Secrecy versus Selective Disclosure in Sterilized Foreign Exchange Interventions

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Abstract

We study sterilized interventions and exchange rate targeting in a market microstructure framework. In a setting where a public disclosure of the central bank's target is not desirable for effective intervention (Vitale (1999)), we show that selectively disclosing the target to another informed market participant, such as another central bank or a large currency trader, may result in better targeting relative to a regime of complete secrecy. In particular, if the market's uncertainty over the bank's target is sufficiently high and if the central bank is leaning against the wind - attempting to move the exchange rate in the opposite direction of where the fundamental based trade takes it - selective disclosure is the preferred intervention regime.

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1 Introduction

Recent interest in the so-called 'secrecy puzzle' surrounding official interventions in foreign exchange markets has spurred a debate over the appropriate degree of transparency for foreign exchange intervention policy. The puzzle itself stems from the fact that operationally, most sterilized interventions are conducted in secret. Central bank interventions are reported, if at all, with a considerable time lag, and they may involve several exchange brokers or commercial banks in order to conceal the true size and intention of the intervention (Lyons (2001), Neely (2001)). As Sarno and Taylor (2001) argue, this secrecy is difficult to explain, given that the most common channel through which sterilized interventions are thought to work - the signalling channel - is ultimately more effective if the policy is publicly announced beforehand and the intervention is widely observed. Dominguez and Frankel (1993), while analyzing the effectiveness of sterilized interventions, conclude: 'Our results suggest that intervention can be effective, especially if it is publicly announced and concerted'.[1]

The literature has been able to provide some answers to the secrecy puzzle: Bhattacharya and Weller (1997) and Vitale (1999) develop market microstructure models of sterilized interventions that exploit signalling channels. Both follow the widely held view that sterilized interventions have no impact on an exchange rate's underlying fundamental value and intervention is assumed to leave intact this fundamental. However, intervention can affect the interim exchange rate by changing the market's expectations of that fundamental. Vitale assumes the central bank knows the fundamental perfectly, and this information, along with its target exchange rate determine the size of the bank's trade. In a market microstructure model a la Kyle (1985), the trades are obscured, since they are 'batched' along with orders originating from other traders. Conditioning on the total order flow, the market maker tries to extract information on the exchange rate fun-

[1] For a summary of sterilized interventions in traditional macroeconomic models, see Obstfeld and Rogoff (1996), Sarno and Taylor (2001), or Lyons (2001).

damental.[2] By concealing its target, the central bank can more effectively 'fool' the market. The main conclusion of Vitale (1999) is even starker and leaves no room for full transparency: Whenever the central bank publicly discloses its target, a sterilized intervention is *completely ineffective* and the central bank cannot target the exchange rate.

This paper extends the Vitale model in a simple but important way and examines the following questions: In a setting where public disclosure of the target always renders intervention as ineffective, can a central bank achieve a more effective intervention by *selectively disclosing* its target to some (but not all) market participants? If so, how (and when) does this disclosure policy work? We choose to work with Vitale's framework in addressing this issue, particularly because of its stark conclusion in favor of the secrecy side of the debate. Our modification is perhaps the simplest one to study this issue - we introduce another informed trader to Vitale's framework. We interpret this second informed trader as another central bank that trades for speculative or wealth preservation reasons only.[3] Without straying too far from Vitale - as far as modelling is concerned - we exploit a novel feature of the Kyle-type market microstructure framework particularly relevant to study the effectiveness of intervention: Too much uncertainty on the central bank's target may also render intervention as ineffective. This follows, since in this case the price impact of any given order flow is low. We show that precisely when the market has too much uncertainty concerning the central bank's target, the bank may improve the price impact and hence the effec-

[2] Similar information and trading constraints are observed in actual forex markets. Usually, the central bank transacts through dealers or commercial banks. The batch framework put by Kyle captures this lack of transparency in the order flows, in the sense that the market maker cannot distinguish the identity of his clients.

[3] There is a debate over whether central banks earn profits from forex interventions and even if profitability is a consideration in these transactions (Edison (1993), Sweeney (1997)). Bank Negara, the central bank of Malaysia, routinely speculated in forex markets during in the 1990's (Pasquerillo (2001)). Neely (2001) notes that even though the monetary authorities in his survey did not report that they intervene solely for profits, profitability is a way to measure the effectiveness of the invention. Arguably, central banks, as public or quasi-public intitutions, may be reluctant to admit they transact in these markets purely for speculation.

tiveness of its intervention by selectively disclosing its target to the other informed trader (in our case, the other central bank).

We are drawn to the possibility that selective disclosure may improve the central bank's targeting on two accounts. The first one is an observation by Lyons (2001) which makes a novel distinction between speculative and target oriented trades regarding the price impact:[4]

> 'An important difference between private trades and central bank trades is that private traders typically want to minimize the price impact, whereas central banks want to maximize the price impact (page 236).'

The second building block of our analysis is a central feature of the Kyle (1985) microstructure model mentioned above. From the perspective of the market maker, the uncertainty on the target of the central bank is similar to the noise in the total order flow stemming from liquidity traders. Both the liquidity trade and the target based trade are fundamentally irrelevant, since they do not convey any information on the fundamental.[5] When this fundamentally irrelevant noise in the total order flow is high, the market maker's pricing response (hence the price impact) to the order flow is low. This implies that a central bank's ability to target the exchange rate may also be very poor, if there is a high level of uncertainty regarding the target. Our analysis identifies an important property of the equilibrium with selective disclosure compared to the equilibrium with complete secrecy: The price

[4] Recent empirical studies of the price impact of intervention trades in microstructure models include Peiers (1997), Evans and Lyons (2000), Payne and Vitale (2001), and Dominguez (2003). For a theoretical assesment and empirical evidence of the effects of government interventions on foreign exchange bid-ask spreads, see Naranjo and Nimalendran (2000).

[5] Vitale's main result stems from the fact that if the dealer knows the target, she can completely filter out all target-based trades from the order flow. In contrast to Vitale (1999), in Bhattacharya and Weller (1997), some foreign exchange investors (speculators), but not the central bank, have better information on the exchange rate fundamental. They conclude there are circumstances in which it is in the interest of the central bank to reveal its target, though it is never advantageous to reveal the size of its intervention. To do so leaves the bank unable to target the exchange rate, along lines similar to why revealing the target in Vitale make targeting ineffective.

impact (or the market maker's response) of a given order flow is always higher in the selective disclosure regime.

So when will it be in the interest of a central bank to selectively disclose its target? The answer to this question rests on whether or not the central bank's targeting agenda is consistent with the direction that the fundamental based trading is moving the exchange rate, i.e., whether the central bank is *leaning with* or *against the wind.* When the bank is leaning against the wind- attempting to move the exchange rate counter to the direction of the fundamental based trade- selective disclosure achieves better targeting if there is enough uncertainty on the central bank's target. This follows, since as well as improving the price impact, selective disclosure also mollifies some of the fundamental based trade driving the exchange rate in the opposite direction from the target. On the other hand, when the bank wants to push further the exchange rate in the same direction as the fundamental based trade is taking it - lean with the wind - the bank is never better off from selectively disclosing the target and complete secrecy is better. This follows, since doing so simply reduces the trades which would move the exchange rate in the same direction the bank wishes to take it.

Our results can also account for communication between central banks (or even between the intervening central bank and dealers in the market) during episodes of intervention.[6] It is important to emphasize that in our framework, such information sharing does not involve any cooperative play between banks, nor does it result in a concerted official intervention in the market. In that sense, ours is a view that has been overlooked in the literature, i.e., communication is not necessarily synonymous with cooperation. While it is difficult to know for sure if central banks actually engage in communicative activities along the lines we describe here (since these discussions, by assumption, are not disclosed publicly), in practice, concerted actions of central banks seem to be limited to information sharing (see Sarno

[6]For a model where the central bank acquires information about transitory exchange rate disturbances and uses intervention to share that aggregated information with dealers, see Popper and Montogomery (2001).

and Taylor (2001)).

The paper proceeds as follows. Section 2 presents the model. Section 3 solves for the trading equilibria under complete secrecy and selective disclosure and compares the two regimes in terms of the price impact and the trading intensities. Section 4 provides a detailed comparison of targeting under the two regimes and contains our main result. Section 5 concludes.

2 The Model

We follow Vitale (1999) and adopt a Kyle-type microstructure framework in the foreign exchange market. The basic ingredients of the model are as follows:

Market Participants

(i) Market Maker: There is a risk neutral dealer (the 'market maker') who trades the foreign currency with two central banks and a group of liquidity traders. Prior to trades, the fundamental value of the exchange rate, f, is known only to the two central banks. For the market maker, f is a normal random variable with mean s_0 and variance Σ. At the time of the trading, the market maker calls an auction for the currency and observes a total order flow X. Competition between market makers and the risk neutrality assumption imply that the equilibrium exchange rate s_1 set by the market maker is given by the following zero profit condition:

$$s_1 = E\left[f|X\right]. \tag{1}$$

(ii) Central Banks: Unlike Vitale (1999), we assume that there are two (not one) central banks in the market. Both central banks know the exchange rate fundamental value f perfectly. To simplify our exposition, we assume only one central bank has an exchange rate targeting agenda. Call this bank, Central Bank A or simply A. It submits a market order x_A to minimize the expected value of the loss function:

$$c \equiv (s_1 - f)x_A + q(s_1 - \bar{s})^2 \tag{2}$$

with s_1 set according to the market maker's pricing rule in (1) above. As in Vitale (1999) and Pasquerillo (2002), the first part of the loss function, $(s_1 - f)x_A$, reflects A's monetary losses, whereas the second part, $q(s_1 - \bar{s})^2$ describes its targeting agenda: $\bar{s}$ is the bank's exchange rate target and $q \geq 0$ describes the central bank's commitment to that target. Furthermore, interventions by A are sterilized completely and do not alter the underlying exchange rate fundamentals.[7]

Central Bank B does not have a targeting agenda and submits a market order x_B to maximize its expected profits, $\pi \equiv (f - s_1)x_B$.

(iii) Liquidity Traders: The market order of the liquidity traders, ε, is a normal random variable with mean zero and variance σ_ε^2 and it is independent from the fundamental value f.

Accordingly, the total order flow X that the market maker receives is

$$X = x_A + x_B + \varepsilon$$

Information Structure

Depending on the Central Bank A's disclosure policy, the other market participants may or may not know the target $\bar{s}$, but its commitment to the target, q, is common knowledge. Without disclosure, the prior distribution of $\bar{s}$ is normal with mean $\hat{s}$ and variance σ_s^2 and it is independent from the fundamental value f. Within this setting, there are three interesting possibilities as regard to who knows the target $\bar{s}$ at the time of the trading.

Complete Secrecy: The target $\bar{s}$ is secret and it is the private information of A.

Public Disclosure: The target is publicly disclosed by A and thus it is common knowledge to all market participants.

Selective Disclosure: A discloses its target to the other participant in

[7] We abstract away from the important issue of timing of intervention, since we rather focus on the secrecy of the bank's target. In other words, the market maker knows that central bank is intervening with some targeting agenda. For a rigorous treatment of the case where the central bank strategically chooses the timing of intervention in a dynamic framework, see Cadenillas and Zapatero (1999).

the market that knows the underlying market fundamental f - in this case, Central Bank B.

Vitale (1999) compares the effectiveness of intervention between public disclosure and complete secrecy and provides the following result.

Proposition 1 *(Vitale (1999)) When the central bank's target* $\bar{s}$ *is publicly disclosed, intervention has no effect and the central bank cannot target the exchange rate. In contrast, when the target is completely secret, the central bank can target the exchange rate.*

The above result establishes that for intervention to have any effect at all, the market maker must have some uncertainty on the central bank's target.[8] Vitale analyzes a trading game between the central bank and the market maker only. Therefore, disclosure can only be public. In this paper, we allow for another informed trader (Central Bank B) and ask the following question: Can Central Bank A achieve better targeting by selectively (as opposed to publicly) disclosing its target to other market participants (other than the market maker), instead of following a completely secret intervention policy? In that sense, our paper provides a comparison between the Selective Disclosure and Complete Secrecy regimes and provides further insights on the secrecy puzzle.

[8] To see the intuition behind Vitale's result, consider the equilibrium strategy of A,

$$x_A = \alpha(f - s_0) + \delta(\bar{s} - s_0),$$

where the trading intensity coefficients α and δ are determined in equilibrium. The first part is the *fundamental based* part of *A's* order. The second part is *target based.* The market maker tries to filter out the target based part, since that part does not contain any information related to the fundamental f. Since orders are batched, the filtering is incomplete if she does not know the target $\bar{s}$. This allows some of the target based flow to actually affect the exchange rate s_1. If, on the other hand, the market maker knows the target, she filters out the entire target-based flow. In this case, the equilibrium exchange rate characterized by (1) is independent from $\bar{s}$.

3 Trading Equilibria under Two Regimes

In this section, we solve for the trading equilibria under two alternative disclosure regimes: No disclosure of the target and selective disclosure of the target to Central Bank B. We present this in the following Proposition.

Proposition 2 *(i) (Complete Secrecy) If the target $\bar{s}$ is completely secret, the unique linear Nash equilibrium of the trading game is such that*

$$x_A = \beta_A(f - s_0) + \theta_A(\bar{s} - \hat{s}) + \gamma_A(\hat{s} - s_0) \tag{3}$$

$$x_B = \beta_B(f - s_0) \tag{4}$$

$$s_1 = s_0 + \lambda^s \left[(\beta_A + \beta_B)(f - s_0) + \theta_A(\bar{s} - \hat{s}) + \varepsilon\right] \tag{5}$$

with the trading intensity coefficients $\beta_A, \beta_B, \theta_A$ and γ_A reported in Table 1 and the liquidity coefficient λ^s is the unique positive root for λ of the following equation

$$2\Sigma(1 + 2\lambda q) = \frac{\lambda^2(3 + 2\lambda q)^2[q^2\sigma_s^2 + (1 + \lambda q)^2\sigma_\varepsilon^2]}{(1 + \lambda q)^2}. \tag{6}$$

(ii) (Selective Disclosure) If the Central Bank A discloses $\bar{s}$ only to B, then the unique linear Nash equilibrium of the trading game is such that

$$x_A = \hat{\beta}_A(f - s_0) + \hat{\theta}_A(\bar{s} - \hat{s}) + \hat{\gamma}_A(\hat{s} - s_0) \tag{7}$$

$$x_B = \hat{\beta}_B(f - s_0) + \hat{\theta}_B(\bar{s} - \hat{s}) \tag{8}$$

$$s_1 = s_0 + \lambda^d \left[(\hat{\beta}_A + \hat{\beta}_B)(f - s_0) + (\hat{\theta}_A + \hat{\theta}_B)(\bar{s} - \hat{s}) + \varepsilon\right] \tag{9}$$

with the trading intensity coefficients $\hat{\beta}_A, \hat{\beta}_B, \hat{\theta}_A$, $\hat{\theta}_B$ and $\hat{\gamma}_A$ reported in Table 1 and the liquidity coefficient λ^d is the unique positive root for λ of the following equation:

$$2\Sigma(1 + 2\lambda q) = 4\lambda^2 q^2\sigma_s^2 + \lambda^2(3 + 2\lambda q)^2\sigma_\varepsilon^2. \tag{10}$$

Proof: See the Appendix.

Table 1: Equilibrium Coefficients

Complete Secrecy	Selective Disclosure
$\beta_A = \dfrac{1-2\lambda^s q}{\lambda^s(3+2\lambda^s q)}$	$\hat{\beta}_A = \dfrac{1-2\lambda^d q}{\lambda^d(3+2\lambda^d q)}$
$\beta_B = \dfrac{1+2\lambda^s q}{\lambda^s(3+2\lambda^s q)}$	$\hat{\beta}_B = \dfrac{1+2\lambda^d q}{\lambda^d(3+2\lambda^d q)}$
$\theta_A = \dfrac{q}{1+\lambda^s q}$	$\hat{\theta}_A = \dfrac{4q}{3+2\lambda^d q}$, $\hat{\theta}_B = \dfrac{-2q}{3+2\lambda^d q}$
$\gamma_A = 2q$	$\hat{\gamma}_A = 2q$

Note that, unlike the case of public disclosure analyzed by Vitale (1999), with selective disclosure, the equilibrium exchange rate depends on the target, and the central bank can still target the exchange rate (see (9)). This is not surprising: As long as the market maker has some uncertainty on $\bar{s}$, she cannot completely filter out the target oriented flow and the equilibrium s_1 she sets depends on the target.

In what follows, we compare the two equilibria on the following accounts: First, how does Central Bank B respond to A's target in the case of selective disclosure? Second, how does the total target oriented flow differ in the two regimes? Third, and perhaps most importantly, how does the price impact of the order flow, measured by the liquidity coefficient λ in the market maker's pricing rule, differ in the two regimes?

Central Bank B's Response: Note that in the equilibrium with selective disclosure, *B's* response to *A's* target level is given by $\hat{\theta}_B < 0$. The negative sign of this trading intensity implies that B always reacts in an offsetting fashion to *A's* target oriented flow. The intuition behind this result can best be described by a case example. Suppose *A's* actual target is above the target mean, so $\bar{s} > \hat{s}$, and, without loss of generality, assume $f > s_0$, so *B's* profit oriented flow is positive. When B does not observe the target, it of course expects A to target at the mean, $\hat{s}$, and incorporates this into its expectation of the price s_1. When B knows the target, it knows - all else the same - that A is trying to push the price higher (since $\bar{s} > \hat{s}$ and since

A's trading intensity θ_A is positive). This lowers expected profit per-unit. In response, B reduces its order flow, i.e. $\hat{\theta}_B < 0$. This feature will play an important role in our comparison of targeting under the two regimes.

Total Target Oriented Flow: In order to compare the total target oriented flow across two regimes, fix a liquidity coefficient λ. For a *given* λ, *A's* target based order intensity $\hat{\theta}_A$ is higher than its intensity in the complete secrecy case (given by θ_A). This means that A's target oriented order is more aggressive when B knows the target. However, the offsetting reaction of B makes the total target oriented flow, given by $(\hat{\theta}_A + \hat{\theta}_B)(\bar{s} - \hat{s})$, lower in the selective disclosure regime. To see this, note that, given a pricing response λ of the market maker, we have

$$\hat{\theta}_A + \hat{\theta}_B = \frac{2q}{3 + 2\lambda q} < \theta_A = \frac{q}{1 + \lambda q}. \tag{11}$$

The implication of this trading behavior on the market maker's response to the total order flow (given by the liquidity coefficient λ) is instrumental for our comparison of the two equilibria in terms of targeting.

Proposition 3 *For any parameter configuration, the equilibrium liquidity coefficient λ^s in case of complete secrecy is lower than the equilibrium liquidity coefficient λ^d of the case with selective disclosure.*

Proof: See the Appendix.

Finally, we identify how σ_s^2, the market maker's uncertainty over the central bank's target, affects the equilibrium liquidity coefficient in the two regimes. The following result is immediate from equations (6) and (10) that characterize the equilibrium liquidity coefficient λ in each case.

Proposition 4 *Regardless of the disclosure regime, the liquidity coefficient λ is decreasing in σ_s^2.*

Proof: See the Appendix.

The above implication of higher uncertainty on the central bank's target is consistent with the general intuition of Kyle's batch framework. For the market maker, σ_s^2 is another source of noise, like the liquidity trade noise σ_ε^2, and its effect on the market maker's signal extraction problem is similar: A higher level of uncertainty on the target makes the total order flow a more noisy indicator of the fundamental f. Therefore, as σ_s^2 increases, the market maker updates her prior on the fundamental less. To see this, note that

$$E(s_1|\bar{s}) = s_0 + \frac{2}{3+2\lambda^s q}(f - s_0) + \frac{\lambda^s q}{1+\lambda^s q}(\bar{s} - \hat{s}) \tag{12}$$

for the complete secrecy case and

$$E(s_1|\bar{s}) = s_0 + \frac{2}{3+2\lambda^d q}(f - s_0) + \frac{2\lambda^d q}{3+2\lambda^d q}(\bar{s} - \hat{s}) \tag{13}$$

for the selective disclosure case. In both cases, as σ_s^2 increases and as a result, the liquidity coefficient becomes smaller, the expected equilibrium exchange rate becomes less and less dependent on the central bank's target $\bar{s}$. In the limit, as σ_s^2 approaches infinity, the liquidity coefficient approaches to zero and $E(s_1|\bar{s})$ becomes completely independent from the target.

The above observations establish that, while making the target common knowledge renders intervention completely ineffective (Vitale (1999)), too much uncertainty on the target may also have a deleterious effect on targeting. When σ_s^2 is high, the market maker's response to a given order flow is low and moreover *it is even lower in case of complete secrecy* and it takes Central Bank A a very large order to have any measured impact on the exchange rate. To achieve better targeting, A may prefer to improve the market maker's response to the total order flow (causing her to set a higher λ) by decreasing the noise she attributes to target oriented flow, as in the case with selective disclosure. This will be more likely to be a concern for the central bank, the higher is σ_s^2.

4 Targeting: Secrecy versus Selective Disclosure

We turn now to the central focus of the paper. We are interested specifically how the efficacy of a central bank's targeting compares across regimes. To this end, note that A's loss function (2) is a quadratic in the difference of the exchange rate and the target, $s_1 - \bar{s}$, so as in Vitale, it is enough to compare the expected conditional deviation of the exchange rate from the target, $E[(s_1 - \bar{s})^2|\bar{s}]$, across regimes. Given the linear pricing rule of the market maker and using the properties of a non-central chi-square distribution, the expected conditional deviation of the exchange rate from the target can be written as (see the Appendix);

$$E[(s_1 - \bar{s})^2|\bar{s}] = [E(s_1|\bar{s}) - \bar{s}]^2 + Var(s_1|\bar{s}). \tag{14}$$

The first term, $[E(s_1|\bar{s}) - \bar{s}]^2$, measures the dispersion of the expected exchange rate from the target, while the second term, $Var(s_1|\bar{s})$, measures the conditional volatility of the exchange rate given the target. Furthermore, the volatility term is simply $Var(s_1|\bar{s}) = \lambda^2\sigma_\varepsilon^2$. It follows that conditional volatility of the exchange rate is always higher in the selective disclosure case, since $\lambda^s < \lambda^d$ by Proposition 3. However, selectively disclosing the target to B can reduce the dispersion $[E(s_1|\bar{s}) - \bar{s}]^2$ and result in better targeting through two effects.

The first one is the direct effect on the liquidity coefficient λ, which describes the extent that the market maker's pricing rule responds to the total order flow in setting the new exchange rate. With selective disclosure, the price impact of any order flow is higher. This is especially important in light of the observation by Lyons (2001) which we highlighted in the Introduction. We refer to this effect as the *price impact effect*.

The second effect is related to the equilibrium composition of the total order flow. Note that the trading intensity coefficients in the complete secrecy case, β_A, β_B in Table 1 have the same functional form as $\hat{\beta}_A, \hat{\beta}_B$ for selective disclosure case. The only difference is that λ is smaller with complete secrecy. With selective disclosure, a higher λ, then, reduces the amount of the *equilibrium* profit oriented (fundamental based) order flow. We refer to this second effect as the *order flow effect*.

Whether these two effects improve overall targeting or not depends critically on the *direction* of the profit oriented order flow compared to the direction A wishes to move the exchange rate. Given the parameters s_0, f, and $\bar{s}$, we describe Central Bank *A's* targeting policy as being one that either leans with or against the wind.

Leaning with the Wind: A targeting policy that leans with the wind is the one that attempts to drive the exchange rate in the same direction as implied by the profit oriented portion of the order flow. For instance, suppose $\bar{s} > f > s_0$ ($s_0 > f > \bar{s}$). This parameter configuration implies that the current exchange rate s_0 is undervalued (overvalued) and any fundamental based order will drive the new exchange rate s_1 up (down) and closer to f. A's target is consistent with this direction and actually A's target requires an appreciation (depreciation) beyond the fundamental value f.

Leaning Against the Wind: A targeting policy leans against the wind if the intervention attempts to reverse the normal course of the exchange rate, as implied by profit oriented trades, or else drives the exchange rate in the same direction as the rest of the trade flow but not to the same extent, and hence, blocks that normal trend. For instance, suppose $\bar{s} > s_0 > f$ (or $f > s_0 > \bar{s}$). This parameter configuration implies that the current exchange rate s_0 is overvalued (undervalued) and any fundamental based order will drive the new exchange rate s_1 down (up) and closer to f. A's target is not consistent with this direction and actually A's target requires a move in the opposite direction.

The table below classifies an intervention policy in terms of the current exchange rate s_0, the fundamental exchange rate f, and the target $\bar{s}$.

Table 2. Intervention Policies

Lean Against the Wind	$\bar{s} > s_0 > f$	$f > s_0 > \bar{s}$
Lean With the Wind	$\bar{s} > f > s_0$	$s_0 > f > \bar{s}$

When will a central bank have the incentive to keep its target completely secret? Interestingly, this occurs whenever the bank attempts to lean with the wind. In this case, the fundamental oriented portion of the flow is already moving the exchange rate in the direction of the target. Take for instance the case with $\bar{s} > f > s_0$. The currency is initially undervalued compared to the fundamental. Any fundamental based order will move the exchange rate closer to f. Moreover, the central bank wants to move the exchange rate in that direction too and beyond f . Selectively disclosing the target reduces some of the fundamental based flow (the effect of λ on β mentioned above), as well as undercuts a portion of the target based flow (since the trading intensity parameter, $\hat{\theta}_B < 0$). Therefore, secrecy achieves better targeting.

On the other hand, if the bank is leaning against the wind, it may be in the interest of the bank to selectively disclose its target to B. Consider the case with $f > s_0 > \bar{s}$. Here, the fundamental based flow will take the exchange rate in the opposite direction and further away from the target. Selectively disclosing the target may then improve targeting, as it mutes some of the fundamental based flow. Unlike the case of leaning with the wind, this is in favor of A's targeting objective. Therefore, we have

Proposition 5 *(i) Central Bank A always prefers complete secrecy over selective disclosure whenever it attempts to lean with the wind. (ii) If Central Bank A is leaning against the wind and if the uncertainty regarding its target,* σ_s^2*, is high enough, A prefers to disclose its target selectively to B for better targeting.*

Proof: See the Appendix.

We close this section with an illustrative example. Assume the parameter values $\sigma_\epsilon^2 = 200$, $\Sigma = 25$, $q = 200$, $f = 100$, $\hat{s} = 100$ and $\bar{s} = 95$. Allowing for different values for the prior, $s_0 = 94, 98,$ and 102, our example captures the characterization of the different targeting policies in Table 2. The figure below shows the difference in the second moment $E[(s_1 - \bar{s})^2|\bar{s}]$ for the two regimes, as a function of the variance of the target, σ_s^2. Low (negative) values for this difference indicate that selective disclosure achieves better targeting. As illustrated in the figure, selective disclosure reduces the deviation of the exchange rate from the target in the case of the two lean against the wind

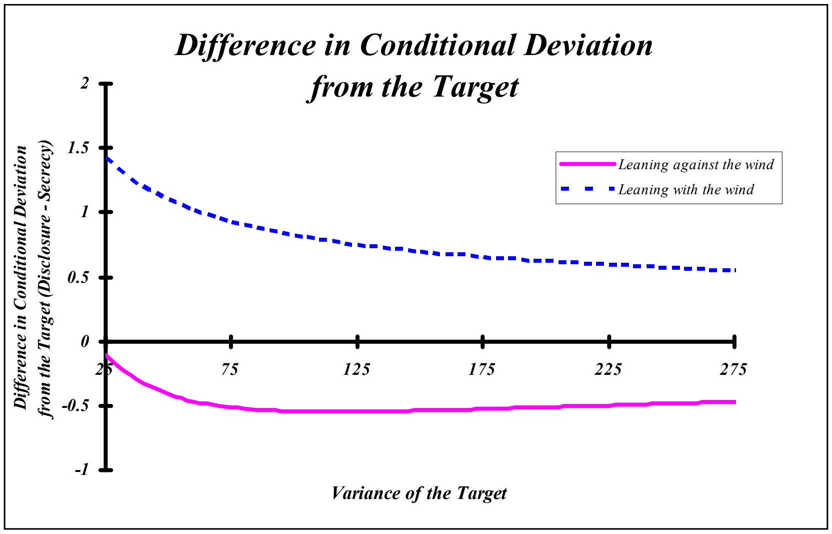

Figure 1: A Comparison of Targeting Across Regimes.

policies, provided there is enough uncertainty on bank's target.[9]

5 Conclusion

To summarize, the main contributions of the paper are as follows:

(i) Unlike Vitale (1999) and Bhattacharya and Weller (1997), we consider an intervention regime where the central bank is not restricted to disclose the target to all or keep it secret from all. The possibility of disclosing the target to some but not all market participants (selective disclosure) is clearly a practical policy alternative to be considered.

(ii) In a framework where a publicly known target renders intervention as ineffective, we identify an adverse impact of a higher level of uncertainty on the target for effective intervention: If the market is highly uncertain about

[9] Incidentally, we also solved for the equilibria when both central banks have a targeting agenda and compared the conditional deviations from the targets numerically. In this case, selective disclosure may improve both banks' targeting, even when one bank is attempting to lean with the wind. These numerical examples are available upon request.

the central bank's target, the equilibrium price impact of a given order flow is low and this makes it more difficult for intervention to work. In that sense, we complement Vitale (1999) who shows that the bank needs some secrecy for intervention to work, by pointing out that too much secrecy may not be the best intervention strategy either.

(iii) We characterize the circumstances under which selective disclosure is the preferred intervention regime in terms of better targeting. We explore the price impact channel (i.e., the equilibrium response of the market maker to the total order flow) and show that price impact under selective disclosure is always higher relative to complete secrecy. Since selective disclosure mutes some of the fundamental based order flow, the bank prefers complete secrecy when it is leaning with the wind. On the other hand, if the central bank is leaning against the wind, selective disclosure achieves better targeting when the public uncertainty on its target is high enough.

(iv) Our analysis also emphasizes that information sharing between the central banks (or with the bank and big players in the market) can be a good policy alternative for intervention, even if this communication does not involve a subsequent concerted and cooperative play. In that respect, our model is consistent with the observation made by Sarno and Taylor (2001) who write: 'In practice, however, concerted official intervention in the foreign exchange market among the major industrialized nations has largely consisted of information sharing and discussions (page 846).'

One broader implication of our work centers around the policy alternatives available to a central bank when it wants to reduce some of the uncertainty surrounding its target. The bank can adjust the market's priors and reduce the variance of its target directly, by making public pronouncements about its target before trades commence. Alternatively, it can reduce the variance selectively (and in our case, to zero), for some but not all market participants. The bank will, presumably, need to reveal more information selectively to an informed trader than it would reveal publicly in order to achieve the same targeting effect. Both require that the information the bank relays is credible. Arguably, it should be easier for the bank to convey its true intentions to a portion of the market only, especially if such communications are limited to other central banks. Moreover, transmitting noisy messages publicly is a blunt, and potentially more costly, approach. For example, the central bank may run the risk that its message is confused by the general public with other aspects of its monetary policy, thereby affecting the market's priors on the fundamental itself. In the event that this occurs, it may be difficult if not impossible for the bank to retract its pronouncements, which will, no doubt, come at considerable cost to the bank's reputation. Such misinterpretation of the bank's intentions is not likely to occur under selective disclosure, since the bank only discloses information on its target to participants that know the market fundamental.

6 Appendix

Proof of Proposition 2

The proof applies the standard solution procedure of the Kyle's batch framework. In order to find a Nash equilibrium, we need to find three strategies; trading rules for the two central banks and a pricing rule for the market maker.

Equilibrium under Complete Secrecy: Let us start with the Central Bank A, which minimizes expected value of the loss function $c \equiv (s_1 - f)x_A + q(s_1 - \bar{s})^2$, taking the pricing rule of the market maker and the trading rule of the other bank as given. Suppose A conjectures that the market maker's pricing rule is

$$s_1 = s_0 + \lambda \left[x_A + x_B + \epsilon - h(\hat{s} - s_0)\right]$$

and B's trading rule is $x_B = \beta_B(f - s_0)$. Plugging these into the bank's objective function, taking expectations over the noise trade ϵ and minimizing it with respect to x_A, one gets

$$x_A = \beta_A(f - s_0) + \theta_A(\bar{s} - \hat{s}) + \gamma_A(\hat{s} - s_0) \tag{15}$$

with the coefficients as defined in Table 1. B maximizes the expected value of $x_B(f - s_1)$ and conjectures that the market maker is setting s_1 according to the rule above and A follows (15). Plugging these and taking expectations over noise trade ϵ and unknown target and maximizing the resulting expression with respect to x_B yields $x_B = \beta_B(f - s_0)$, where β_B is as defined in Table 1. Finally, the market maker conjectures the above trading rules of the two central banks and sets the exchange rate according to the zero profit condition $s_1 = E\left[f|X\right]$ where $X = x_A + x_B + \epsilon$. Using the projection theorem with the normal distribution, the posterior mean can be written as $s_1 = E\left[f|X\right] = s_0 + \lambda X$ where

$$\lambda = \frac{1}{\beta_A + \beta_B}\left(\frac{\Sigma}{\Sigma + Var\left[f|X\right]}\right) \tag{16}$$

with

$$\begin{aligned} Var\left[f|X\right] &= [\frac{\theta_A}{\beta_A+\beta_B}]^2\sigma_s^2 + [\frac{1}{\beta_A+\beta_B}]^2\sigma_\varepsilon^2 \\ &= [\frac{\lambda q(3+2\lambda q)}{2(1+\lambda q)}]^2\sigma_s^2 + [\frac{3+2\lambda q}{2}]^2\sigma_\varepsilon^2 \end{aligned} \tag{17}$$

Plugging this last expression back into (16), one obtains the characteristic equation that describes the equilibrium λ in (6)

Equilibrium Under Selective Disclosure: In this case, B knows the Central Bank A's target $\bar{s}$. Accordingly, B chooses a trading rule

$$x_B = \hat{\beta}_B(f - s_0) + \hat{\theta}_B(\bar{s} - \hat{s})$$

to maximize expected value of profits $x_B(f - s_1)$, given that A follows a trading rule

$$x_A = \hat{\beta}_A(f - s_0) + \hat{\theta}_A(\bar{s} - \hat{s}) + \hat{\gamma}_A(\hat{s} - s_0)$$

and market maker sets $s_1 = E\left[f|X\right] = s_0 + \lambda X$. Plugging these and taking expectations over just the noise trade ϵ (but not the target, since it is known by B in this case) and maximizing the resulting expression with respect to x_B yields (8) with the trading intensity coefficients $\hat{\beta}_B$ and $\hat{\theta}_B$ described as in Table 1. Similarly, given B's strategy and the market maker's pricing rule, A's optimal linear trading rule x_A that minimizes (2) yields (7) with coefficients $\hat{\beta}_A$, $\hat{\theta}_A$ and $\hat{\gamma}_A$ described in Table 1. Finally, the market maker's pricing rule solves $s_1 = E\left[f|X\right] = s_0 + \lambda X$ where

$$\lambda = \frac{1}{\hat{\beta}_A + \hat{\beta}_B}(\frac{\Sigma}{\Sigma + Var\left[f|X\right]}) \tag{18}$$

with

$$\begin{aligned} Var\left[f|X\right] &= [\frac{\hat{\theta}_A+\hat{\theta}_B}{\hat{\beta}_A+\hat{\beta}_B}]^2\sigma_s^2 + [\frac{1}{\hat{\beta}_A+\hat{\beta}_B}]^2\sigma_\varepsilon^2 \\ &= \lambda^2 q^2\sigma_s^2 + \frac{\lambda^2(3+2\lambda q)^2\sigma_\varepsilon^2}{4} \end{aligned} \tag{19}$$

Plugging this last expression back into (18), one obtains the characteristic equation that describes the equilibrium λ in (10) ■

Proof of Proposition 3

The left hand sides of the characteristic equations (6) and (10) are the same affine function of λ with limit 2Σ as $\lambda \to 0$. Both right hand sides of these equations are convex functions of λ, with limit 0 as $\lambda \to 0$. Subtract the right-hand side of (10) from the right hand side of (6); the difference is positive for any $\lambda > 0$. It follows from these properties of the characteristic equations that the positive roots of these equations satisfy $\lambda^s < \lambda^d$. ■

Proof of Proposition 4

Note that the right-hand sides of the characteristic equations (6) and (10) are increasing in σ_s^2, while the left-hand sides of (6) and (10) are independent of σ_s^2. It follows that greater the variance, the smaller the positive root in both cases. ■

Proof of Equation (14)

Given $s_1 = s_0 + \lambda X$, define $\tilde{z} \equiv \tilde{s}_1 - \bar{s}$. Then we have,

$$(\tilde{z}|\bar{s}) \equiv (\tilde{s}_1 - \bar{s}|\bar{s}) \sim N(E(s_1|\bar{s}) - \bar{s}, Var(s_1|\bar{s}))$$

which implies that

$$\tilde{Y} \equiv \frac{(\tilde{s}_1 - \bar{s}|\bar{s})^2}{Var(s_1|\bar{s})}$$

has a noncentral chi-square distribution with a non-centrality parameter $E(s_1|\bar{s}) - \bar{s}$. Using the moment generating function of non central chi-square distribution (see Hogg and Craig, page 289), one obtains

$$E(\tilde{Y}) = \frac{Var(s_1|\bar{s}) + [E(s_1|\bar{s}) - \bar{s}]^2}{Var(s_1|\bar{s})}$$

which yields (14).■

Proof of Proposition 5

From (12), the expectation of s_1 conditional on the target, is

$$E(s_1|\bar{s}) = s_0 + \frac{2}{3+2\lambda^s q}(f - s_0) + \frac{\lambda^s q}{1+\lambda^s q}(\bar{s} - \hat{s})$$

for the complete secrecy case, and from (13),

$$E(s_1|\bar{s}) = s_0 + \frac{2}{3+2\lambda^d q}(f - s_0) + \frac{2\lambda^d q}{3+2\lambda^d q}(\bar{s} - \hat{s})$$

for the case with selective disclosure.

Let Δ denote the difference between the conditional deviation from the target, $E[(s_1 - \bar{s})^2|\bar{s}]$ under selective disclosure and under complete secrecy. Using the expressions above along with (14), we have

$$\begin{aligned} \Delta \quad \equiv \quad & \left[(s_0 - \bar{s}) + \frac{2\lambda^d q\,(\bar{s} - \hat{s})}{3+2\lambda^d q} + \frac{2\,(f - s_0)}{3+2\lambda^d q}\right]^2 + \left(\lambda^d\right)^2 \sigma_\epsilon^2 \qquad (20) \\ & - \left[(s_0 - \bar{s}) + \frac{\lambda^s q\,(\bar{s} - \hat{s})}{1+\lambda^s q} + \frac{2\,(f - s_0)}{3+2\lambda^s q}\right]^2 - (\lambda^s)^2 \sigma_\epsilon^2. \end{aligned}$$

When there is little uncertainty on the target, secrecy achieves better targeting. Our focus, therefore, will be on how targeting compares across the regimes for large values of the variance for the target, o_s^2. In our proof, we utilize the following property of equilibrium liquidity coefficients, λ^s and λ^d:

$$\lim_{\sigma_s^2 \to \infty} \lambda^i = 0 \text{ for } i \in \{s, d\}.$$

This property follows directly from (16) and (18). Given this property, we note that for a large enough σ_s^2, Δ can be made arbitrarily close to $\widetilde{\Delta}$, where

$$\widetilde{\Delta} \equiv \left[(s_0 - \bar{s}) + \frac{2\,(f - s_0)}{3+2\lambda^d q}\right]^2 - \left[(s_0 - \bar{s}) + \frac{2\,(f - s_0)}{3+2\lambda^s q}\right]^2. \qquad (21)$$

Therefore, if we can establish the sign of $\widetilde{\Delta}$ for large σ_s^2, we can determine the sign of Δ, and hence, which regime achieves better targeting. Negative $\widetilde{\Delta}$ (Δ) implies that the conditional deviation from the target is higher under secrecy, i.e., selective disclosure achieves better targeting.

Case a) Leaning against the wind. If A is leaning against the wind, we have $f > s_0 > \bar{s}$ or $f < s_0 < \bar{s}$. By Proposition 3, $\lambda^d > \lambda^s$. In both of these cases, the first term of (21) is less then the second (since $\lambda^d > \lambda^s$), so $\widetilde{\Delta} < 0$. Hence, for large enough σ_s^2, we have $\Delta < 0$ and thus selective disclosure achieves better targeting.

Case b) Leaning with the wind. If A is leaning with the wind, we have $s_0 > f > \bar{s}$ or $\bar{s} > f > s_0$. Take for example, the case where $s_0 > f > \bar{s}$. In this case, since $\lambda^d > \lambda^s > 0$, both terms under the squared brackets are positive and

$$(s_0 - \bar{s}) + \frac{2(f - s_0)}{3 + 2\lambda^s q} < (s_0 - \bar{s}) + \frac{2(f - s_0)}{3 + 2\lambda^d q},$$

and hence $\widetilde{\Delta} > 0$. Now consider $\bar{s} > f > s_0$ and note that both terms under the squared brackets are negative and

$$(s_0 - \bar{s}) + \frac{2(f - s_0)}{3 + 2\lambda^s q} > (s_0 - \bar{s}) + \frac{2(f - s_0)}{3 + 2\lambda^d q},$$

and hence $\widetilde{\Delta} > 0$. It follows that for σ_s^2 large enough, in both cases, we have $\Delta > 0$ and targeting is better under complete secrecy when leaning with the wind. ■

What about the cases when $s_0 > \bar{s} > f$ or $s_0 < \bar{s} < f$? In these cases, the bank's policy is neither leaning with nor against the wind. However, we have been able to compare the two regimes as well by imposing more conditions on the parameters. Take for instance $s_0 > \bar{s} > f$. One can show that complete secrecy (selective disclosure) achieves better targeting for large σ_s^2 provided that

$$\bar{s} < (>) \frac{1}{3} s_0 + \frac{2}{3} f.$$

For $s_0 < \bar{s} < f$, complete secrecy (selective disclosure) achieves better targeting if

$$\bar{s} > (<) \ \frac{1}{3} s_0 + \frac{2}{3} f.$$

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