3 Interventions transmission

3.1 The signaling approach to interventions

The way interventions influence exchange rates has been largely debated. Oral interventions solely influence exchange rates through the signaling channel (Musza, 1981). Besides, actual interventions may also impact the market through the signaling channel (as long as they are not secret) but also through the portfolio balance channel (see Edison, 1993; Dominguez and Frankel, 1993; Sarno and Taylor, 2001 conducted by Japan between 2003 and 2004 were secret. That is, these transactions were not contemporaneously detected by market participants. This nuances the signaling role of that intervention episode.\(^3\)Jansen and de Haan (2005, forth.) have studied oral interventions taken alone and establishes that their effectiveness is limited.
and Neely, 2006 for surveys).  

The portfolio balance approach supposes that financial transactions operated by monetary authorities affect the proportion of foreign and domestic assets in the market. If they are not perfect substitutes, the exchange rate adapts to incite agents to purchase the assets whose proportion increased. On the other hand, the signaling framework describes how the exchange rate can be regulated by the disclosure of the central bank’s private information. Indeed, additionally to the information concerning their own future monetary and exchange rate policy, central banks usually have a privileged access to information on general macroeconomic developments. Pieces of this information can be “signaled” to the market through interventions to induce traders to reshape their beliefs in accordance (e.g. a sale of domestic currency may indicate that it is overvalued, then, if the signal is clear and credible, it might change agents’ trading behavior that in turn will help to depreciate the currency).

Empirical evidence massively suggests that the signaling channel is the most important theory explaining how interventions work (see Edison, 1993; Dominguez and Frankel, 1993 and Sarno and Taylor, 2001 for surveys). This might be explained by the fact that the magnitude of interventions amounts is relatively small with respect to the market’s overall size. Recent findings of the microstructure approach to exchange rates indicate however that there is room for an effect through the portfolio balance channel (Evans and Lyons, 2001). Nevertheless, as the different types of interventions share the ability of providing the market with relevant official information, it is worth examining more in details the signaling framework.

As discussed by Dominguez (1998), the potential impact of a given intervention on the exchange rate level or volatility is influenced by the degree of market efficiency and by the credibility and unambiguity of the operation. For efficient markets, this is illustrated in table 1. \( I_t \) denotes an actual intervention designed to appreciate the domestic currency or to calm disorderly markets. \( S_t \) is the exchange rate level (domestic price of foreign currency). \( \Delta S_t | I_t \) is the exchange rate level change due to the intervention. \( \text{var}[\Delta S_t | I_t] \) captures the exchange rate volatility. We see that as long as the signal conveyed by the intervention is credible and unambiguous it may move the exchange rate in the desired direction or reduce the market’s volatility. On the other hand, if the signal is not sufficiently credible or is ambiguous, it may have counterproductive effects.

The concept of transparency developed in the monetary policy literature can help to understand the mechanism described in the previous lines. Indeed, transparency synthesizes well the two notions of unambiguity and credibility. It usually refers to the absence of information asymmetries between
Table 1: Theoretical impact of interventions in an efficient market

<table>
<thead>
<tr>
<th></th>
<th>Level</th>
<th>Volatility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credible and unambiguous signal</td>
<td>$</td>
<td>\Delta S</td>
</tr>
<tr>
<td>Not credible or ambiguous signal</td>
<td>$</td>
<td>\Delta S</td>
</tr>
</tbody>
</table>

**Note:** On efficient markets, the impact of an intervention designed to appreciate the domestic currency or to calm disorderly markets ($I_t$) on the exchange rate level ($|\Delta S|I_1$, where $S_t$ is the domestic price of the foreign currency) or volatility ($\text{var}[|\Delta S|I_1]$) depends on the credibility and unambiguity of the signal conveyed by the intervention. The more credible or unambiguous the signal, the more virtuous the impact on exchange rates.

monetary policy-makers and the private sector (Geraats, 2002). According to this, improving the degree of transparency requires the disclosure of private information by authorities from time to time. However, the amount of information transmitted to the market is not sufficient as this extra information will allow agents to make better informed decisions only to the extent that they properly understand it. Winkler (2000) argues that transparency should be seen as a multi-dimensional concept in which qualitative aspects of the information like the degree of “clarity” and “honesty” of the policy also play an important role. That is, authorities’ measures will be transparent only if they are clearly perceived and understood by the market (they are unambiguous) and if they are honest in the sense that the declared objectives are consistent with the ones actually pursued (which influences the credibility).

Domínguez (1998)’s approach may be extended to incorporate different types of interventions. Table 1 shows that, as market conditions are given, the degree of credibility and unambiguity are key factors determining the strength of the signal conveyed by an intervention. More generally, they also influence the effectiveness of the regulation policies adopted by central banks. However, the degree of credibility and unambiguity may not be the same for different types of interventions. Hence, they do not all carry the same “signal strength”. Extending Domínguez (1998)’s framework requires then assessing the strength of the signal conveyed by interventions.

This task is obvious for secret interventions. Indeed, according to the signaling approach, a distinction in terms of signal between days in which secret interventions were conducted or days in which no interventions took place cannot be made. This is supported by the microstructure approach to FX interventions. In particular, Lyons (2001) and Evans and Lyons (2001) show that the secrecy of order flows allows an intervention to be indistinguishable from private trades. This directly arises because authorities deliberately lose the signaling impact of their operations by concealing them. Therefore,

---

7Since they are directly derived from a standard forward looking exchange rate model with very few assumptions, the mechanisms presented in table 1 are robust and can be safely trusted (see Domínguez, 1998 for details).
Despite they involve financial trades, secret interventions are assumed to provide a non explicit signal.

In comparison to secret ones, oral, actual and confirmed interventions provide stronger and explicit signals. In this work, we consider that the strength of these explicit signals can be captured by the authorities’ determination and credibility when attempting to correct a bad exchange rate dynamic. As the burden cost is not the same for the different types of interventions, we use this criterion to assess the strength of their signal.\(^8\) That is, the larger the burden cost authorities are decided to support, the larger their determination and credibility and the stronger the signal of their visible interventions. Below, we discuss how the auxiliary information on interventions total cost can be used to assess the strength of the explicit signal conveyed by these interventions.

### 3.2 Interventions costs and signal strength

As discussed above, oral, actual and confirmed interventions provide the market with an explicit signal. We assess it by referring to their related total cost. Several types of costs can be considered. Almekinders (1995) evokes purely bureaucratic costs that refer to the loss of flexibility of the regulation policy due to the time and bargaining required to decide and implement an intervention. This cost may be thought to be larger for actual and confirmed interventions than for oral ones. Indeed, in countries in which specific political authorities order central banks to implement interventions transactions (e.g. the United States, the Euro Zone and Japan), several agents are involved (i.e. at least the political authority and the central bank). A minimum level of costly coordination should then be achieved in order to ensure the efficiency of interventions (see Bernal, 2006 for details).\(^9\) Speeches associated to confirmed interventions clarify the authorities’ policy objectives. Then, they may also require a certain degree of coordination between the different agents involved in the intervention process. On the other hand, oral interventions are directly decided and conducted by responsible authorities and coordination is less necessary as long as the announcement remains sufficiently vague. That is, it only provides general orientations and not precise targets (Stein, 1989’s cheap-talk approach ).\(^10\) Financial costs should also be considered. They occur when operations in the FX market do not move the exchange rate in the desired direction. Indeed, the central bank would then hold an open position (i.e. if the currency purchase (resp. sell) is not followed by an actual currency appreciation (resp. depreciation) the central bank may experience losses). Obviously, these costs are only relevant for interventions involving currency transactions. A last type of cost is related to the authorities overall reputation. When interventions are implemented, authorities

---

\(^8\)As we will see, a measure of unambiguity is not necessary to our purpose.

\(^9\)As expressed by Peter Fisher (Executive Vice-President of the New York Fed in 1998) concerning the United States (that is institutionally highly similar to Japan): “The decision to intervene is not one that is made in 60 seconds. It is a consensus process of getting the […] Federal Reserve, […] Treasury officials [and] our counterparts in a foreign country in agreement” (Dow Jones, July 30, 1998). Note also that if many interventions are conducted several days in a row, the bureaucratic cost associated to the subsequent interventions may be lower than for the first operation (Ito and Yabu, 2004). This occurs because the official approval has already been granted.

\(^10\)Evidence obtained through the Factiva database (http://www.factiva.com) clearly indicates that major central banks only reveal precise target on very rare circumstances.
signal the market their will to correct an unsatisfactory exchange rate situation. Then, if the intervention fails to correct the exchange rate dynamics, market participants and foreign counterparts become aware of the authorities inability to correct things. The authorities’ reputation and more generally their ability to implement efficient exchange rate policies would then be weakened by that failure. In practice, oral interventions generally do not indicate precise targets. Actual interventions’ sign and magnitude provide *per se* a more accurate information on the authorities objectives than vague announcements. Then, they may be thought to carry a higher reputation cost than oral interventions. This view is reinforced by the fact that statements can be made by isolated policy-makers. Whereas actual interventions are necessarily the outcome of a political process and may be considered of surely reflecting the official point of view. Furthermore, as it does happen that some interventions are wrongly reported, a doubt on whether or not a signal was actually sent to the market remains even if a news report announces an intervention (see Gnabo et al., 2006). This underlying uncertainty can be unambiguously removed by confirmation or clarifying speeches. The resulting confirmed intervention carry then a higher reputation cost than actual interventions.

Table 2 summarizes the different costs level (i.e. $BC$ for bureaucratic cost, $FC$ for financial cost and $RC$ for reputation cost) associated to the different types of intervention (i.e. $OI$ for oral interventions, $AI$ for actual interventions and $CI$ for confirmed interventions). Total costs are assumed to provide auxiliary information on the intervention signal strength. Accordingly, the weakest, intermediate and strongest explicit signal can be respectively associated to oral, actual and confirmed interventions. It should be noted that secret interventions also generate positive costs. However, they cannot be distinguished from private trades. They are then considered to provide only a non explicit signal and consistently with the signaling channel framework, days of secret interventions are associated to no interventions days. The classification of the different types of interventions assumed in this work is illustrated in figure 2.

One may object that the burden cost is a rich but incomplete criterion. It clearly reflects the overall credibility of the policy (i.e. it increases with the burden cost authorities are decided to sustain). How-

---

Table 2: Interventions classified according to their associated cost

<table>
<thead>
<tr>
<th>Intervention Type</th>
<th>Bureaucratic Cost ($BC$)</th>
<th>Financial Cost ($FC$)</th>
<th>Reputation Cost ($RC$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral ($OI$)</td>
<td>$BC_{OI} &gt; 0$</td>
<td>-</td>
<td>$RC_{OI} &gt; 0$</td>
</tr>
<tr>
<td>Actual ($AI$)</td>
<td>$BC_{AI} &gt; BC_{OI}$</td>
<td>$FC_{AI} &gt; 0$</td>
<td>$RC_{AI} &gt; RC_{OI}$</td>
</tr>
<tr>
<td>Confirmed ($CI$)</td>
<td>$BC_{CI} &gt; BC_{AI}$</td>
<td>$FC_{CI} = FC_{AI}$</td>
<td>$RC_{CI} &gt; RC_{AI}$</td>
</tr>
</tbody>
</table>

*Note:* Oral interventions ($OI$) are associated to the weakest burden cost, actual interventions ($AI$) carry an intermediate cost while confirmed interventions ($CI$) carry the highest cost. The cost criterion is used to classify visible interventions signal strength.

---

11If the oral intervention consisted in announcing a precise exchange rate target, the reputation cost may become larger than for actual interventions. The central bank’s loss would then become explicit to all market participants.

12During the 1990s, the communication policy of Japan was sometimes discordant. While some officials claimed a depreciation of the currency, others (especially the governor of the Bank of Japan) privileged a *status quo*.
Figure 2: FX interventions signal strength

Note: Confirmed interventions are associated to the strongest explicit signal while oral interventions carry the weakest one. Actual interventions provide an intermediate explicit signal strength. Secret interventions only carry a non explicit signal and cannot be distinguished from days in which no interventions were conducted.

ever, the unambiguity of the signal is not explicitly captured. Nevertheless, the classification presented in figure 2 would not be jeopardized if a measure of the unambiguity of interventions was incorporated. Both oral and actual interventions indicate the direction toward which authorities are pushing the currency. In theory, oral interventions could be even more precise by providing an explicit target. A systematic analyze of news reports shows that policy-makers are strongly reluctant to make precise statements about their target as it might give some exchange rate level target for speculators to challenge (Chiu, 2003).\footnote{For example a Japanese Ministry of Finance official, Kuroda, announced on November the 1st 1999: “Yen rise excessive, doesn’t reflect fundamentals” (Dow Jones) without clarifying further what he considered as an ideal level.} Therefore, market participants can learn from oral interventions whether the domestic currency is overvalued or undervalued, but not much more.\footnote{This phenomenon is well documented in the literature on monetary policy which talks about “monetary mystique” (Goodfriend, 1986; Rosa and Verga, 2005).} On the other hand, the sign and magnitude of actual interventions provide a better estimate of the authorities objectives. They may then be seen as providing a stronger signal than oral interventions. The confirmation speech accompanying a confirmed intervention obviously provides a clearer signal than both oral and actual interventions (e.g. the motivations of the actual intervention is further explained by officials themselves). Therefore, this type of intervention carry the strongest signal. The respective location of oral, actual and confirmed interventions in our classification can then consistently be attributed only using the burden cost criterion.

4 Empirical part

4.1 Econometric model for an extended reaction function

Traditional reaction functions are designed to explain when actual interventions occur. They are generally derived from a standard loss minimization program (see Almekinders and Eijffinger, 1996, Ito and Yabu, 2004, Kearns and Rigobon, 2004 and Bernal, 2006). In such a framework, interventions occur because of the losses caused by an inadequate exchange rate level, an excessive volatility or a bad economic
conjuncture. Equation (1) can be seen as a generic reaction function. $I_t^*$ denotes optimal interventions. $X_t$, $Z_t$ and $W_t$ are vectors of variables respectively capturing evolutions of the exchange rate level and volatility, and of the economic conjuncture. $\epsilon_t \sim N(0, 1)$ is a random error term.

$$I_t^* = f(\beta_1 X_t, \beta_2 Z_t, \beta_3 W_t) + \epsilon_t$$

(1)

Our work proposes an extended reaction function. It incorporates the different types of interventions previously described and provides some elements valuable to understand their occurrence. From the theoretical discussion of the previous sections, interventions can be classified in a discreet way according to the strength of the signal they convey. Furthermore, equation (1) can be seen as a model for a latent variable (i.e. the shadow intervention). The actual structure of the intervention process may then be appropriately described by an ordered probit model (McKelvey and Zavoina, 1975). In such models, the dependent variable’s different outcomes would correspond to the different types of interventions. Equation (2) represents such a specification. Outcome 0 denotes secret interventions or no interventions days (i.e. no explicit signal). Whereas, 1, 2 and 3 respectively correspond to oral, actual and confirmed interventions (i.e. explicit signals). $\Theta = (\Theta_1 \Theta_2 \Theta_3)'$ is an unknown parameter jointly estimated with $\beta = (\beta_1 \beta_2 \beta_3)'$. It indicates thresholds causing $I_t$ to take the different outcomes values (i.e. the thresholds that should be attained by $I_t^*$ in order for $I_t$ to equal 0, 1, 2 or 3). That is, $\Theta$ represents unbalances in terms of $X_t$, $Z_t$ and $W_t$ inducing sufficiently large losses to cause corrective measures.

$$\begin{cases} I_t = 0 & I_t^* \leq \Theta_1 \\ I_t = 1 & \Theta_1 < I_t^* \leq \Theta_2 \\ I_t = 2 & \Theta_2 < I_t^* \leq \Theta_3 \\ I_t = 3 & \Theta_3 < I_t^* \end{cases}$$

(2)

The non-linear econometric model determined by equations (1) and (2) is estimated by maximum likelihood techniques.\textsuperscript{15} The interpretation of $\beta$ is not trivial. For instance, $\beta_1 > 0$ indicates that $X_t$ positively (resp. negatively) influence the last (resp. first) outcome occurrence probability. The impact of $X_t$ on the intermediate outcomes cannot be presumed a priori. Specific marginal effects should then be computed. They reflect the change in the occurrence probability of the different types of interventions induced by a marginal change in the regressors. Following Wooldridge (2002), these marginal effects are computed using equations (3). $\phi$ is the standard normal distribution density function.

\textsuperscript{15}For a technical discussion see Maddala (1983), Greene (2000) and Wooldridge (2002).
\[
\frac{\partial P(I_t=0|X_t)}{\partial X_t} = -\beta_1 \phi(\Theta_1 - X_t\beta_1 - Z_t\beta_2 - W_t\beta_3)
\]
\[
\frac{\partial P(I_t=1|X_t)}{\partial X_t} = \beta_1[\phi(\Theta_1 - X_t\beta_1 - Z_t\beta_2 - W_t\beta_3) - \phi(\Theta_2 - X_t\beta_1 - Z_t\beta_2 - W_t\beta_3)]
\]
\[
\frac{\partial P(I_t=2|X_t)}{\partial X_t} = \beta_1[\phi(\Theta_2 - X_t\beta_1 - Z_t\beta_2 - W_t\beta_3) - \phi(\Theta_3 - X_t\beta_1 - Z_t\beta_2 - W_t\beta_3)]
\]
\[
\frac{\partial P(I_t=3|X_t)}{\partial X_t} = \beta_1\phi(\Theta_3 - X_t\beta_1 - Z_t\beta_2 - W_t\beta_3)
\]

The value of $\Theta$ cannot be interpreted per se. It is however necessary that $\Theta_1 < \Theta_2 < \Theta_3$ for the probabilities estimated from the model to be positive. Moreover, in our case, as long as $\Theta_1 < I^*_t < \Theta_2$ oral interventions are likely to be used (i.e. the loss caused to the central bank by $X_t$, $Z_t$ and $W_t$ is not sufficient to justify stronger measures). Whereas, if $\Theta_2 < I^*_t < \Theta_3$ actual interventions would be used instead (i.e. the loss is large enough for the central bank to involve its own assets). Finally, if $\Theta_3 < I^*_t$, confirmed interventions may be observed (i.e. the loss induced by the bad exchange rate dynamics is so important that very strong corrective measures are required giving room for the simultaneous use of actual interventions and announcements to enhance the efficiency of the intervention). To control whether or not the classification imposed by $\Theta$ is meaningful, we test the hypothesis that adjacent threshold are indistinguishable. We use the $z$-ratio test for a linear combination of coefficients written in equation (4) where $j = 1, 2, 3$.

\[
z_{j,j-1} = \frac{\Theta_j - \Theta_{j-1}}{\sqrt{\hat{\sigma}_{\Theta_j}^2 + \hat{\sigma}_{\Theta_{j-1}}^2 - 2\hat{\sigma}_{\Theta_j} \hat{\sigma}_{\Theta_{j-1}}}}
\]

Under the null hypothesis that two adjacent thresholds are equal, the $z_{j,j-1}$ statistic follows a normal distribution. The critical value at the 5% level is 1.96 (see Greene, 2000 for details).

### 4.2 The data

#### 4.2.1 Measure of interventions

The dependent variable of the ordered probit model (denoted $I_t$ in equation (2)) is built using the Japanese experience on the YEN/US$ market from April 1991 to September 2004. The Japanese case is particularly interesting because of the huge variability both in frequency and intensity of their intervention policy (for a detailed description see Ito, 2003, 2006). Building the dependent variable required obtaining data for the different types of interventions. Official data on Japanese actual interventions is publicly available on the Japanese Ministry of Finance website. However, this data is aggregated in the sense that it does not indicate which interventions were secret and which were not. Data for oral and confirmed interventions is not available on a systematic basis. Relevant information was then collected

---

16 There is a well-known identification problem with ordered probit models (see Verbeek, 2000 for an intuitive description). To circumvent this it is usual to fix the value of one of the parameters (this do not affect the probabilities). In this work, we fix the constant to zero. This allows to estimate an unconstrained $\Theta$. An alternative would have been to fix $\Theta_1 = 0$. In that case, condition $\Theta_1 < \Theta_2 < \Theta_3$ should have been rewritten to $0 < \Theta_2 < \Theta_3$.

17 Precise dates of interventions, currencies involved and transactions amounts can be obtained on http://www.mof.go.jp/english/e1c021.htm
Table 3: Sample of news reports used to identify oral interventions

<table>
<thead>
<tr>
<th>Date</th>
<th>Source</th>
<th>Newswire</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 9, 1997</td>
<td>Dow Jones</td>
<td>Japan MoF Vice Minister Kato: “excessive forex volatility undesirable”</td>
</tr>
<tr>
<td>October 9, 1998</td>
<td>Dow Jones</td>
<td>Sakakibara: “Dlr-Yen excessive volatility undesirable”</td>
</tr>
<tr>
<td>May 21, 1999</td>
<td>Dow Jones</td>
<td>Japan Sakakibara: “Forex volatility undesirable”</td>
</tr>
<tr>
<td>June 21, 1999</td>
<td>Dow Jones</td>
<td>“An excessively strong yen is bad for both the Japanese and overseas economies”. Vice Finance Minister Koji Tanami said on Monday</td>
</tr>
<tr>
<td>September 2, 2003</td>
<td>Dow Jones</td>
<td>“No real reason for the yen to strengthen at present”, a Japanese Ministry of Finance official said</td>
</tr>
<tr>
<td>December 9, 2003</td>
<td>Dow Jones</td>
<td>“Yen’s latest surge against the dollar is out of step with economic fundamentals”, Japanese Finance Minister said</td>
</tr>
</tbody>
</table>

Note: These news reports indicate that the Japanese authorities were not comfortable with the exchange rate level or volatility. Therefore, they are used to build the variable indicating the occurrence of oral interventions.

to build the series. We achieved this by using the Factiva online database.18

For every day of the period of interest in which no actual intervention occurred (according to official series), we searched for the existence of any official announcement indicating that authorities were not comfortable with the exchange rate level or volatility. News reports obtained with that procedure permitted to identify those days were so-called oral interventions took place. Table 3 contains a sample of news reports of this kind. To identify confirmed interventions, the procedure consisted, for all the days in which actual interventions were conducted, to search for official speeches confirming or commenting the intervention of the day. Table 4 contains some news reports of that type. Finally, we used the method proposed by Beine and Lecourt (2004) to identify secret interventions. For each official intervention day, we looked for the existence of news reports indicating that the market was aware of the transaction. If such news reports could not be found, the intervention was considered as secret (for example of new reports indicating that the market knew that an intervention was taking place see Beine and Bernal, 2006)

Having gathered the data, our dependent variable was built as a categorical variable with four outcomes as illustrated in table 5.

4.2.2 Independent variables

Exchange rate level

Authorities intervene when the exchange rate level moves away from its target. More generally, interventions are generally designed as leaning-against-the-wind operations. These are operations elaborated to fight an inappropriate exchange rate trend. The difficulty is to determine the time horizon over which this

18For details see http://www.factiva.com
Table 4: Sample of news reports used to identify confirmed interventions

<table>
<thead>
<tr>
<th>Date</th>
<th>Source</th>
<th>Newswire</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 28, 2001</td>
<td>Dow Jones</td>
<td>“We again intervened this morning single-handedly. Since there have been many speculative dollar/yen moves recently, we’ll continue to intervene as necessary,” Shiokawa told a regular press conference. The finance minister denied the ministry and the Bank of Japan have any particular target level for the dollar/yen, but said the yen should be a little weaker (against the dollar) in light of the deteriorating Japanese economy. “We have no particular (dollar/yen) target levels in mind. But given the current weak economic conditions in Japan, I think it would be better if the yen was a little weaker,” he said.</td>
</tr>
<tr>
<td>March 15, 2000</td>
<td>Dow Jones</td>
<td>“Japan’s Ministry of Finance took action in the foreign exchange market Wednesday and might intervene again depending on the situation”, Finance Minister Kiichi Miyazawa said Wednesday. “We don’t want Japan’s economic recovery disturbed by foreign exchange moves,” Miyazawa said. “We might intervene more depending on the situation,” he said.</td>
</tr>
<tr>
<td>August 15, 1995</td>
<td>Dow Jones</td>
<td>“U.S. Treasury Secretary Robert Rubin later confirmed the coordinated intervention, and a BoJ official said it was consistent with the April Group of Seven (G-7) communiqué that called for an orderly reversal of the dollar’s decline.”</td>
</tr>
<tr>
<td>May 23, 2002</td>
<td>Dow Jones</td>
<td>“Japan MoF confirms yen-selling intervention”</td>
</tr>
</tbody>
</table>

*Note:* These news reports are official announcements that refer to an actual intervention conducted during the same day. Therefore, they may be used to identify confirmed interventions.

Table 5: Descriptive statistics on variable $I_t$ (April 1991 - September 2004)

<table>
<thead>
<tr>
<th></th>
<th>No (explicit) signal ($I_t = 0$)</th>
<th>Explicit signal ($I_t = 1, 2$ and 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>Secret</td>
</tr>
<tr>
<td>April 1991 - September 2004</td>
<td>2475</td>
<td>131</td>
</tr>
</tbody>
</table>

*Note:* This table reports some descriptive statistics on variable $I_t$ from April 1991 to September 2004. $I_t = 0$ holds for secret interventions or days of no intervention. From the signaling framework, these outcomes cannot be distinguished. Oral, actual and confirmed interventions are identified by $I_t = 1, 2$ or 3 respectively.
trend should be defined. To cope with this issue, empirical papers (Almekinders and Eijffinger, 1996; Ito, 2003; Ito and Yabu, 2004 and Frenkel et al., 2004) have considered movements of the exchange rate over the short, mid and long term as explanatory variables to the occurrence of interventions. In this paper, we adopt the same approach by considering the absolute deviation of the current exchange rate from the previous trading day rate \(X_{1t} = |s_t - s_{t-1}|\), the 21 trading days moving average \(X_{2t} = |s_t - \frac{1}{21}\sum_{i=1}^{21} s_{t-i}|\)
and the 260 trading days moving average \(X_{3t} = |s_t - \frac{1}{260}\sum_{i=1}^{260} s_{t-i}|\). The absolute misalignment is also included \(X_{4t} = |s_t - \pi_t|\).\(^{19}\) In its current form, however, variable \(X_{4t}\) can suffer from non-stationarity. To circumvent this, as an alternative way to measure the misalignment, we built a dummy variable that takes the value 1 on days of high misalignment and 0 otherwise. The “high misalignment” days correspond to the 10% of trading days with the highest positive misalignment and the 10% of days with the highest negative misalignment. Note that the exchange rates measures are the domestic price of the foreign currency (i.e. yen per dollar) and are taken in log. The variables are lagged to avoid simultaneity issues.

Variables \(X_{1t}, X_{2t}, X_{3t}\) and \(X_{4t}\) enter the reaction function to test whether or not authorities tend to intervene to avoid large fluctuations of the exchange rate level over diverse horizons. If this is the case, the variables are expected to positively influence the probability of observing an intervention (of either type).

**Exchange rate volatility**

Authorities claim to intervene to “calm disorderly” markets. That is, when the exchange rate volatility is excessive. Therefore, referring to Andersen et al. (2001), we introduce variable \(Z_{1t}\) that corresponds to the daily realized volatility (\(RV\)). It is computed as the sum of the 288 5-minutes squared returns of a day \(Z_{1t} \equiv RV_{t,h} = \sum_{i=0}^{288} r_{t,h-i}^2\).\(^{20}\) We choose \(h\) corresponding to 9 p.m. GMT (i.e. New York market’s close). The realized volatility is a far less noisy measure than the daily volatility obtained from GARCH-type models used in several studies (Baillie and Osterberg, 1997; Dominguez, 1998; Almekinders and Eijffinger, 1996). It is also less subject to the issue of generated regressors (Pagan, 1984). To prevent any simultaneity problem, variable \(Z_{1t}\) is lagged. Given the volatility clustering usually observed for exchange rates, this should be a good approximation.

It should be mentioned that, so far, most of studies have failed to find evidence that periods of excess volatility are accompanied by corrective measures from central banks. Given the objectives announced by the authorities themselves, this is paradoxical. Two reasons (at least), may explain this issue. The first is the nature of volatility itself. As volatility is latent (i.e. it cannot be observed), any variable

---

\(^{19}\)\(\pi_t\) is the fundamental equilibrium rate estimated by Bénassy-Quéré et al. (2004) which is a rate consistent with a global equilibrium between the G-20’s countries.

\(^{20}\)The 5-minutes scaled prices are provided by Olsen and Associates.
capturing it is submitted to a measurement error risk. The second reason is that authorities can be more concerned by variations of the overall volatility rather than by specific levels or regimes of volatility. From these elements, it clearly appears that variable $Z_{1t}$ might not be sufficient to appropriately capture the role of volatility as a determinant to interventions. Consistently with this, additional variables for the exchange rate volatility should be tested.

To have a more precise measure of the exchange rate volatility, the realized volatility ($Z_{1t}$) can be split into an integrated volatility process (i.e. continuous and persistent) and a jump process (i.e. the occurrence of which is random). Measures for these two components should then be found. As noticed by Andersen et al. (2001), the realized volatility is a consistent estimator of the integrated volatility only to the extent that there are no jumps in the underlying process. In the presence of jumps, the identification of the jump and non-jump contributions can be achieved following Andersen et al. (2005). Variables $Z_{2t}$ and $Z_{3t}$ respectively holding for the integrated volatility and jumps are then built.

Most empirical works show that interventions tend to increase the exchange rate volatility, at least on the short term. Authorities may then be reluctant to intervene for “volatility purposes” except if the increase in the market’s overall volatility is important. Therefore, two variables are introduced to respectively indicate whether the volatility increased or decreased with respect to the previous day volatility. They are denoted by $Z_{4t} = \epsilon |RV_{t,h} - RV_{t-1,h}|$ and $Z_{5t} = \epsilon' |RV_{t,h} - RV_{t-1,h}|$ where $\epsilon$ (resp. $\epsilon'$) is an indicator function taking the value 1 when $RV_{t,h} - RV_{t-1,h} > 0$ (resp. $< 0$) and 0 otherwise. To ease the interpretation of these variables, we considered them in absolute value.

If authorities react to an excessive volatility, $Z_{5t}$ should reduce the probability of observing an intervention while $Z_{1t}$, $Z_{2t}$, $Z_{3t}$ and $Z_{4t}$ should have a positive influence on the intervention activity.

**Economic conjuncture**

During the period of interest, the Japanese economy behaved in a very specific way. Indeed, Japan entered a period of deflation and into a liquidity trap since 1997.\footnote{Statistics on the Japanese consumer price index are available on the Japanese Ministry of International Affairs and Communications website (http://www.stat.go.jp/english/data/cpi/index.htm).} Therefore, when analyzing the exchange rate policy of the Japanese authorities, it is crucial to take account of the overall economic conjuncture. That is, variables related to the Japanese economy fundamentals should be incorporated into the authorities reaction function. The output appears as a good candidate. However, it is only available on a quarterly basis. As the model is estimated at the daily frequency, this could be an issue. Therefore, given the export orientation of the Japanese economy, the evolution of the real trade balance appears as a good alternative. It is available at the monthly frequency on the Bank of Japan’s website.\footnote{http://www.boj.or.jp/en/type/stat/dlong/etc/index.htm}

The variable considered is the absolute deviation of the real trade balance from its one-year moving average. It is denoted by $W_{1t} = |RB_t - \frac{1}{12} \sum_{i=1}^{12} RB_{t-i}|$ where $RB$ is the real trade balance. As variations
of the exchange rate potentially influences the real trade balance, to avoid simultaneity problems, we lagged the variable.

Similarly to the volatility, we considered two additional variables that respectively indicate whether or not there was an improvement of the real trade balance from its previous month level. The rationale underlying the use of such variables is that authorities may not react symmetrically to an improvement or a deterioration of the real trade balance. The variables are denoted by \( W_{2t} = \kappa |RB_t - RB_{t-1}| \) and \( W_{3t} = \kappa' |RB_t - RB_{t-1}| \) where \( \kappa \) (resp. \( \kappa' \)) is an indicator function taking the value 1 when \( RB_t - RB_{t-1} > 0 \) (resp. <0) and 0 otherwise.

We expect variable \( W_{2t} \) to have a negative impact on the occurrence of interventions. On the other hand, \( W_{1t} \) and \( W_{3t} \) should positively influence the use of interventions.

5 Results

Table 6 indicates the main econometric results. The estimated coefficients should be interpreted in terms of the last outcome of the dependent variable (i.e. confirmed interventions that corresponds to the strongest signal). Several models were considered. Specification (1) is the basic model. It does not include neither the volatility decomposition nor the evolution of the real trade balance. Specifications (2) and (3) respectively incorporate the volatility decomposition and the dynamic of the real trade balance. These two alternative measures are simultaneously incorporated in specification (4). For all specifications, the likelihood ratio, the log likelihood and the number of observations are reported. Thresholds estimates are indicated. They are all significant at the 1% level. The \( z_{j,j-1} \) statistics are also significant and support the hypothesis that adjacent thresholds are statistically different. This confirms the relevance of our classification of the different types of interventions based upon the strength of the signal they convey.

Before examining the main results of our econometric analysis it should be stressed that Japanese interventions show a high degree of variability across time. In particular, an apparent structural break occurred during the so-called Sakakibara period (mid 1995 - 2002) as described by Ito (2006). Additionally to these political aspects, it is noteworthy that Japan entered into a period of deflation in 1997. According to Fatum and Hutchinson (2004) Japan tried to stimulate prices by favoring the growth of the monetary base since 2001. Two dummies were then considered alternatively. The first one indicates the Sakakibara period and the change in the monetary policy is captured by the second one. These variables do not appear to be significant and our principal results remain stable when they are included. This suggests that our estimates are robust across the different sub-periods.\(^{23}\)

Results for the exchange rate level variables \( (X_t) \) indicate, for all specifications, that large fluctuations of the exchange rate cause authorities to send strong and explicit corrective signals (i.e. all the \( X_t \)

\(^{23}\)These estimates are not reported for the sake of clarity but are available upon request.
<table>
<thead>
<tr>
<th>Variable</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( X_{1t} ) (short term deviation)</td>
<td>0.16***</td>
<td>0.16***</td>
<td>0.16***</td>
<td>0.16***</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.05)</td>
<td>(0.05)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>( X_{2t} ) (mid term deviation)</td>
<td>0.16***</td>
<td>0.17***</td>
<td>0.16***</td>
<td>0.16***</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(0.02)</td>
<td>(0.02)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>( X_{3t} ) (long term deviation)</td>
<td>0.04***</td>
<td>0.05***</td>
<td>0.05***</td>
<td>0.05***</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>( X_{4t} ) (misalignment)</td>
<td>0.01***</td>
<td>0.01***</td>
<td>0.02***</td>
<td>0.02***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>( Z_{1t} ) (realized volatility)</td>
<td>-0.08</td>
<td>-</td>
<td>-0.07</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td></td>
<td>(0.07)</td>
<td></td>
</tr>
<tr>
<td>( Z_{2t} ) (continuous volatility)</td>
<td>-</td>
<td>-0.10</td>
<td>-</td>
<td>-0.9</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td></td>
<td>(0.08)</td>
<td></td>
</tr>
<tr>
<td>( Z_{3t} ) (jumps)</td>
<td>-</td>
<td>0.54**</td>
<td>-</td>
<td>0.54**</td>
</tr>
<tr>
<td></td>
<td>(0.25)</td>
<td></td>
<td>(0.25)</td>
<td></td>
</tr>
<tr>
<td>( Z_{4t} ) (positive volatility variation)</td>
<td>0.28**</td>
<td>0.23*</td>
<td>0.26**</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>(0.12)</td>
<td></td>
<td>(0.12)</td>
<td></td>
</tr>
<tr>
<td>( Z_{5t} ) (negative volatility variation)</td>
<td>0.02</td>
<td>0.02</td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td></td>
<td>(0.05)</td>
<td></td>
</tr>
<tr>
<td>( W_{1t} ) (real trade balance variation)</td>
<td>-0.007***</td>
<td>-0.007***</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td></td>
<td>(0.002)</td>
<td></td>
</tr>
<tr>
<td>( W_{2t} ) (positive real trade balance variation)</td>
<td>-</td>
<td>-</td>
<td>-0.002</td>
<td>-0.002</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td></td>
<td>(0.002)</td>
<td></td>
</tr>
<tr>
<td>( W_{3t} ) (negative real trade balance variation)</td>
<td>-</td>
<td>-</td>
<td>-0.01***</td>
<td>-0.01***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td></td>
<td>(0.003)</td>
<td></td>
</tr>
<tr>
<td>( \Theta_1 ) (threshold 1)</td>
<td>1.47***</td>
<td>1.48***</td>
<td>1.53***</td>
<td>1.54***</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td></td>
<td>(0.07)</td>
<td></td>
</tr>
<tr>
<td>( \Theta_2 ) (threshold 2)</td>
<td>2.31***</td>
<td>2.31***</td>
<td>2.36***</td>
<td>2.38***</td>
</tr>
<tr>
<td></td>
<td>(0.08)</td>
<td></td>
<td>(0.08)</td>
<td></td>
</tr>
<tr>
<td>( \Theta_3 ) (threshold 3)</td>
<td>3.01***</td>
<td>3.03***</td>
<td>3.08***</td>
<td>3.10***</td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
<td></td>
<td>(0.10)</td>
<td></td>
</tr>
<tr>
<td>( z_{2,1} ) (threshold 2 and 1)</td>
<td>24.77***</td>
<td>24.80***</td>
<td>24.65***</td>
<td>24.69***</td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
<td></td>
<td>(0.10)</td>
<td></td>
</tr>
<tr>
<td>( z_{3,2} ) (threshold 3 and 2)</td>
<td>12.74***</td>
<td>12.77***</td>
<td>12.66***</td>
<td>12.70***</td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
<td></td>
<td>(0.10)</td>
<td></td>
</tr>
<tr>
<td>LR (likelihood ratio)</td>
<td>312.07***</td>
<td>322.02***</td>
<td>339.22***</td>
<td>348.84***</td>
</tr>
<tr>
<td>LL (log likelihood)</td>
<td>-2158.17</td>
<td>-2153.19</td>
<td>-2144.15</td>
<td>-2139.55</td>
</tr>
<tr>
<td>Number of observations</td>
<td>3341</td>
<td>3341</td>
<td>3341</td>
<td>3341</td>
</tr>
</tbody>
</table>

**Note:** Specification (1) corresponds to the basic model. It does not include neither the volatility decomposition nor the evolution of the real trade balance. Specifications (2) and (3) respectively incorporate the volatility decomposition and the dynamics of the real trade balance. These two alternative measures are simultaneously incorporated in specification (4). The \( z - ratio \) statistics, \( z_{j,j-1} \), test whether threshold \( j \) is statistically different from threshold \( j - 1 \) (the null hypothesis is that \( \Theta_j = \Theta_{j-1} \) and the critical value is 1.96). Standard errors are reported between brackets. *, ** and *** respectively denote significance at the 10%, 5% and 1% level.
coefficients are positive and significant). This confirms the leaning-against-the-wind strategy usually adopted by the Japanese authorities and documented by Ito (2003), Ito and Yabu (2004) and Bernal (2006). However, to get a more accurate view of these results, it is necessary to have a look at the marginal effects of these variables on the intermediate outcomes (they reflect the change in the occurrence probability of the different types of interventions induced by a marginal change in the regressors).24

The marginal effect of the short term deviation ($X_{tt}$) shows a negative sign for the absence of explicit signal and a positive sign for oral, actual and confirmed interventions in all specifications.25 Interestingly, these marginal effects slightly decrease as the strength of the signal increases. Given the structure of our econometric model, this could be interpreted as the authorities adopting increasingly stronger and explicit corrective measures as the magnitude of the exchange rate deviation from its past values raises. In other words, authorities tend to use stronger measures as the market’s conditions deteriorate. This confirms the intuition that the different types of interventions may be substitutes or complements depending on the circumstances (Fratzscher, 2004, 2006; Beine et al., 2004 and Gnabo and Teiletche, 2006). For instance, in specification (1), the marginal effect of $X_{tt}$ on the occurrence of oral interventions is equal to 0.03 meaning that a one-percent increase of the short term deviation raises the probability of sending a weak explicit signal (an oral intervention) by 0.03%. This variation is slightly lower for stronger signals (0.01% for actual interventions) suggesting that authorities can rapidly shift from simple talks to actual interventions when the deviation is widening. This confirms the view of Fratzscher (2005) that both types of interventions tend to be domestically coordinated (i.e. they are used on the same periods). By contrast, Japanese authorities seem far more reluctant to do the following step since the marginal effect on confirmed interventions is only of 0.004%. In a sense, words and acts are used as complements only in extreme cases. Results are quite similar for medium term deviations ($X_{tt}$) while those on longer horizons (i.e. the long term deviation ($X_{lt}$) and the misalignment ($X_{dt}$) variables) highlight lower marginal effects.26 Note that the marginal effects of the different variables appear to be strongly robust across the different specifications.

A possible interpretation of the results on marginal effects is that the central bank wants to preserve its reputation by “putting its money where its mouth is” when the situation is worsening. In other words, the communication policy mainly plays the role of a “first line of defense”. But when the exchange rate crosses the so-called “line in the sand”, FX authorities rapidly back words with deeds. This scenario is actually well summed up by Mr. Kosuke Nakahira (a former Japanese Vice-Finance Minister for International Affairs): “If verbal [oral] intervention proves to be effective I don’t think it is necessary for them [the Japanese authorities] to get into the market [to intervene]. If it is inefficient, then they have

24 The marginal effects of specifications (1), (2), (3) and (4) are reported in the Appendix.
25 By construction, the marginal probability effects change their sign only once when moving from the smallest to the largest outcome in ordered probit models (Boes and Winkelmann, 2006).
26 The use of a dummy variable as an alternative to the misalignment variable do not show different results. Estimates are not reported for the sake of brevity but are available upon request.
to take stronger means” (Reuters, August 17, 2001). On the market side, numerous news reports also reveal that market participants need stronger signal to readjust their trading behavior when simple talks are ineffective: “Ministry of Finance currency guru Eisuke Sakakibara made his now-routine warning to the market that MoF was determined to avoid premature yen strength, but mere verbal [oral] intervention was having less and less effect unless backed with money” (Reuters, June 28, 1999). Alternatively, the close dependence between words and acts can be viewed as a strategy in which statements are used to test market conditions. If these conditions are favorable, a physical (financially risky) intervention is conducted, if not, the entry in the market is postponed. In any case, these findings are particularly interesting since they shed some light on the reasons why market participants usually expect new rounds of interventions (i.e., so-called unrequited interventions described by Dominguez and Panthaki, 2005 that are found to have a significant empirical relation with official statements by Gnabo et al., 2006) when officials express their discomfort with the exchange rate. Indeed, several news reports confirm that market participants usually expect more interventions after statements such as “Japanese Vice-Finance Minister for International Affairs Haruhiko Kuroda said earlier that the recent rise in the yen was not appropriate given economic fundamentals, keeping markets wary about possible intervention to cap yen strength” (Reuters, August 27, 2001) or “For the time being, few expect actual market intervention by the Bank of Japan. First they expect Japanese officials to start verbal [oral] intervention in an effort to talk the dollar back down” (Dow Jones, August 6, 1997).

Estimations on the different volatility measures ($Z_t$) are mitigated. From specifications (1) and (3), the realized volatility ($Z_{1t}$) is not significant. This is in line with the bulk of empirical works, but contrasts with usual declarations from officials who claim to be concerned by volatility issues. To control whether or not this is due to the way volatility is usually measured, we consider the volatility decomposition into its continuous and jump components. Results are reported in specification (2) and (4). The continuous volatility ($Z_{2t}$) is still not significant. By contrast, the jumps components ($Z_{3t}$) has a significant impact at 5%. Interestingly, this justifies our decomposition since working at an aggregate level obviously hides some information. From an economic point of view, this means that authorities pay attention to rapid shifts or jumps in the volatility rather than to its overall level. This remark is reinforced by results on variables indicating whether the volatility increased or decreased with respect to the previous day volatility level ($Z_{4t}$ and $Z_{5t}$). As partially expected, $Z_{5t}$ is not significant. So FX authorities do not react to a decreasing volatility. They do however intervene when volatility increases ($Z_{4t}$ has a positive and significant coefficient). On the whole, these results imply that authorities are more prompt to intervene when there are large and rapid fluctuations of the exchange rate rather than when the overall volatility is high.

Again the examination of the marginal effects confirms that the central bank intervenes with increasing strength as the volatility raises. This result is particularly interesting as it is consistent with official
declarations. Furthermore, marginal effects are on average larger than for the exchange rate level variables. Indeed, we see that a one percent increase in the short term deviation of the volatility ($Z_{4t}$) raises the probability of having a visible signal of about 0.025%. The short term evolution of the exchange rate level ($X_{1t}$) only raises that probability of about 0.014%.\textsuperscript{27} This confirms that volatility is important in the regulation policy.

Finally, results on the economic conjuncture variables ($W_t$) indicate, on the whole, that authorities are reluctant to send a signal when the real trade balance moves away from the long term equilibrium ($W_{1t}$ has a significant negative coefficient in specifications (1) and (2)) or from the previous month level ($W_{3t}$ has a significant negative coefficient in (3) and (4)). The examination of the average marginal effects of variables $W_{1t}$ and $W_{3t}$ do not show, however, very strong effects on the occurrence of interventions ($-0.0005\%$ and $-0.001\%$ respectively). Nevertheless, these results may be interpreted as the authorities not reacting openly when the real trade balance deteriorates. This may indicate their reluctance to defend a devaluation policy aimed at supporting their international position with respect to their foreign counterparts. Interestingly, US officials regularly expressed their disagreement with any manipulation of the currency, especially if it was aimed at boosting the economy. For instance, the Secretary of the Treasury Lawrence Summers warned that “Japan’s manipulation of its currency would not help restore prosperity”, and that “the focus in Japan has to be on strengthening the fundamentals”. (Dow Jones, July 8, 1999). More generally, this type of policy would not be consistent with the “Principles of guidance” of members’ exchange rate policies adopted by the IMF according to which “A member shall avoid manipulating exchange rates or the international monetary system in order to prevent effective balance of payments adjustment or to gain an unfair competitive advantage over other members”.\textsuperscript{28} This is fully consistent with Japan massively intervening secretly between 2003 and 2004 to depreciate the yen while it was already undervalued from the level consistent with a global equilibrium (see Bénassy-Quéré et al., 2004; Beine and Lecourt, 2004; Beine and Bernal, 2006 and Bernal, 2006).

6 Conclusion

In this paper we propose a new approach to central bank’s reaction functions. It does not only consider official transactions on FX markets but also incorporates their general communication policy. This allows us to consider different types of interventions according to whether they involve currency transactions (i.e. actual and confirmed interventions) or not (i.e. oral interventions). There is a clear shift observed in several important countries (i.e. the United States, the Euro Zone and more recently Japan) toward less actual interventions. Determining which are the circumstances making authorities to use one type of intervention or the other is then important. Furthermore, understanding to what extent oral interventions

\textsuperscript{27} For a given variable, the average marginal effects are computed using the marginal effect on the oral, actual and confirmed interventions outcomes exclusively.

\textsuperscript{28} http://www.imf.org/external/np/pdr/surv/2004/082404.htm
may be used instead of or with actual ones is important for policy purposes.

The fact that, at a given moment, authorities decide to endorse a higher burden cost than in other circumstances may be seen as a good indicator of their degree of determination. Then, we assume that the strength of the signal conveyed by their visible interventions can be assessed by this criterion. Secret interventions cannot be distinguished from private trades. They are then considered as carrying a non explicit signal. According to this, it is possible to elaborate an econometric ordered probit model whose dependent variable is a categorical one for the different types of interventions. They are classified with respect to the strength of the signal they convey. The model is estimated over usual determinants to interventions (i.e. exchange rate level and volatility variables and control variables for the economic conjuncture) using Japanese data for the 1991-2004 period.

The main econometric results indicate that authorities tend to adopt a leaning-against-the-wind strategy. They fight against large deviations of the exchange rate from its past values and the fundamental equilibrium. Estimates related to the volatility variables traduce that only large fluctuations of the exchange rate and especially jumps tend to prompt authorities to intervene and not the overall level of the volatility. They appear then to be aware that interventions generally trigger volatility. Results on the real trade balance variables show that authorities do not react openly to fluctuations of the real trade balance. Furthermore, if it deteriorates, they tend to avoid intervening or to use secret interventions. This may indicate that authorities do not want to show their intention of defending their international position by influencing exchange rates to their foreign counterparts.

Finally, the examination of the marginal effects on the different outcomes strongly suggests that the strength of the measures decided by the Japanese authorities increases with the gravity of the circumstances. That is, if the exchange rate level moves in an inappropriate direction or if the volatility increases and these fluctuations are moderate, they will first use oral interventions. Actual or confirmed interventions would only be used if the fluctuations magnitude increases. In other terms, words and acts seem to be used in a complementary way only in extreme cases.

References


23


Ito, T., 2006, Myths and reality of foreign exchange interventions: an application to Japan, *mimeo.*


**Appendix**

**Marginal effects**

Marginal effects reflect the change in the occurrence probability of the different types of interventions (no explicit signal, oral, actual and confirmed interventions) induced by a marginal change in the regressors. Importantly, marginal effects sum to 0. They are computed at the mean of the different explanatory variables. For technical details, see Wooldridge (2002).

<table>
<thead>
<tr>
<th>Intervention</th>
<th>No/Secret</th>
<th>Oral</th>
<th>Actual</th>
<th>Confirmed</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_{1t}$ (short term deviation)</td>
<td>-0.04</td>
<td>0.03</td>
<td>0.01</td>
<td>0.004</td>
</tr>
<tr>
<td>$X_{2t}$ (mid term deviation)</td>
<td>-0.04</td>
<td>0.03</td>
<td>0.01</td>
<td>0.004</td>
</tr>
<tr>
<td>$X_{3t}$ (long term deviation)</td>
<td>-0.01</td>
<td>0.009</td>
<td>0.003</td>
<td>0.001</td>
</tr>
<tr>
<td>$X_{4t}$ (misalignment)</td>
<td>-0.004</td>
<td>0.002</td>
<td>0.001</td>
<td>0.0003</td>
</tr>
<tr>
<td>$Z_{it}$ (realized volatility)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$Z_{4t}$ (positive volatility variation)</td>
<td>-0.08</td>
<td>0.05</td>
<td>0.02</td>
<td>0.007</td>
</tr>
<tr>
<td>$Z_{5t}$ (negative volatility variation)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$W_{1t}$ (real balance variation)</td>
<td>0.002</td>
<td>-0.0014</td>
<td>-0.0006</td>
<td>-0.0002</td>
</tr>
</tbody>
</table>
Table 8: Marginal effects for specification (2)

<table>
<thead>
<tr>
<th>Intervention</th>
<th>No/Secret</th>
<th>Oral</th>
<th>Actual</th>
<th>Confirmed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>X_{1t}</strong> (short term deviation)</td>
<td>-0.04</td>
<td>0.03</td>
<td>0.01</td>
<td>0.004</td>
</tr>
<tr>
<td><strong>X_{2t}</strong> (mid term deviation)</td>
<td>-0.05</td>
<td>0.03</td>
<td>0.01</td>
<td>0.004</td>
</tr>
<tr>
<td><strong>X_{3t}</strong> (long term deviation)</td>
<td>-0.01</td>
<td>0.009</td>
<td>0.003</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>X_{4t}</strong> (misalignment)</td>
<td>-0.004</td>
<td>0.002</td>
<td>0.001</td>
<td>0.0003</td>
</tr>
<tr>
<td><strong>Z_{2t}</strong> (continuous volatility)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Z_{3t}</strong> (jumps)</td>
<td>-0.16</td>
<td>0.10</td>
<td>0.04</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Z_{4t}</strong> (positive volatility variation)</td>
<td>-0.06</td>
<td>0.04</td>
<td>0.01</td>
<td>0.004</td>
</tr>
<tr>
<td><strong>Z_{5t}</strong> (negative volatility variation)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>W_{1t}</strong> (real balance variation)</td>
<td>0.002</td>
<td>-0.001</td>
<td>-0.0006</td>
<td>-0.0002</td>
</tr>
</tbody>
</table>

Table 9: Marginal effects for specification (3)

<table>
<thead>
<tr>
<th>Intervention</th>
<th>No/Secret</th>
<th>Oral</th>
<th>Actual</th>
<th>Confirmed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>X_{1t}</strong> (short term deviation)</td>
<td>-0.04</td>
<td>0.03</td>
<td>0.01</td>
<td>0.004</td>
</tr>
<tr>
<td><strong>X_{2t}</strong> (mid term deviation)</td>
<td>-0.04</td>
<td>0.03</td>
<td>0.01</td>
<td>0.003</td>
</tr>
<tr>
<td><strong>X_{3t}</strong> (long term deviation)</td>
<td>-0.01</td>
<td>0.009</td>
<td>0.004</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>X_{4t}</strong> (misalignment)</td>
<td>-0.007</td>
<td>0.004</td>
<td>0.002</td>
<td>0.0006</td>
</tr>
<tr>
<td><strong>Z_{1t}</strong> (realized volatility)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Z_{4t}</strong> (positive volatility variation)</td>
<td>-0.05</td>
<td>0.03</td>
<td>0.01</td>
<td>0.004</td>
</tr>
<tr>
<td><strong>Z_{5t}</strong> (negative volatility variation)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>W_{2t}</strong> (positive real balance variation)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>W_{3t}</strong> (negative real balance variation)</td>
<td>0.004</td>
<td>-0.003</td>
<td>-0.001</td>
<td>-0.0004</td>
</tr>
</tbody>
</table>

Table 10: Marginal effects for specification (4)

<table>
<thead>
<tr>
<th>Intervention</th>
<th>No/Secret</th>
<th>Oral</th>
<th>Actual</th>
<th>Confirmed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>X_{1t}</strong> (short term deviation)</td>
<td>-0.04</td>
<td>0.03</td>
<td>0.01</td>
<td>0.004</td>
</tr>
<tr>
<td><strong>X_{2t}</strong> (mid term deviation)</td>
<td>-0.04</td>
<td>0.03</td>
<td>0.01</td>
<td>0.003</td>
</tr>
<tr>
<td><strong>X_{3t}</strong> (long term deviation)</td>
<td>-0.01</td>
<td>0.009</td>
<td>0.004</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>X_{4t}</strong> (misalignment)</td>
<td>-0.004</td>
<td>0.003</td>
<td>0.001</td>
<td>0.0004</td>
</tr>
<tr>
<td><strong>Z_{2t}</strong> (continuous volatility)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Z_{3t}</strong> (jumps)</td>
<td>-0.15</td>
<td>0.10</td>
<td>0.04</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Z_{4t}</strong> (positive volatility variation)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Z_{5t}</strong> (negative volatility variation)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>W_{2t}</strong> (positive real balance variation)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>W_{3t}</strong> (negative real balance variation)</td>
<td>0.005</td>
<td>-0.003</td>
<td>-0.001</td>
<td>-0.0004</td>
</tr>
</tbody>
</table>
DULBEA Working Paper Series

2007

N° 07-03.RS Oscar Bernal and Jean-Yves Gnabo « Talks, financial operations or both? Generalizing central banks’ FX reaction functions », February 2007.


2006


N° 06-05.RS Pierre-Guillaume Méon « Majority voting with stochastic preferences: The whims of a committee are smaller than the whims of its members », April 2006.


2005


N° 05-10.RS Michele Cincera « The link between firms’ R&D by type of activity and source of funding and the decision to patent », April 2005.


Apart from its working papers series, DULBEA also publishes the *Brussels Economic Review-Cahiers Economiques de Bruxelles*.

**Aims and scope**

First published in 1958, *Brussels Economic Review-Cahiers Economiques de Bruxelles* is one of the oldest economic reviews in Belgium. Since the beginning, it publishes quarterly the Brussels statistical series. The aim of the Brussels Economic Review is to publish unsolicited manuscripts in all areas of applied economics. Contributions that place emphasis on the policy relevance of their substantive results, propose new data sources and research methods, or evaluate existing economic theory are particularly encouraged. Theoretical contributions are also welcomed but attention should be drawn on their implications for policy recommendations and/or empirical investigation. Regularly the review publishes special issues edited by guest editors.

Authors wishing to submit a paper to be considered for publication in the *Brussels Economic Review* should send an e-mail to Michele Cincera: mcincera@ulb.ac.be, with their manuscript as an attachment. An anonymous refereeing process is guaranteed.

Additional instructions for authors and subscription information may be found on the *Brussels Economic Review*’s website at the following address:

http://homepages.vub.ac.be/~mcincera/BER/BER.html