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ABSTRACT

The paper presents a political economy model of official foreign exchange market intervention and tests the model against the recent experience of Japan. In several industrial countries, the government is responsible for intervention decisions while the central bank is given operational independence in its conduct of monetary policy. The paper models the interaction between the two agencies, empirically tests the central bank reaction function, and considers conditions under which intervention might change monetary policy. Daily Japanese intervention data give broad support to the prediction of the model with respect to central bank behavior. Although it is difficult to be definitive about the hidden motive of central bank actions, during the extraordinary period of 2001-04 when Japan remained under deflationary pressure, the central bank, faced with large political costs of sterilization, accommodated a considerable portion of the massive interventions made by the government. Under normal conditions coordination between the two agencies might be desirable, not least to make the signal of any intervention credible, but giving an alternative agency the authority over intervention decisions can be a means of enhancing democratic accountability for an independent central bank while preserving the credibility of monetary policy.

JEL classification numbers: E42, E58, F31

Keywords: foreign exchange market intervention; central banking; quantitative easing; Japanese intervention

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INTRODUCTION

This paper presents a political economy model of official foreign exchange market intervention, tests the model against the recent experience of Japan, and considers whether intervention systematically influenced monetary policy. In some countries (which include Japan, the United Kingdom, and the United States),[1] the official entity responsible for intervention decisions is different from the one responsible for monetary policy.[2] But foreign exchange market intervention, which alters the balance of base money, necessitates a monetary policy decision, thus presenting a potential conflict between intervention and monetary policy. A question naturally arises as to why such a system exists in the first place, how it functions in practice, and whether it delivers an outcome different from that under an alternative system (where the central bank is made responsible for both intervention and monetary policy decisions). The paper is a modest, first attempt to explore these issues of institutional design with respect to foreign exchange and monetary policies.

While Japan is not alone in having two separate entities for intervention and monetary policy decisions, it provides an ideal setting for considering the political economy of foreign exchange market intervention in such a system, given the sheer scale of intervention (conducted by the Ministry of Finance) under quantitative easing (pursued by

[1] In the United States legal ambiguity exists as to the respective roles of the Treasury and the Federal Reserve, but Treasury supremacy over exchange rate policy has developed through bargaining and decades of cooperation and has not been challenged (Destler and Henning 1989). FRB (2005) states: "The Federal Reserve conducts foreign currency operations [..,] acting in close and continuous consultation and cooperation with the U.S. Treasury, which has overall responsibility for U.S. international financial policy.

[2] These countries, however, appear to be in the minority. In a Bank for International Settlements paper, Moser-Boehm (2005) reports that, out of the 22 countries surveyed in December 2004 for the study (which exclude Japan, the United Kingdom, and the United States), 19 countries had an arrangement in which central banks had the authority to make decisions for intervention; two out of the remaining three countries had a system in which central banks and governments shared the responsibility. In contrast, the government, not the central bank, determines the choice of exchange rate regime in the overwhelming majority of countries (Lybek and Morris 2004).

the Bank of Japan) during 2001-04. After a prolonged period of economic stagnation characterized by low economic growth and deflation, in March 2001, the Bank of Japan (BOJ) adopted what became known as the quantitative easing monetary policy (QEMP). It consisted of three pillars: (i) the BOJ supplied ample liquidity by using the deposits of commercial banks held at the central bank (current account balances, or CAB)—a component of the monetary base—as the main operating target; (ii) it publicly committed itself to maintaining ample liquidity until core consumer price index (CPI) inflation became zero or higher on a sustained basis; and (iii) it increased the purchases of Japanese government bonds (JGBs) to inject liquidity (see Maeda et al. 2005 for technical details).

For the period of QEMP as a whole, the Ministry of Finance (MOF) intervened in the foreign exchange market over 130 times (using its own balance sheet, but acting through the Bank of Japan as its agent), with a cumulative sale of about 42 trillion yen (about $380 billion). While the MOF's policy at the outset of the QEMP period was to intervene decisively but infrequently, the intervention tactic changed in January 2003 when intervention became both frequent and large-scale (Figure 1). During the 15-month period of the so-called "great intervention" (from January 2003 through March 2004),[3] the authorities sold for US dollars a cumulative sum of 35 trillion yen, an amount equivalent to 7 percent of Japan's annual GDP. In 2003 and 2004, the purchases of foreign assets by the

[3] In Japan, the great intervention has also been named as the Mizoguchi-Taylor intervention after Zenbei Mizoguchi and John B. Taylor who were at the time largely responsible for making or condoning the Japanese government's intervention decisions as Japanese Vice Minister of Finance and US Treasury Undersecretary, respectively. Taylor explained that by "adopting a more tolerant position toward intervention—especially if it went unsterilized" the US position was to "help to increase the money supply in Japan" (Taylor 2007, p.286). The 22 March 2004 issue of *Business Week* magazine, calling Mizoguchi "Mr. Dollar," described him as "a faceless bureaucrat in a town full of them [who] enjoys celebrity status" in trading pits in London and New York.

public sector were so large that the private sector recorded a capital account surplus even though the country had a large surplus in the current account. The great intervention ended abruptly on 16 March 2004, though QEMP would last until March 2006.[4]

The fact that the BOJ was pursuing QEMP is of critical importance. The Bank of Japan Law guarantees the central bank's operational independence from government oversight in its conduct of operations aimed at price and financial system stability. If the BOJ had been under the more normal operating procedure of most contemporary advanced country central banks, it would have had to sterilize any impact of intervention on the monetary base in order to maintain the short-term policy interest rate (the overnight call rate in the case of Japan) at a target level.[5] Then, an intervention decision would have been largely divorced from a monetary policy decision, as should be the case when an independent central bank desires to maintain the credibility of its monetary policy. Under these circumstances, the MOF can only hope to influence the level of foreign exchange reserves and the composition of base money. Intervention could still affect the exchange rate but only through the signaling and portfolio balance channels,[6] the substantive and lasting effectiveness of which is generally considered in the literature as limited at best (Edison 1993; Sarno and Taylor 2001).

[4] The Japanese authorities would not intervene in the foreign exchange market at all until 15 September 2010. The September 2010 intervention was a one-time event in which they sold 2.1 trillion yen for US dollars.
[5] Even with interest rate targeting, however, sterilization would not have been necessary if interest had been paid on excess reserves, in which case the interest rate on excess reserves becomes the floor below which market interest rates cannot fall. The Bank of Japan only began to pay interest on excess reserves in November 2008.
[6] If the signaling effect works by influencing market expectations about the future stance of monetary policy, it may be absent in a system where the entity responsible for intervention cannot make a credible commitment to the future actions of an independent central bank. This issue is discussed further in a later section of this paper.

Under quantitative easing, on the other hand, there is potential room for collaboration between intervention and monetary policy decisions. It is conceivable in the case of Japan, for example, that the BOJ could use the MOF's intervention (to purchase foreign assets) as an instrument of achieving a particular CAB target. During the period under consideration, moreover, the policy interest rate was virtually zero. This means that, given the zero lower bound, the BOJ was not constrained by the operational requirements to sterilize the impact of intervention on the monetary base with a view to maintaining the interest rate at a particular level. These considerations motivate our strategy of building a political economy model of intervention where separate entities are responsible for intervention and monetary policy decisions, and testing it against the experience of Japan during 2001-04.

The rest of the paper is organized as follows. Section I constructs a simple political economy model of the interaction between the Ministry of Finance (an entity responsible for intervention decisions) and the Bank of Japan (an entity responsible for monetary policy decisions while acting also as the government's agent for intervention operations). Section II estimates the Bank of Japan reaction function derived from the theoretical model, in order to see how monetary policy decisions responded to intervention decisions within the monetary policy framework of 2001-04. Section III considers the broader political economy question of whether the Ministry of Finance altered the behavior of the central bank with respect to monetary policy decisions, through its massive interventions in the foreign exchange market. Finally, section IV presents concluding remarks.

I. A POLITICAL ECONOMY MODEL OF INTERVENTION

Modeling the interaction between the MOF and the BOJ

We construct a simple political economy model of the interaction between the MOF (responsible for intervention decisions) and the BOJ (responsible for monetary policy or sterilization decisions) to reflect the circumstances of the 2001-04 period of quantitative easing when intervention was all in the direction of purchasing US dollars in exchange for Japanese yen. Let x denotes the amount of intervention, z ($\in [0, x]$) the amount of sterilization, $\tilde{m}$ the initial (pre-intervention) level of the monetary base, and $\tilde{s}$ the initial level of the exchange rate defined as units of yen per US dollar. Here, in view of the economic environment in Japan during the period of quantitative easing, a positive value of x means a net sale of yen for US dollars (and we do not consider a negative value for x).

Suppose that the MOF intervenes in the foreign exchange market to sell yen for dollars and that the BOJ responds subsequently by sterilizing part or all of the intervention. Then, the monetary base m becomes:

$$m = \tilde{m} + x - z . \tag{1}$$

By linear approximation, the expected value of the exchange rate (s^e) is assumed to be:

$$s^e = \tilde{s} + \alpha x - \delta z , \tag{2}$$

where $\alpha > \delta > 0$. By postulating equation (2) we are not asserting that intervention influences the exchange rate in a particular way. It is possible that intervention, whether sterilized or unsterilized, does not in reality influence the level of the exchange rate. Equation (2) simply notes that the authorities when intervening in the foreign exchange

market believe that they are influencing the future exchange rate in a particular way. Otherwise, there would be no reason to intervene in the first place.

We assume that the objective functions (or loss functions) of the MOF and the BOJ are given, respectively, by the following equations:

$$L_1 = \lambda_1 (s^e - s_1^*)^2 + \mu_1 (m - m_1^*)^2 + \Theta(x), \tag{3}$$

$$L_2 = \lambda_2 (s^e - s_2^*)^2 + \mu_2 (m - m_2^*)^2 + \Sigma(z), \tag{4}$$

where $\lambda_1 > 0$, $\mu_1 \geq 0$, $\lambda_2 \geq 0$, and $\mu_2 > 0$; s_1^* and m_1^* are the MOF's targets for the exchange rate and the monetary base, respectively; and s_2^* and m_2^* are the BOJ's counterparts. These functions can be considered as the "reduced forms" obtainable from minimizing the respective loss functions that explicitly contain inflation and GDP gap (Barro and Gordon 1983; Woodford 2010).[7] The assumed signs of the parameters imply that the MOF (BOJ) may not care about the base money (the exchange rate), given their assigned roles in Japan's economic policymaking apparatus. In this case, μ_1 (for the MOF) and λ_2 (for the BOJ) would be zero. In fact, we later assume that the BOJ has no target for the level of the exchange rate ($\lambda_2 = 0$) in one of the empirical specifications.[8]

Because we only consider yen-selling intervention in an environment of deflationary pressure, we assume that $s_1^* > \tilde{s}$ and $m_1^* > \tilde{m}$. $\Theta(x)$ in equation (3) represents

[7] If we start out with explicit loss functions defined by inflation and GDP gap, we obtain the secondary loss functions (corresponding to equations (3) and (4)) as polynomials in *s* and *m*. It is only for the sake of simplification that we start with loss functions defined directly by *s* and *m*.

[8] On the other hand, a strong case can be made for believing that the Ministry of Finance had an implicit target for the monetary base (or money supply) in the early 2000s. In the fall of 2001, the government made it a central pillar of macroeconomic policy to fight deflation and subsequently included *monetary policy* (the exclusive domain of the central bank) in a package of measures to be implemented (Yoshikawa 2009).

the cost of intervention (which satisfies $\Theta(0) = 0$, $\Theta' > 0$, and $\Theta'' > 0$), and $\Sigma(z)$ in equation (4) represents the cost of sterilization (which satisfies $\Sigma(0) = 0$, $\Sigma' > 0$, and $\Sigma'' > 0$). These costs not only reflect the transactions and administrative costs of relevant market operations but also may involve political and other considerations. For example, the MOF may receive foreign criticism for intervention if it is large and sustained; the BOJ may likewise receive criticism or harassment from the MOF or politicians for sterilization operations and face the risk of increasing market volatility as the scale of sterilization rises. Both of these costs are modeled as quadratic, such that: $\Theta(x) = \theta_1 x + \theta_2 x^2$ ($\theta_1 > 0$, $\theta_2 > 0$) and $\Sigma(z) = \sigma_1 z + \sigma_2 z^2$ ($\sigma_1 > 0$, $\sigma_2 > 0$).

Finally, the MOF makes intervention decisions while taking into account the reaction of the BOJ in terms of any sterilization. As for the BOJ, it takes the amount of intervention x as given and makes a sterilization decision so as to minimize the value of L_2. The amount of sterilization z can therefore be represented as the reaction function $z = \Psi(x)$. The MOF takes this reaction function into account when it determines the amount of intervention x so as to minimize the value of L_1.

The optimization problem for the BOJ

Following the method of backward solution, we first consider the optimization problem for the BOJ, given the amount of intervention x. Substituting equations (1) and (2) into equation (3), we obtain:

$$L_2 = \lambda_2(\tilde{s} + \alpha x - \delta z - s_2^*)^2 + \mu_2(\tilde{m} + x - z - m_2^*)^2 + \sigma_1 z + \sigma_2 z^2$$

Differentiating with respect to z, we have:

$$\frac{\partial L_2}{\partial z} = 2(\lambda_2\delta^2 + \mu_2 + \sigma_2)(z - \psi x + \omega),$$

where $\psi \equiv \dfrac{\lambda_2\alpha\delta + \mu_2}{\lambda_2\delta^2 + \mu_2 + \sigma_2} (> 0)$ and $\omega \equiv \dfrac{\lambda_2\delta(s_2^* - \tilde{s}) + \mu_2(m_2^* - \tilde{m}) + \frac{1}{2}\sigma_1}{\lambda_2\delta^2 + \mu_2 + \sigma_2}$; we here assume $\psi < 1$ because σ_2 is positive in the specification for the cost of sterilization.

Because the BOJ has two potential targets (the monetary base and the exchange rate), we must consider the following two cases, depending on the deviation of the actual monetary base from the target ($m_2^* - \tilde{m}$) in relation to the deviation of the actual exchange rate from the target ($s_2^* - s$):

[A] $\omega > 0 \Leftrightarrow \mu_2(m_2^* - \tilde{m}) > -\lambda_2\delta(s_2^* - \tilde{s}) - \frac{1}{2}\sigma_1$ (the initial deviation of the monetary base from the target is sufficiently large)

[B] $\omega < 0 \Leftrightarrow \mu_2(m_2^* - \tilde{m}) < -\lambda_2\delta(s_2^* - \tilde{s}) - \frac{1}{2}\sigma_1$ (the initial deviation of the monetary base from the target is sufficiently small)

We consider these cases in turn below.

First, in Case A ($\omega > 0$), the optimal value of z is given by:

$$z = \Psi(x) = \begin{cases} 0 & \text{if } x \le \omega/\psi \\ \psi x - \omega & \text{if } x > \omega/\psi \end{cases} \qquad (5)$$

If the amount of intervention x is below the critical level ω/ψ, the BOJ does not sterilize the intervention at all. If the amount of intervention x is above the critical level ω/ψ, on the other hand, the BOJ only partially sterilizes the intervention. The reaction function $z = \Psi(x)$ can be depicted as Figure 2, which essentially shows that the central bank wants

to use the intervention as a means of achieving the target for the monetary base when there is a large shortfall in the balance of base money.

Second, in Case B ($\omega < 0$), the optimal value of z is given by:

$$z = \Psi(x) = \begin{cases} x & \text{if } x \le -\omega/(1-\psi) \\ \psi x - \omega & \text{if } x > -\omega/(1-\psi) \end{cases} \tag{6}$$

If the amount of intervention x is below the critical level $-\omega/(1-\psi)$, the BOJ fully sterilizes the intervention. If the amount of intervention x is above the critical level $-\omega/(1-\psi)$, on the other hand, the BOJ only partially sterilizes the intervention. The reaction function $z = \Psi(x)$ in this case can be depicted as Figure 3. The kinked line essentially incorporates the behavior of the central bank that sterilizes the intervention fully or partially when the monetary base target is already reached or the shortfall in the balance of base money is small.

The optimization problem for the MOF

Having considered the optimization problem for the BOJ, we next consider the optimization problem for the MOF, given the BOJ's reaction function $z = \Psi(x)$. Here again, we must separately consider two cases, A and B, corresponding to $\omega > 0$ and $\omega < 0$, respectively. First, in Case A ($\omega > 0$), substituting equations (1), (2), and (5) into equation (4), we obtain:

$$L_1 = \begin{cases} L_1^I(x) & \text{if } x \le \omega/\psi \\ L_1^{II}(x) & \text{if } x > \omega/\psi \end{cases},$$

where: $L_1^I(x) = \lambda_1(\tilde{s} + \alpha x - s_1^*)^2 + \mu_1(\tilde{m} + x - m_1^*)^2 + \theta_1 x + \theta_2 x^2$, and

$$L_1^{II}(x) = \lambda_1\{\tilde{s} + \alpha x - \delta(\psi x - \omega) - s_1^*\}^2 + \mu_1\{\tilde{m} + x - (\psi x - \omega) - m_1^*\}^2 + \theta_1 x + \theta_2 x^2.$$

Further differentiating with respect to x, we obtain:

$$\frac{dL_1^I(x)}{dx} = 2[(\lambda_1\alpha^2 + \mu_1 + \theta_2)x - \{\lambda_1\alpha(s_1^* - \tilde{s}) + \mu_1(m_1^* - \tilde{m}) - \tfrac{1}{2}\theta_1\}],$$

$$\frac{dL_1^{II}(x)}{dx} = 2[\{\lambda_1(\alpha - \delta\psi)^2 + \mu_1(1-\psi)^2 + \theta_2\}x$$

$$-\{\lambda_1(\alpha - \delta\psi)(s_1^* - \tilde{s} - \omega) + \mu_1(1-\psi)(m_1^* - \tilde{m} - \omega) - \tfrac{1}{2}\theta_1\}].$$

Because the MOF is assumed to have its own potential targets for the exchange rate and the monetary base, there are three separate cases to consider for the optimal value of x, depending on the relative sizes of the deviation of the actual exchange rate from the target ($s_1^* - s$) and the deviation of the actual monetary base from the target ($m_1^* - \tilde{m}$).

Case A1: If $\dfrac{\lambda_1\alpha(s_1^* - \tilde{s}) + \mu_1(m_1^* - \tilde{m}) - \frac{1}{2}\theta_1}{\lambda_1\alpha^2 + \mu_1 + \theta_2} < 0$, the optimal value of x is $x = 0$.

Case A2: If $0 < \dfrac{\lambda_1\alpha(s_1^* - \tilde{s}) + \mu_1(m_1^* - \tilde{m}) - \frac{1}{2}\theta_1}{\lambda_1\alpha^2 + \mu_1 + \theta_2} < \omega/\psi$, the optimal value of x is given by:

$$x = \frac{\lambda_1\alpha(s_1^* - \tilde{s}) + \mu_1(m_1^* - \tilde{m}) - \frac{1}{2}\theta_1}{\lambda_1\alpha^2 + \mu_1 + \theta_2} (\in (0, \omega/\psi)).$$

Case A3: If $\dfrac{\lambda_1\alpha(s_1^* - \tilde{s}) + \mu_1(m_1^* - \tilde{m}) - \frac{1}{2}\theta_1}{\lambda_1\alpha^2 + \mu_1 + \theta_2} > \omega/\psi$ $\left(\text{and} \quad \dfrac{dL_1^{II}(\omega/\psi)}{dx} < 0\right)$, the optimal value of x is given by:[9]

[9] If $\dfrac{\lambda_1\alpha(s_1^* - \tilde{s}) + \mu_1(m_1^* - \tilde{m}) - \frac{1}{2}\theta_1}{\lambda_1\alpha^2 + \mu_1 + \theta_2} > \omega/\psi$ and $\dfrac{dL_1^{II}(\omega/\psi)}{dx} > 0$, the optimal value of x is $x = \omega/\psi$.

$$x = \frac{\lambda_1(\alpha - \delta\psi)(s_1^* - \tilde{s} - \omega) + \mu_1(1-\psi)(m_1^* - \tilde{m} - \omega) - \frac{1}{2}\theta_1}{\lambda_1(\alpha - \delta\psi)^2 + \mu_1(1-\psi)^2 + \theta_2} (> \omega/\psi).$$

To summarize in words, if the exchange rate and monetary base deviations from the target ($s_1^* - s$) and ($m_1^* - \tilde{m}$) are sufficiently small (Case A1), the MOF does not intervene in the foreign exchange market at all. When intervention does take place, the amount rises with the size of the deviation. In Case A2, where the amount of intervention is smaller than ω/ψ, the BOJ does not sterilize the intervention at all. In Case A3, where the amount of intervention is larger than ω/ψ, the intervention is partially sterilized.

Next, we consider Case B, where we have $\omega < 0$. Substituting equations (1), (2) and (6) into equation (4), we obtain:

$$L_1 = \begin{cases} L_1^{III}(x) & \text{if } x \le -\omega/(1-\psi) \\ L_1^{II}(x) & \text{if } x > -\omega/(1-\psi) \end{cases},$$

where: $L_1^{III}(x) = \lambda_1(\tilde{s} + \alpha x - \delta x - s_1^*)^2 + \mu_1(\tilde{m} - m_1^*)^2 + \theta_1 x + \theta_2 x^2$.

Further differentiating with respect to x, we obtain:

$$\frac{dL_1^{III}(x)}{dx} = 2[\{\lambda_1(\alpha - \delta)^2 + \theta_1\}x - \{\lambda_1(\alpha - \delta)(s_1^* - \tilde{s}) - \tfrac{1}{2}\theta_1\}]$$

In this case, depending on how the actual exchange rate deviates from the target ($s_1^* - s$), there are three separate cases to consider for the optimal value of x, as follows:

Case B1: If $\dfrac{\lambda_1(\alpha - \delta)(s_1^* - \tilde{s}) - \frac{1}{2}\theta_1}{\lambda_1(\alpha - \delta)^2 + \theta_2} < 0$, the optimal value of x is $x = 0$.

Case B2: If $0 < \dfrac{\lambda_1(\alpha - \delta)(s_1^* - \tilde{s}) - \frac{1}{2}\theta_1}{\lambda_1(\alpha - \delta)^2 + \theta_2} < -\omega/(1-\psi)$, the optimal value of x is given by:

$$x = \frac{\lambda_1(\alpha-\delta)(s_1^* - \tilde{s}) - \frac{1}{2}\theta_1}{\lambda_1(\alpha-\delta)^2 + \theta_2} (\in (0, -\omega/(1-\psi)).$$

Case B3: If $\frac{\lambda_1(\alpha-\delta)(s_1^* - \tilde{s}) - \frac{1}{2}\theta_1}{\lambda_1(\alpha-\delta)^2 + \theta_2} > -\omega/(1-\psi)$ $\left(\text{and} \quad \frac{dL_1^{II}(-\omega/(1-\psi))}{dx} < 0 \right)$, the optimal value of x is given by:[10]

$$x = \frac{\lambda_1(\alpha-\delta\psi)(s_1^* - \tilde{s} - \omega) + \mu_1(1-\psi)(m_1^* - \tilde{m} - \omega) - \frac{1}{2}\theta_1}{\lambda_1(\alpha-\delta\psi)^2 + \mu_1(1-\psi)^2 + \theta_2} (> -\omega/(1-\psi)).$$

In words, if the deviation $s_1^* - s$ is sufficiently small (Case B1), the MOF does not intervene in the foreign exchange market at all; when intervention does take place, the amount of intervention x rises with the size of the deviation. In Case B2, where the amount of intervention is smaller than $-\omega/(1-\psi)$, the BOJ fully sterilizes the intervention. Finally, in Case B3 where the amount of intervention is larger than $-\omega/(1-\psi)$, the BOJ only partially sterilizes the intervention.

II. Estimating the Bank of Japan Reaction Function

Empirical specification of the BOJ reaction function

The Bank of Japan's possible behavior with respect to sterilization is indicated by equations (5) and (6) of our political economy model, which specify its reaction under different sets of conditions to the size of intervention (as determined by the Ministry of Finance). Given the operational framework in place during the period of QEMP, the central bank reaction function derived from our political economy model would lead us to expect

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[10] If $\frac{\lambda_1(\alpha-\delta)(s_1^* - \tilde{s}) - \frac{1}{2}\theta_1}{\lambda_1(\alpha-\delta)^2 + \theta_2} > -\omega/(1-\psi)$ and $\frac{dL_1^{II}(-\omega/(1-\psi))}{dx} > 0$, the optimal value of x is $x = -\omega/(1-\psi)$.

that the BOJ was reluctant to fully accommodate the resulting reserve inflows associated with a large intervention, when it did not wish to allow the CAB target to be exceeded by a large margin. On the other hand, the model would have us believe that the central bank was more willing to accommodate the reserve inflows when the prevailing CAB level was well below the target. In specifying the empirical version of the central bank reaction function below, we will try to capture explicitly the size of each intervention relative to the existing or prospective deviation between the actual CAB and the target.

Incorporating these ideas into equations (5) and (6), we specify the following empirical reaction function, which we will estimate by using daily data for the period of QEMP:

$$dCAB_t = c_1 + \beta_{11} ITV_{t-2} + \beta_{12} [D_1 ITV_{t-2}] + \beta_{13} [D_2 ITV_{t-2}] + \varepsilon_{1t} \qquad (7)$$

where dCAB is a daily change in CAB, ITV is daily intervention (lagged two business days to reflect t+2 settlement); c_1 is a constant; β_{11}, β_{12} and β_{13} are parameters to be estimated; ε_1 is a random error term; and D_1 and D_2 are dummy variables that represent the size of intervention relative to the CAB target. Specifically, D_1 takes the value of unity (zero otherwise) when CAB_{t-1} is below the target (at t-1) and ITV_{t-2} is larger than the deviation (at t-1), such that the target is exceeded at settlement if fully accommodated; D_2 takes the value of unity (zero otherwise) when CAB_{t-1} is below the target (at t-1) and ITV_{t-2} is smaller than the deviation (at t-1), such that the target is not exceeded at settlement even if fully accommodated.

The specification of equation (7) incorporates the implications of the theoretical model that, even if the CAB is below the target, the central bank may not fully

accommodate a (typically) large intervention that, if fully accommodated, will cause the target to be exceeded. Thus, we hypothesize that $\beta_{11}+\beta_{12}<1$. On the other hand, the central bank is more likely to fully accommodate a (typically) small intervention that will not cause the target to be exceeded even when fully accommodated. In this case, we hypothesize that $\beta_{11}+\beta_{13}=1$. If CAB_{t-1} already exceeds the target, both dummy variables take the value of zero, so that we have:

$$dCAB_t = c_1 + \beta_{11} ITV_{t-2} + \varepsilon_{1t} \qquad (7')$$

If the central bank fully sterilizes the intervention, we have $\beta_{11}=0$; otherwise, $0<\beta_{11}<1$.

In terms of the theoretical model, these empirical specifications correspond to the assumptions that $\lambda_2 = 0$ (the BOJ does not have a target for the exchange rate) and $\sigma_1 = 0$ (the cost of sterilization only has a quadratic term), which together imply $m_2^* - \tilde{m} > 0$ in Case A and $m_2^* - \tilde{m} < 0$ in Case B. That is to say, these restrictions mean that the BOJ only considers the deviation of the monetary base from the target when making sterilization decisions.[11] In Case A, the critical value of the reaction function then becomes $\omega/\psi = m_2^* - \tilde{m}$. This means that, when $x > \omega/\psi$, CAB_{t-1} is below the target (at t-1) and ITV_{t-2} is larger than the deviation (at t-1), corresponding to $D_1=1$. Equation (5) then means $\beta_{11}+\beta_{12}<1$. When $x < \omega/\psi$, CAB_{t-1} is below the target (at t-1) and ITV_{t-2} is smaller than the deviation (at t-1), corresponding to $D_2=1$. Equation (5) in this case means $\beta_{11}+\beta_{13}=1$. In Case B, on the other hand, CAB_{t-1} exceeds the target (at t-1), corresponding to $D_1=D_2=0$. Thus, equation (6) in this case means $\beta_{11}=0$ if $x < -\omega/(1-\psi)$ or $0<\beta_{11}<1$ if $x > -\omega/(1-\psi)$.

[11] This is not an unreasonable assumption because the central bank was likely more concerned about macro-prudential risks than the explicit level of the exchange rate.

Equation (7) was estimated by using the average realized CAB balance as the target CAB when the BOJ's announced target implied a range, rather than a single value (see the next section for details). The daily data come from the 3-year period covering 19 March 2001 to 16 March 2004 and include 130 days of intervention; they exclude six intervention days when the Japanese market was closed because the BOJ did not engage in domestic market operations on those days. The empirical results broadly support the implications of the political economy model, namely, the BOJ allowed the monetary base to rise in response to intervention only when there was a shortfall in meeting the CAB target (Table 1). When there was no shortfall, intervention was fully sterilized, such that the coefficient of intervention in such cases (β_{11}) was statistically insignificant. On the other hand, the coefficients of the slope dummies (representing the size of intervention) were both statistically significant. Moreover, the degree of accommodation was larger when the size of intervention was smaller than the CAB shortfall, compared to a situation where the size of intervention was larger than the deviation, such that $\beta_{12} < \beta_{13}$. In fact, the hypothesis of $\beta_{13}=1$ cannot be rejected (with a t-statistic of 0.0124), suggesting that the BOJ fully accommodated an intervention whose size was smaller than the deviation.

Incorporating non-linear behavior

The linear model of equation (7) explains the Bank of Japan's daily reaction to intervention remarkably well, but it may fail to uncover an important non-linearity in central bank behavior (which may be reflected in the low R-squared). For example, the BOJ may have become progressively more determined to accommodate intervention when a

CAB deviation was larger. With such non-linearity, it is possible that the degree of accommodation was not constant but intensified as the deviation increased in size.

In fact, such possibility can be shown in our theoretical model by comparing the reaction functions for different deviations of the monetary base from the target. For example, consider the following five deviations of the monetary base from the target: $m_2^* - \tilde{m} = M^1$, M^2, M^3, M^4, and M^5 ($M^1 > M^2 > M^3 > M^4 > M^5$). Then, the corresponding reaction functions can be depicted as five upward sloping lines, all but one of which are kinked (Figure 4). Three cases can be considered separately, as follows.

First, the only straight line ($m_2^* - \tilde{m} = M^3$) represents the case of $\omega = 0$ (i.e., $M^3 = \{-\lambda_2 \delta(s_2^* - \tilde{s}) - \frac{1}{2}\sigma_1\} / \mu_2$), in which the reaction function is given by $z = \Psi(x) = \psi x$ for $\forall x > 0$. Second, the two lower kinked lines ($m_2^* - \tilde{m} = M^1$ and $m_2^* - \tilde{m} = M^2$) are examples of Case A ($\omega > 0$); the critical value of the reaction function ω / ψ is larger in the case of M^1 than in the case of M^2. Third, the upper kinked lines ($m_2^* - \tilde{m} = M^4$ and $m_2^* - \tilde{m} = M^5$) are examples of Case B ($\omega < 0$); the critical value of the reaction function $-\omega/(1-\psi)$ is smaller in the case of M^4 than in the case of M^5. It is clear from these lines that, given the same amount of intervention x, the size of sterilization z falls as the deviation becomes larger (as long as sterilization is partial). In other words, the degree of accommodation ((*x*-*z*)/*x*) rises with the monetary base (or CAB) deviates more from the target.

Equation (8) below attempts to capture this type of potential non-linearity in the central bank's reaction function:

$$dCAB_t = c_{21} + \Phi_t [c_{22} + \beta_2 ITV_{t-2}] + \varepsilon_{2t} \quad (8)$$

where c_{21} and c_{22} are constants, β_2 is a parameter to be estimated, and ε_2 is a random error term; Φ is a variable that reflects the deviation of the actual CAB from the target (CAB^*), defined as:

$$\Phi_t = [1 + \exp \{-\eta_2 (DEV_{t-1} - c_{23})\}]^{-1} \quad (9)$$

where $DEV_{t-1} = CAB^*_{t-1} - CAB_{t-1;}$ η_2 is a parameter to be estimated; and c_{23} is a constant.[12] Note that Φ is defined to lie between zero and unity, i.e., Φ approaches zero [unity] as the CAB deviation approaches negative [positive] infinity as long as η_2 is positive. In equation (8), $\Phi_t\beta_2$ indicates the proportion of accommodation—the extent to which the central bank is willing to allow the CAB to move in the direction of intervention.

The results from estimating equation (8) are reported in Table 2. All the coefficients are found to be statistically significant, except for the constant c_{21}. More meaningful is the proportion of accommodation or non-sterilization ($\Phi_t\beta_2$), which is depicted in Figure 5. It is evident that, as the deviation increases from a negative range to a positive range, the proportion rises progressively from zero. As the deviation increases further, the proportion approaches unity and goes beyond. We conclude that the BOJ increasingly accommodated the reserve inflows from intervention when the actual CAB was farther below the target.

III. Did Intervention Systematically Change Monetary Policy?

Intervention and monetary base expansion

[12] The constant c_{23} is included to depress the value of Φ (toward zero) in the negative range of the CAB deviation. This specification is motivated by the results from estimating the linear model, where we found that the BOJ almost fully sterilized intervention when the deviation was negative.

We have observed that the Bank of Japan sterilized or accommodated the impact of intervention on the monetary base according to how much the CAB balance was above or below the target. This is consistent with the prediction of our political economy model of central bank behavior. This means that, *given* the CAB target, the BOJ used intervention as an instrument of monetary policy. As long as the target was the BOJ's own choice, the central bank's operational independence appeared preserved. But the MOF could have affected the CAB balance though massive interventions, either by influencing the BOJ's choice of the target or by raising the costs of sterilization. If so, monetary policy was no longer independent of intervention. The critical political economy question then concerns the potential endogeneity of the central bank target and the costs of sterilization with respect to intervention.

In order to consider this question, we first combine the behavior of the BOJ and that of the MOF (equations (1), (5) and (6) in the theoretical model) to obtain the following expressions for a change in the monetary base ($m - \tilde{m}$) due to the MOF's intervention:

$$\text{Case A}: \; m - \tilde{m} = \begin{cases} x & \text{if } x \le \omega/\psi \\ (1-\psi)x + \omega & \text{if } x > \omega/\psi \end{cases} \tag{10}$$

$$\text{Case B}: \; m - \tilde{m} = \begin{cases} 0 & \text{if } x \le -\omega/(1-\psi) \\ (1-\psi)x + \omega & \text{if } x > -\omega/(1-\psi) \end{cases} \tag{11}$$

As previously, Case A ($\omega > 0$) represents a situation in which the initial deviation of the monetary base from the BOJ's target is sufficiently large, while Case B ($\omega < 0$) describes a situation in which the initial deviation of the monetary base from the BOJ's target is sufficiently small.

Equation (10) states that, in Case A, the change in the monetary base necessarily becomes larger as the amount of intervention (x) becomes larger. On the other hand, equation (11) shows that, in Case B, intervention does not change the monetary base if its amount is below the critical level $-\omega/(1-\psi)$; if the amount is above the critical level, intervention can still increase the monetary base in this case because the BOJ finds the costs of sterilization too high. Understanding of the monetary impact of intervention can be facilitated by depicting these equations as diagrams, where x (the amount of intervention) is drawn on the horizontal axis and $m-\tilde{m}$ (an increase in the base money) on the vertical axis; these are drawn separately for $\omega > 0$ (Figure 6) and $\omega < 0$ (Figure 7). Analogous to Figure 4, the relationship between a change in base money due to intervention ($m-\tilde{m}$) and a deviation of the monetary base from the central bank target ($m_2^* - \tilde{m}$) can also be shown diagrammatically (Figure 8). The figure essentially shows how intervention alters the monetary base as the central bank target changes. Given the size of x and the initial balance of base money, as the target increases, as expected, there tends to be a larger increase in the monetary base.

The monetary impact of an increase in the costs of sterilization (Σ), modeled here as a quadratic function $\Sigma(z) = \sigma_1 z + \sigma_2 z^2$ ($\sigma_1 > 0$, $\sigma_2 > 0$), can likewise be analyzed diagrammatically both for $\omega > 0$ (Figure 9) and for $\omega < 0$ (Figure 10). As the costs are assumed to involve two components, each of these figures depicts the monetary impact of an increase in the costs separately for the linear term (case (i)) and for the quadratic term (case (ii)). In all four cases, as the costs of sterilization increase, a given amount of intervention will have a larger effect on the monetary base (it is only a mathematical

artifact that an increase in the linear cost term would lead to an upward, parallel shift in the monetary impact line, whereas an increase in the quadratic cost term causes both an upward shift and a steeper slope). We have therefore established that sufficiently large and persistent interventions by the government could alter the monetary policy decisions of the central bank by raising the monetary base target, the political costs of sterilization, or both.

Institutional framework of intervention

Some understanding of the institutional frameworks of intervention and quantitative easing in place during 2001-04 is essential before assessing whether the Ministry of Finance was able to alter the behavior of the Bank of Japan through its massive interventions. In Japan, the MOF intervenes in the foreign exchange market by using a special account of the National Budget called the Foreign Exchange Fund Special Account, and through the BOJ acting as its agent. When purchasing (selling) dollars, the MOF issues (redeems) financing bills (FBs), which are short-term government notes. Once issued, FBs are rolled over continuously as long as the underlying foreign assets are maintained as foreign exchange reserves. Sale of the underlying foreign assets, however, reduces the outstanding balance of FBs to the extent that the government redeems them. Because FBs are sold to (or purchased from) the public at market rates, some have interpreted this institutional arrangement to mean that intervention is automatically sterilized by design (Ito 2005; Fatum and Hutchison 2005), a position also reiterated by the Bank of Japan on the impact of intervention on the monetary base (see Maeda et al. 2005).

This must be qualified in four respects, however, in order to understand the mechanics of BOJ operations in response to intervention. First, when FBs are issued for

intervention purposes, they are entirely purchased by the BOJ. Because FB auctions are held weekly, there is no other practical way of conducting foreign exchange market intervention in a flexible and timely manner. Second, although FBs are sold to the market during a weekly auction, given the large and continuous rollover needs, the MOF usually does not repurchase the BOJ-held FBs all at once.[13] Watanabe and Yabu (2007) suggest that about two months of time elapses between the intervention-induced purchase of FBs by the BOJ and the public sale of FBs by the MOF executed to unwind the position at the BOJ. Moreover, nothing would prevent the BOJ from holding the FBs longer or even purchasing the FBs from the secondary market, as indicated by sharp increases in the BOJ's holding of FBs in the first half of 2002, and again in 2003 (Figure 6). Third, outright purchases of JGBs and other market instruments are another means of unsterilizing foreign exchange market intervention,[14] notwithstanding the public sales of FBs by the MOF.

Fourth, the BOJ could provide short-term liquidity to the government under exceptional circumstances. As a recent example, on 26 December 2003, the MOF reached agreement with the BOJ to sell US Treasury bills (TBs) held as foreign exchange reserves. This agreement came about in a circumstance where the massive dollar-purchasing intervention of 2003 had caused the balance of FBs to reach the statutory limit set by the National Diet. Specifically, the agreement noted that this was a time-bound measure whereby the BOJ would be prepared to purchase TBs from the Foreign Exchange Fund

[13] According to an official of the MOF's Financial Bureau, as a general practice, up to 300 billion yen of new FB issues could be accommodated in each auction. This means that if there is a yen-selling intervention of 900 billion, it would take a minimum of three subsequent weekly auctions to unwind the position at the BOJ.
[14] The Bank of Japan purchased (in net terms) long-term JGBs worth more than 18 trillion yen, bills worth 34 trillion yen, and equities held by commercial banks worth 3 trillion yen during the period of QEMP. In July 2003, it also began to purchase commercial paper against collateral.

Special Account up to 10 trillion yen until the end of March 2004; it also specified that the BOJ would resell the TBs back to the Foreign Exchange Fund Special Account within three months from purchase. Essentially, the intervention financed by the sale of TBs (with a repurchase agreement) during the first three months of 2004 was unsterilized by definition. In the event, the maximum balance of 6.15 trillion yen of short-term liquidity was provided to the MOF under this scheme, which was all unwound during June 2004 (see Figure 11).

Interpreting the BOJ's balance sheet expansion

Over the period of QEMP, there was a rapid growth in base money (roughly consisting of current account balances and central bank notes) of over 43 trillion yen, which was almost exactly matched by a cumulative sale of 42 trillion yen by the Ministry of Finance in the foreign exchange market. The foreign exchange market intervention during QEMP can therefore be said to have been entirely unsterilized in terms of its economic impact, even though a large portion of the FBs initially absorbed by the Bank of Japan may have been subsequently sold to the public. The growth of base money was accompanied by periodic increases in the CAB target. Given the endogeneity of the public's demand for central bank notes, the BOJ used the more controllable CAB as an intermediate target of monetary policy. Between March 2001 and January 2004, the BOJ raised the target in several steps, from about 5 trillion yen to 30–35 trillion yen, which would remain in effect through the end of QEMP in March 2006 (Table 3).

At the same time, during the period of QEMP, the BOJ publicly announced the amount of monthly JGB purchases, which it raised, in several steps, from 400 billion yen initially to 1.2 trillion yen in October 2002 (see Table 3). As a result, the balance of long-

term JGBs in the BOJ's portfolio steadily rose from around 46 trillion yen initially to over 65 trillion yen in March 2004 (Figure 12). An inspection of the BOJ balance sheet indicates that about a half of the increase in base money from March 2001 to March 2004 was made possible by the open market purchases of long-term JGBs, with the other half coming from the purchases of other assets (not shown in the figure). The outright purchases of long-term JGBs were subject to the self-imposed rule (introduced when QEMP began) that the balance should be kept below the outstanding balance of central bank notes issued (Maeda et al. 2005). During the period of the great intervention, this rule may have acted as a constraint on the amount by which intervention was allowed to increase the balance of base money.

The critical question for our purpose concerns the motives behind the decision of the BOJ to raise the CAB target periodically over the course of QEMP. Are we to interpret the BOJ balance sheet expansion as a response to accommodate the monetary impact of large and sustained foreign exchange market interventions by the MOF? If so, the MOF was successful in using intervention to alter the BOJ's behavior toward the balance of base money, hence the central bank's otherwise independent monetary policy. Alternatively, should we think of the periodic increases in the CAB target as an autonomous monetary policy decision of the BOJ? Oda and Ueda (2007) show that market participants perceived the successive upward CAB revisions as a signal of greater commitment to monetary

accommodation; the announcement and successive upward revisions of the CAB target were used as a type of signaling device.[15]

To be sure, the BOJ was under intense political pressure. In the early 2000s, public dissatisfaction with the BOJ was so strong that politicians were openly proposing to revise the Bank of Japan Law (Umeda 2011). Yoshikawa (2009), who was an academic member of the Prime Minister's Council on Economic and Fiscal Policy during 2001-2005, reviews the internal debate between the government and the Bank of Japan on the causes of deflation. The government took the view that monetary policy was the cause of deflation while the BOJ repeatedly argued that deflation was an outcome of economic stagnation. In the 15 February 2002 meeting of the Council, the Minister of Economy and Industry called for additional monetary easing, to which the BOJ Governor responded by saying that the monetary easing already in place was more than sufficient and that there was little the central bank could do to increase the money supply as long as the economy remained stagnant.

Given the tense political background, the costs of undoing every effort of the government to inject liquidity through intervention must have been enormous. Watanabe and Yabu (2007), making a distinction between intervention and other government payments,[16] used a dynamic regression model to show that, during the period of the great

[15] Jung et al. (2005) show in a theoretical model that the optimal monetary policy, when the central bank is faced with a weak economy and the zero interest rate bound, is to make a credible commitment to maintain zero interest rates even after the natural rate of interest returns to a positive level, as this would lead to higher expected inflation, lower long-term interest rates, and a weaker domestic currency.

[16] The current account balances of commercial banks increase, not only when the government intervenes in the foreign exchange market to purchase dollars for yen, but also when it makes pension and other payments to the private sector (conversely, the CABs decline when the government collects taxes from the private

intervention, the BOJ (i) accommodated more of the impact of intervention on the CAB (nearly 55 percent on average) and (ii) allowed the impact to remain longer (up to nine business days), compared with the impact of other government payments (40 percent and up to two business days, respectively). The fact that the CAB target was raised four times during the great intervention, from 17-22 trillion yen to 30-35 trillion yen (where the target would remain until the end of QEMP), is too coincidental to dismiss the possibility that, yielding to political pressure, the BOJ created additional room for unsterilized intervention. At least, this is how those on the government side seemed to perceive the situation (Mizoguchi 2004).

Remarkable, however, is the complete absence in the Policy Board minutes of any reference to foreign exchange market intervention.[17] Equally remarkable, not a single reference to foreign exchange market intervention appears in a book-length analysis of Japanese monetary policy during 1998-2005 by Ueda (2005), who was a Policy Board member during that time. It is possible that, given the operational independence of the Bank of Japan, the central bankers conscientiously avoided any appearance of their decisions being influenced by government actions by keeping complete silence about intervention; it is unimaginable that they would have admitted yielding to political pressure even if they had in fact done so.

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sector). As is expected, the size of these government payments and receipts far exceeds that of foreign exchange market operations.

[17] The minutes of a monetary policy meeting of the Policy Board are released to the public, in the Japanese original and English translation, a month after the meeting (available at www.boj.or.jp/en/mopo/). These are not the full transcript. According to the BOJ's transparency policy, the full transcripts are released to the public only after 10 years. This means that we must wait until 2013 and 2014 to know if any reference was made by any member of the Board to foreign exchange market intervention as a basis for a monetary policy decision during the great intervention.

But a detailed analysis of each of the nine decisions to raise the CAB target under QEMP reveals that Board members often disagreed with the proposed decision, leading to a split vote in six of the nine cases. The Policy Board articulated in each case why an increase in the CAB target was warranted on the basis of its technical assessment of the prevailing economic and financial conditions; only in one case (20 May 2003) was there a passing reference to exchange rate volatility (but not foreign exchange market intervention) as part of the background against which the Board took the decision (Umeda 2011). Compelled in a press conference to explain the relationship between foreign exchange market intervention and the just announced decision to raise the CAB target, on 10 October 2003, BOJ Governor Toshihiko Fukui stated that the BOJ's decision to supply liquidity was based on its assessment of overall economic conditions, and categorically denied any notion that it had been done to effect unsterilized intervention (as quoted in Umeda 2011, p. 151).

In order to test formally the hypothesis that MOF intervention did not change BOJ behavior, we use the following ordered probit model:

$$PBD_t^* = c_3 + \beta_3 CMI_t + \varepsilon_{3t} \tag{12}$$

$$PBD_t = \begin{cases} 0 & \text{if } PBD_t^* \le \gamma_1 \\ i & \text{if } \gamma_i < PBD_t^* \le \gamma_{i:+1} \\ 9 & \text{if } \gamma_9 < PBD_t^* \end{cases}$$

where PBD_t refers to a discrete variable that represents the CAB target at time t, as determined by one of the ten BOJ Policy Board decisions to raise the CAB target (see Table 3), such that PBD_t takes the value of 0 for the CAB balance following the first decision, the value of 1 following the third decision, and so forth; PBD_t^* is an unobservable

continuous variable that corresponds to PBD_t; CMI_t is the value of cumulative interventions up to time t; γ_i (i=1,9) is a threshold value of PBD^* that triggers a BOJ decision to raise the CAB target to the next level; c_3 and β_3 are parameters to be estimated; and ε_3 is an error term. The maximum likelihood estimates of the parameter β_3, along with the threshold parameters, reject the hypothesis that the Bank of Japan systematically raised the CAB target in response to the value of cumulative interventions (Table 4). While the model fits the data fairly well (with a pseudo R-squared of 0.8), the estimated value of β_3, though positive, is not statistically significant (with the p-value of 0.253). Likewise, Granger causality tests (not formally reported here) have rejected the hypothesis that MOF interventions caused the actual CAB balance or the CAB target.

Part of the lack of strong quantitative evidence supporting causality from MOF interventions to BOJ decisions to raise the CAB target comes from the fact that the Bank of Japan took several decisions to raise the CAB target aggressively during the first half of the period while a greater part of the interventions took place toward the end of the period (Figure 13). But it is still possible that the Bank of Japan raised the CAB target in anticipation of future MOF interventions, in which case MOF interventions did influence monetary policy. At least, the Bank of Japan created room for unsterilized interventions by the Ministry of Finance. Iwata (2010), Deputy Governor of the Bank of Japan from March 2003 to March 2008, while stressing the near equivalence between the amount of intervention and the change in base money as a coincidence, endorsed the MOF-BOJ interaction as equivalent to central bank purchases of foreign bonds when the acquisition of

foreign assets by the government was consolidated with the acquisition of JGBs by the central bank.

IV. Conclusion

This paper has considered the political economy of foreign exchange market intervention in a country, such as Japan and the United States, where two separate entities are responsible for intervention and monetary policy decisions. Noting the large scale of intervention conducted under the framework of quantitative easing during 2001-04, we used the case of Japan to motivate a theoretical model of the interaction between the Ministry of Finance (responsible for intervention) and the Bank of Japan (responsible for monetary policy). Estimation of the central bank reaction function derived from the model confirmed the theoretical prediction, namely, the BOJ determined the degree of sterilization on the basis of the size of intervention relative to the deviation of the current account balances (CAB) from the target. In particular, the BOJ accommodated a greater portion of the intervention when the actual CAB was farther below the target, while it fully sterilized when the target was already reached. There was also non-linearity in central bank response in that non-sterilization became progressively more intense as the CAB deviation was larger.

An important implication of the political economy model is that the Ministry of Finance can alter central bank behavior with respect to the monetary base if the central bank target or the political costs of sterilization become endogenous to the size and persistence of intervention. Our assessment of whether the MOF changed the monetary policy of the central bank by injecting liquidity through massive foreign exchange market

intervention depends on how we interpret the successive increases in the CAB target made by the BOJ. Over the period of QEMP, the rapid growth in base money was almost exactly matched by the amount of cumulative interventions by the Ministry of Finance. While this is too coincidental to dismiss the possibility that, yielding to political pressure, the BOJ created additional room for unsterilized intervention, the official minutes of the BOJ Policy Board meetings are silent about foreign exchange market intervention as a factor in its monetary policy decisions. Nor do formal econometric tests give quantitative evidence supporting causality from intervention to monetary policy.

Whether the MOF did or did not in practice change BOJ behavior during 2001-04 is of secondary importance, from the point of view of how society should design an institutional arrangement for exchange rate and monetary policies. The critical point is that, in a system where the government is in charge of intervention decisions while the central bank is given operational independence to pursue its own monetary policy objectives, there is potential room for government interference with the independence of the central bank when the political costs of sterilization become large. A conflict could arise if the objectives, or the judgment of prevailing economic and financial conditions, differed between the government and the central bank. On the other hand, if the two agencies share the same objectives and judgment, a case can be made for eliminating the duplication by transferring the intervention authority of the government to the central bank, as is already the case in many countries. Then, exchange rate policy can be made consistent with, and subordinated to, monetary policy, with the exchange rate used as an instrument of

achieving price stability (if not to maintain a certain exchange rate level).[18] This type of arrangement makes sense in some small open economies, such as Singapore, where the exchange rate is a more direct instrument of influencing the price level than a market interest rate (Parrado 2004); likewise, central banks under inflation targeting should be given authority to intervene in the foreign exchange market if the domestic price level is significantly determined by the exchange rate (Gersl and Holub 2006; Kamil 2008).

Under normal conditions it makes little sense for the government to intervene in the foreign exchange market against the judgment of the central bank. Unless interest rates are at the zero lower bound or interest is paid on excess reserves, the central bank is obliged to undo the monetary impact of any intervention operation by the government. Without the support of the central bank, therefore, intervention would have no monetary policy effect on the exchange rate. Moreover, unless the direction of intervention is the same as the expected future stance of monetary policy, no signaling effect could be expected in any case. There is even a possibility that foreign exchange market intervention sends a wrong signal about monetary policy. It is for this reason that Shirakawa (2008) argues that the authority to make intervention decisions should be given to the central bank; or at least the government should be required to consult with the central bank before intervening in the foreign exchange market. This appears to be the case in the United States, where there is said to be a "mutual veto system" between the Treasury and the Federal Reserve and,

[18] The central bank cannot pursue price and exchange rate stability at the same time unless it resorts to capital controls.

according to an informal agreement reached in the late 1970s both agencies usually provide roughly equal amounts of funds when official intervention does take place (FRB 2005).[19]

But what could society do when its independent central bank began to abuse its power by making a series of wrong decisions? Does it have to sit still until the term of the incumbent governor (or all of its Board members) ends? Or should there be an additional channel of checks and balances? Endowing the government with the authority to intervene in the foreign exchange market could play such a role of enhancing the democratic accountability of an independent central bank. In Japan, the Ministry of Finance at least came close to using (if not actually used) this authority to expand the balance of base money when it thought the policy stance of the Bank of Japan was insufficiently easy. The benefits are not entirely one-sided. This arrangement, by giving the intervention authority to the government, protects the central bank from political pressure to intervene especially in a country with a powerful trade lobby. It helps preserve the credibility of monetary policy under normal conditions when the central bank has no intention to change the stance of monetary policy and intervention is therefore of little efficacy as a tool of exchange rate policy.

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Table 1. Bank of Japan's Daily Reaction Function under QEMP:
A Linear Model

Variable	Coefficient	Standard error	t-statistic	Probability
Constant	199.2551	273.8592	0.727582	0.467101
ITV (β_{11})	-0.05952	0.212983	-0.27944	0.779982
D_1 ITV (β_{12})	0.732272	0.314194	2.330641	0.020042
D_2 ITV (β_{13})	1.045596	0.36893	2.83413	0.004721
Adjusted R-squared	0.019983	Durbin-Watson statistic		1.98939

Notes: D_1 and D_2 take the value of unity 16 and 43 times, respectively, with all other interventions taking place when CAB was above the target; the number of observations is 739.

Table 2. Bank of Japan's Daily Reaction Function under QEMP:
A Non-Linear Model

Variable	Coefficient	Standard error	t-statistic	Probability
ITV (β_2)	1.535974	0.491813	3.123087	0.0019
DEV (η_2)	0.000128	5.73E-05	2.239735	0.0254
Constant (c_{21})	-2957.079	1975.101	-1.497179	0.1348
Constant (c_{22})	8987.236	3167.889	2.836979	0.0047
Constant (c_{23})	7644.518	3691.805	2.070672	0.0387
Adjusted R-squared	0.080123	Durbin-Watson statistic		1.872804

Notes: standard errors and covariance are estimated by White heteroskedasticity-consistent estimators because, unlike the linear case, heteroskedasticity cannot be rejected; a Ramsey RESET test was used to reject the hypothesis of linearity (with an F-statistic of 12.891 and the p-value of 0); the restriction β_2=1cannot be rejected by a Wald test with a chi-square statistic of 1.18765 and the p-value of 0.2758.

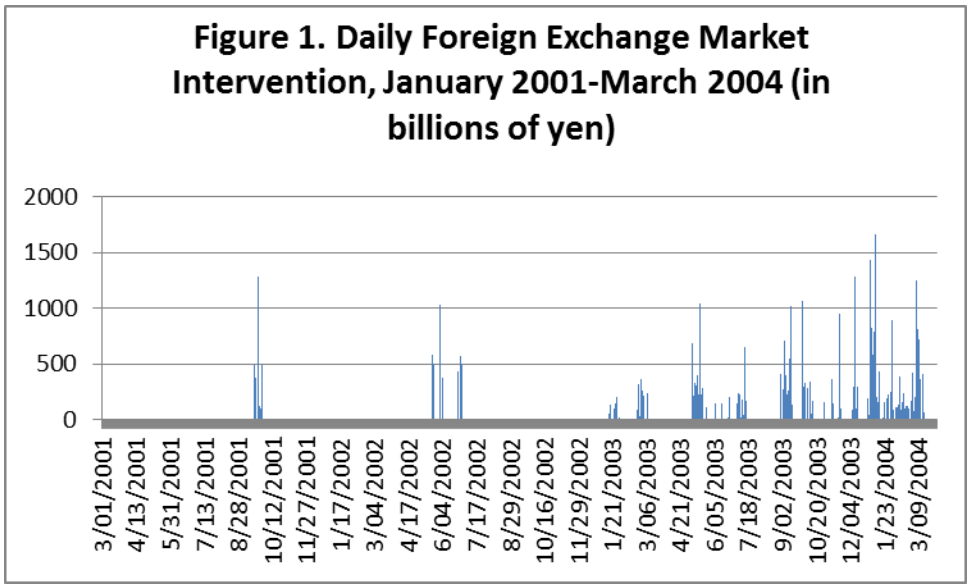
Table 3. Monetary Policy Decisions under Quantitative Easing, March 2001-January 2004

Policy Board meeting where the decision was made	Targeted current account balances (CAB)	Monthly purchases of Japanese government bonds (JGBs)
19 March 2001	About 5 trillion yen	400 billion yen
14 August 2001	About 6 trillion yen	600 billion yen
18 September 2001	Over 6 trillion yen	--
19 December 2001	About 10-15 trillion yen	800 billion yen
28 February 2002	--	1 trillion yen
30 October 2002	About 15-20 trillion yen	1.2 trillion yen
25 March 2003	About 17-22 trillion yen 1/	--
30 April 2003	About 22-27 trillion yen	--
20 May 2003	About 27-30 trillion yen	--
10 October 2003	About 27-32 trillion yen	--
20 January 2004	About 30-35 trillion yen	--

1/ Effective 1 April 2003. This was explained as a technical adjustment necessitated by the conversion of the Postal Services Agency (in charge of postal savings) into Japan Post Public Corporation as part of a long-term privatization plan.
Source: Bank of Japan.

Table 4. Ordered Probit Model of Bank of Japan Decisions: Maximum Likelihood Estimates

Variable	Coefficient	Std. Error	z-Statistic	Probability
β_3	0.004828	0.004226	1.142332	0.2533
Threshold parameters				
γ_1	0.808073	0.125846	6.421141	0.0000
γ_2	2.523451	0.405992	6.215518	0.0000
γ_3	154.6156	135.6994	1.139398	0.2545
γ_4	349.1948	305.4462	1.143228	0.2529
γ_5	459.1957	402.3471	1.141292	0.2537
γ_6	460.5573	402.3474	1.144676	0.2523
γ_7	569.8181	498.8199	1.142332	0.2533
γ_8	1090.956	955.1157	1.142223	0.2534
γ_9	1592.681	3.29E+11	4.84E-09	1.0000
Pseudo R-squared	0.800380	Observations		739



Source: Ministry of Finance.

Figure 2. The Central Bank Reaction Function ($\omega > 0$)

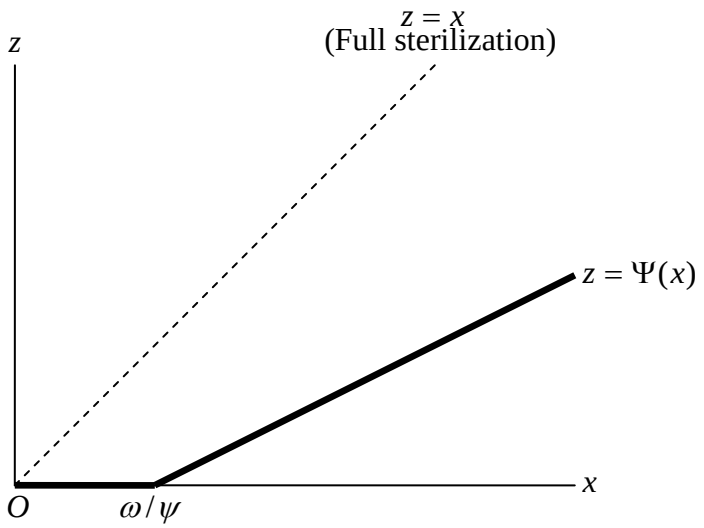


Figure 3. The Central Bank Reaction Function ($\omega < 0$)

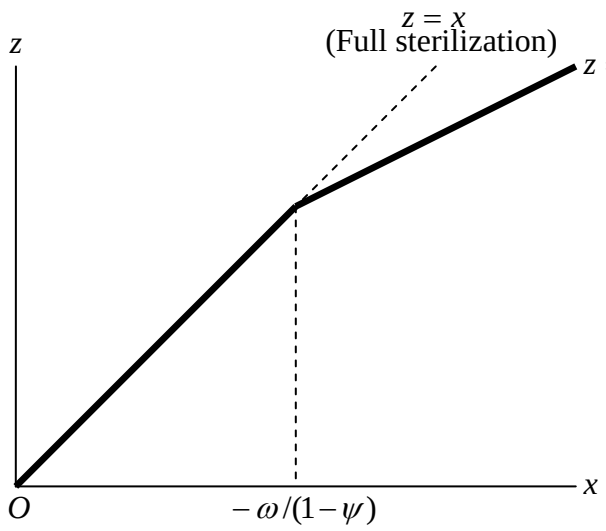


Figure 4
Monetary Base Deviations and Corresponding Central Bank Reaction Functions

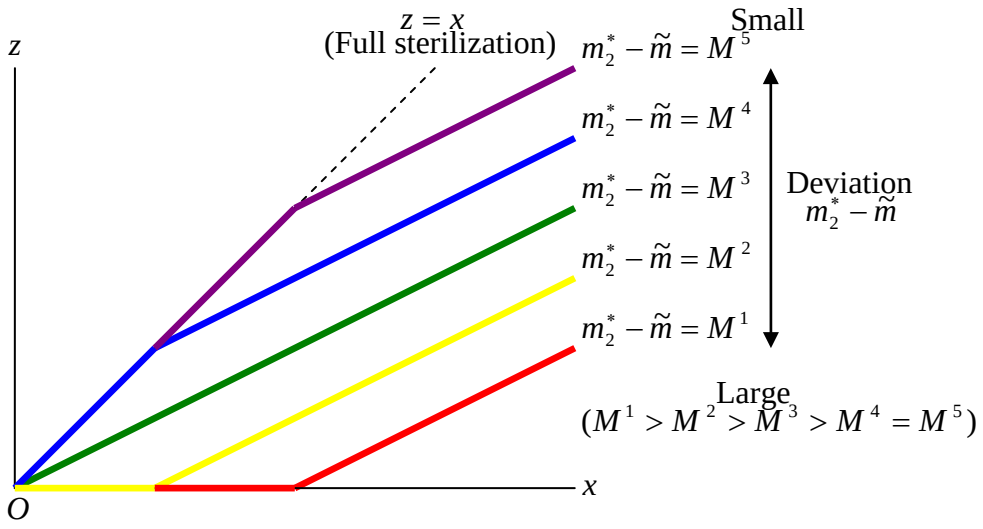
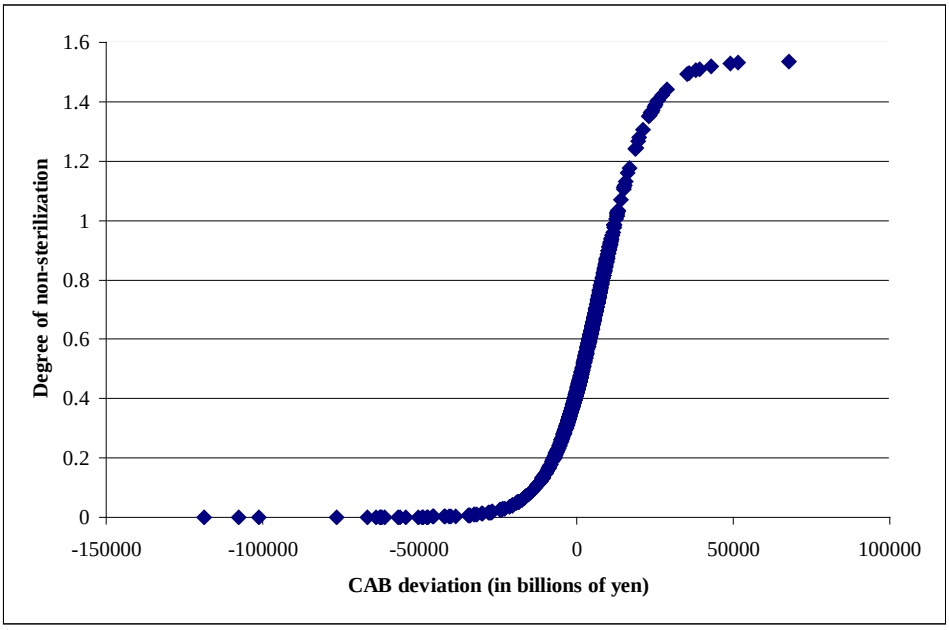


Figure 5. Bank of Japan Response to Daily Intervention, March 2001-March 2004



Notes: Zero non-sterilization (on the vertical axis) means that intervention is fully sterilized; a positive CAB deviation (on the horizontal axis) indicates that the CAB falls short of the target.

Figure 6.
The Monetary Impact of Intervention ($\omega > 0$)

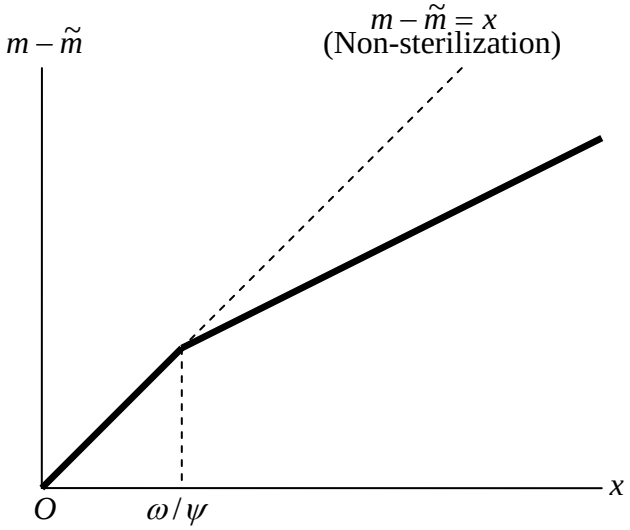


Figure 7.
The Monetary Impact of Intervention ($\omega < 0$)

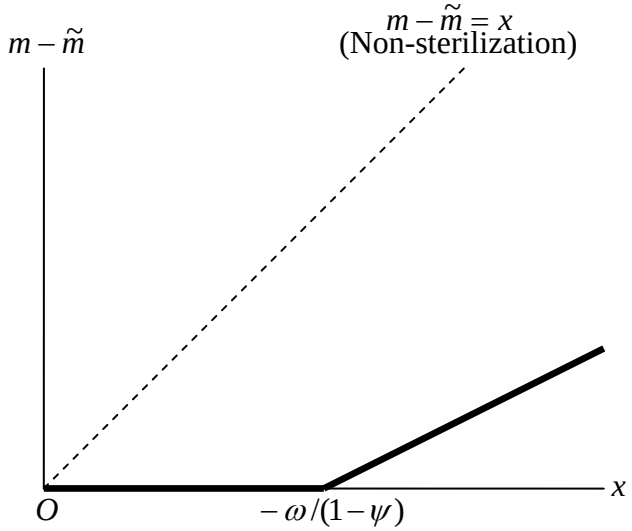


Figure 8.
The Monetary Impact of Intervention When the Target Changes

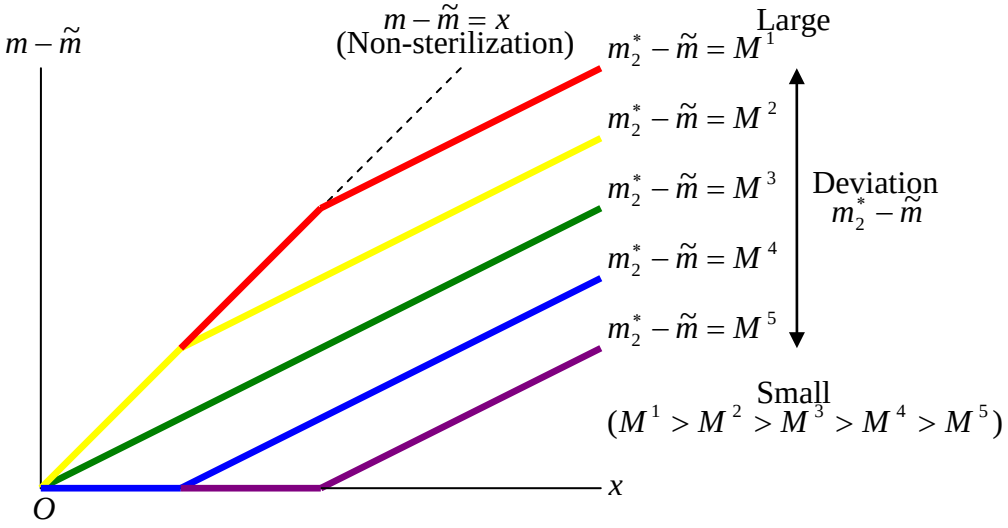
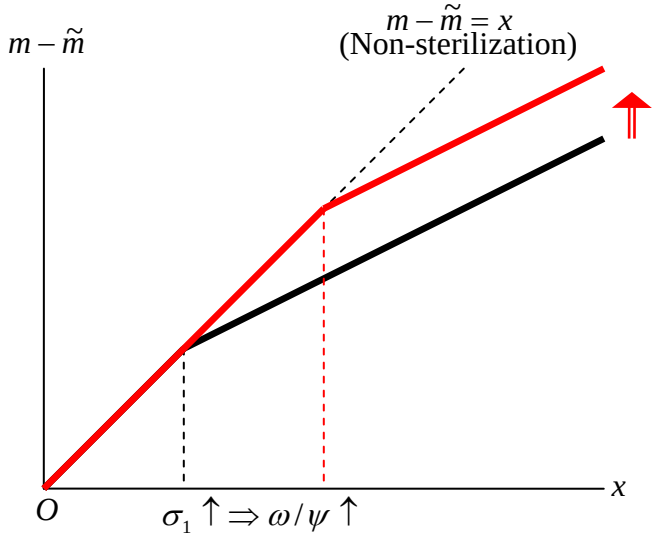


Figure 9.
The Monetary Impact of Intervention When the Costs of Sterilization Change ($\omega > 0$)

(i) The case of an increase in σ_1



(ii) The case of an increase in σ_2

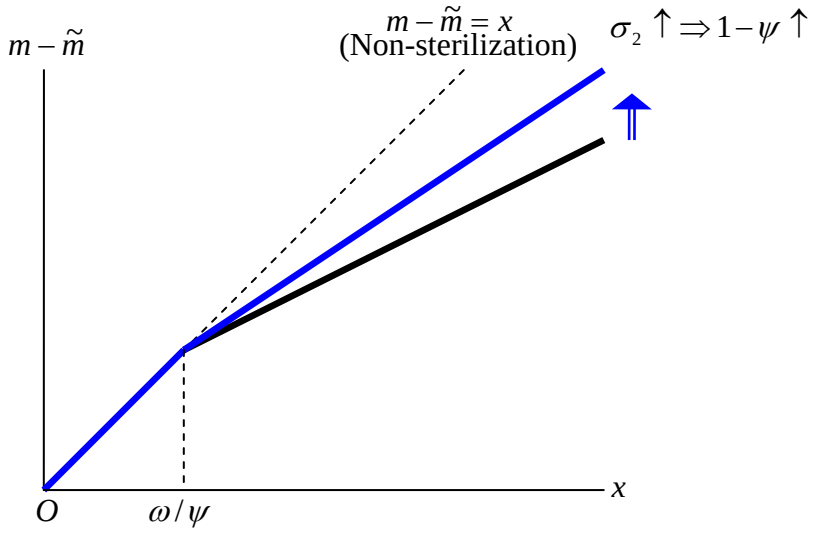
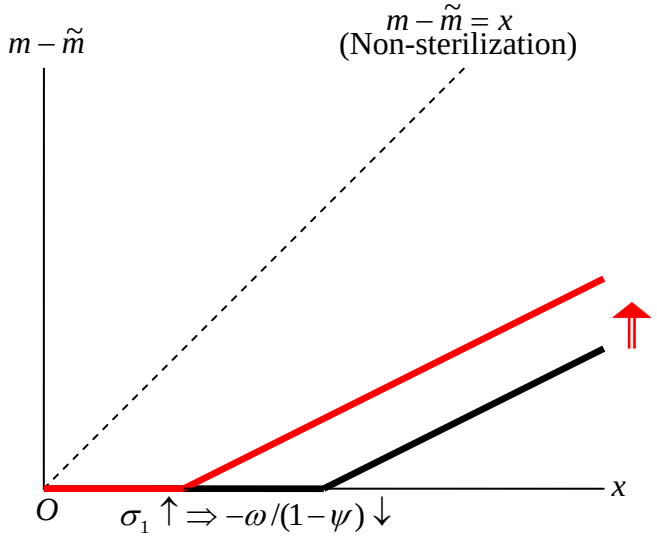
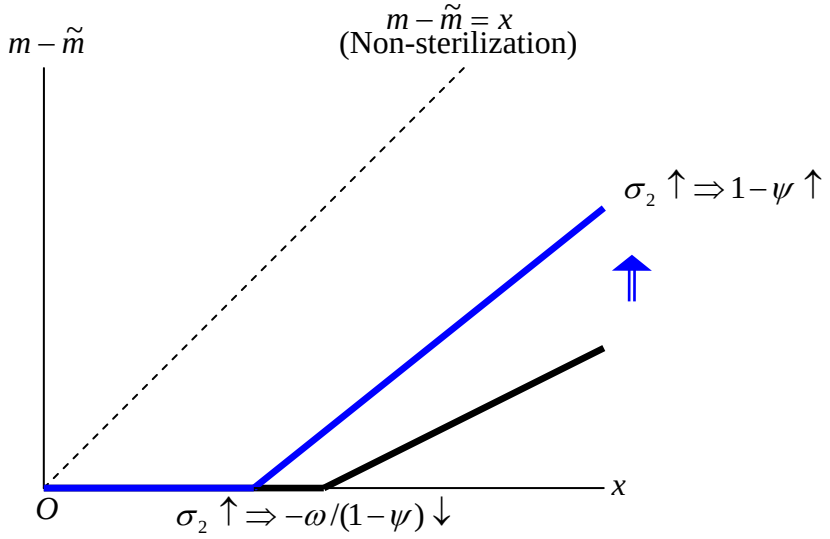


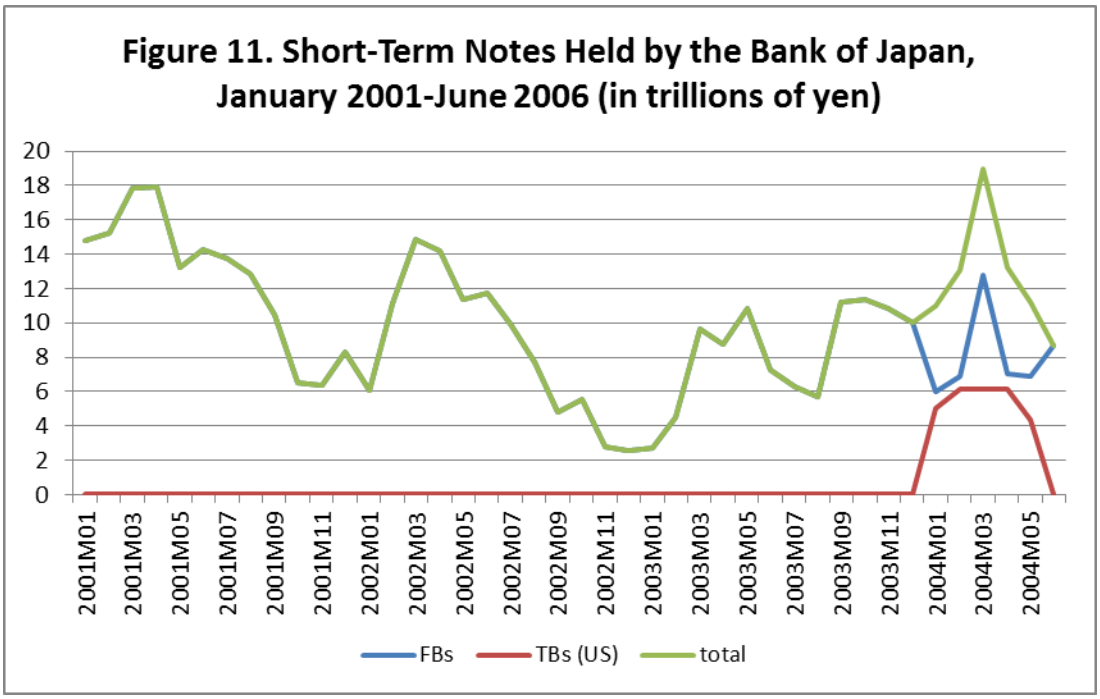
Figure 10.
The Monetary Impact of Intervention When the Costs of Sterilization Change ($\omega < 0$)

(i) The case of an increase in σ_1

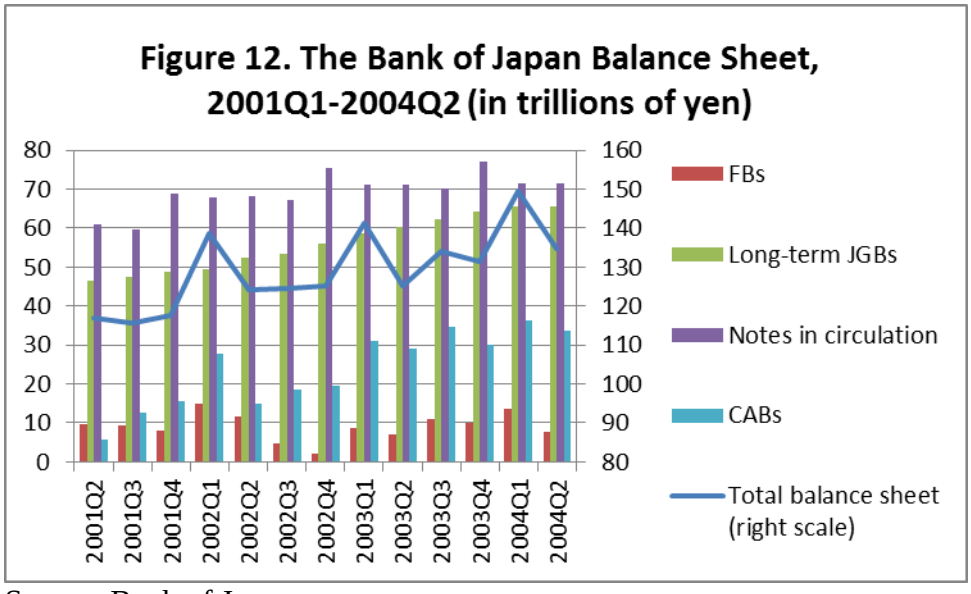


(ii) The case of an increase in σ_2





Source: Bank of Japan.



Source: Bank of Japan

Figure 13. Cumulative Interventions (CMI) and Discrete CAB Target Increases (PBD)