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Managed Floating as a Monetary Policy Strategy*

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Abstract:

Although there seems to be a broad consensus among economists that purely floating or completely fixed exchange rates (the so-called corner solutions) are the only viable alternatives of exchange rate management, many countries do not behave according to this paradigm and adopt a strategy within the broad spectrum of exchange rate regimes that is limited by the two corner solutions. Many of these intermediate regimes are characterized by significant foreign exchange market interventions and a certain degree of exchange rate flexibility with non-preannounced exchange rate targets. While academic research in this area usually concentrates on some specific aspects of intermediate regimes (such as the effectiveness of interventions or institutional aspects), managed floating has rarely been analyzed as a comprehensive monetary policy strategy. In this paper, we present a monetary policy framework in which central banks simultaneously use the exchange rate and the interest rate as operating targets of monetary policy. We explain the mechanics of foreign exchange market interventions and sterilization and we explain why a central bank has an interest of controlling simultaneously the two operating targets. We derive the monetary policy rules for the two operating targets from a simple open economy macro model in which the uncovered interest parity condition and the Monetary Conditions Index play a central role.

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Keywords:

exchange rate regime, monetary policy, interventions, sterilization, floating, Monetary Conditions Index

Abbreviations:

AR	autoregressive
CCL	contingent credit line
ECB	European Central Bank
EMS	European Monetary System
EMU	European Monetary Union
ERM	exchange rate mechanism of the EMS
IFS	International Financial Statistics of the IMF
IMF	International Monetary Fund

MCI	monetary conditions index
NFA	net foreign assets
PPP	purchasing power parity
UIP	uncovered interest parity
VSTF	very short-term financing facility
WTO	World Trade Organization

1 Introduction

While there is large number of central banks practicing the strategy of 'managed floating', this policy regime has so far received relatively little academic interest. Due to this 'fear of floating' of many researchers[1], the central terms 'floating' and 'managed floating' lack a clear and widely shared definition and there is no theoretical framework which lays down the core principles of such a strategy. As a consequence a central bank which intends to adopt managed floating receives almost no academic guidance for the concrete management of monetary and exchange rate policies.[2] This lack of a positive as well as a normative theory of managed floating impairs above all the discussion about the transition to EMU by the countries in Central and Eastern Europe. As most economists are inclined to dismiss all intermediate regimes too easily, the academic discussion is unduly focused on the two corner solutions of the exchange rate spectrum: Euroization and purely floating exchange rates.

The present study intends to fill the gap between central bank practice and academic thinking by providing a theoretical framework for a strategy of managed floating. In Section 2 we start by presenting three different definitions of floating: pure floating, independent floating, and managed floating. The main difference between the latter and the first two forms of floating is that under a managed float the central bank mainly determines the course of the exchange rate without, however, preannouncing the future path. We explain why in standard models for open economy inflation targeting there is no role for interventions in the foreign exchange market. In Section 3 we present a simple theoretical framework for managed floating in which monetary policy uses two operating targets simultaneously: the exchange rate and the short-term interest rate. We show how foreign exchange market interventions as an additional policy tool can be integrated into a simple Neo-Keynesian model of the open economy. We then demonstrate how the two operating targets have to be adjusted if the economy is affected by different shocks. The main difference to purely floating exchange rates concerns the role of shocks to uncovered interest parity. The last Section summarizes the main results.

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[1] While there was some discussion of this issue in the 1980s, in the last few years there are almost no publications that are directly related to a managed floating exchange rate system; for instance, by searching in all free text fields of the EconLit database (December 2002 issue) only 18 publications can be found under 'managed float' and 31 publications under 'managed floating' since 1990.

2 A closer look at the floating rate corner

2.1 'Floating': the predominant exchange rate regime in the New Millennium

In the last decade the international monetary order has undergone a dramatic transformation. Intermediate regimes which had been the prevailing exchange rate arrangement in the early 1990s are now only used by about one third of the IMF's member countries. In the group of developing and emerging market economies the decline has been even more pronounced. Table 1 shows that for all three country groupings floating has become the predominant exchange rate arrangement. Hard pegs could also profit from the 'vanishing middle', especially in developing countries, but their market share remains much lower than the share of floating.

Table 1

In the literature this 'hollowing out' has been widely welcomed and is even recommended as an optimum solution for almost all countries (Fischer, 2001, Frankel, 1999, Summers, 2000). Eichengreen (1999, p. 105) has become a specially prominent promoter of this approach: "Hence, the IMF needs to more forcefully encourage its members to move to policies of greater exchange rate flexibility, and the sooner the better. With few exceptions it should pressure its members, in the context of Article IV consultations and program discussions, to abandon simple pegs, crawling pegs, narrow bands and other mechanisms for limiting exchange rate flexibility before they are forced to do so by the markets."

2.2 Floaters frequently intervene in the foreign exchange market

Actual policies however often diverge from official declarations. While hard peg regimes can be easily identified by looking at the exchange rate time series and the institutional setting surrounding the currency regime, the floating corner can only be verified by examining the behavior of foreign exchange reserves. According to the textbook model of floating exchange rates, central banks do not intervene in the foreign exchange market so that the level of the central bank's foreign exchange reserves should remain constant or at least be characterized

[2] See Fischer (2001, p. 7) about foreign exchange market interventions in system of managed floating: "This is one of the remaining areas in which central bankers place considerable emphasis on the touch and feel of the market, and where systematic policy rules are not yet common."

by very little volatility (in particular in comparison with intermediate regimes or fixed rate regimes). Empirical work by Calvo and Reinhart (2000) and Levy-Yeyati and Sturzenegger (2002), however, found that in practice countries that officially declare that they allow their exchange rate to float frequently intervene in the foreign exchange market. While foreign exchange reserves are highly volatile for these countries, the volatility of the nominal exchange rate is relatively low (in particular in comparison with countries that really let their currency float). Thus, Calvo and Reinhart (2000, p. 30) come to the conclusion that "the supposedly disappearing middle accounts for the lion's share of country practices."

By concentrating on the floating rate corner, in Bofinger and Wollmershäuser (2001) we went one step further and built an index that classifies foreign exchange market interventions according to their objective which can be divided into two main categories: exchange rate smoothing and exchange rate targeting (Jurgensen, 1983). According to the smoothing objective, interventions are undertaken to counter erratic short-term (day-to-day) exchange rate movements, but not to alter the market determined trend. The changes in the foreign exchange reserves that are related with this objective should be randomly distributed around zero. According to the targeting objective, interventions are undertaken to establish a level or a path for the exchange rate. The changes in the foreign exchange reserves that are related with this objective are expected to exhibit a high degree of persistence (a purchase of foreign exchange is followed by several successive purchases and vice versa) since their purpose is to counter an existing market trend. The results of our study in which we investigated the behavior of foreign exchange reserves of 44 countries for the periods in which they officially declared to follow an independent or a managed float (between 1975 and 2000) are striking. We found that 77 per cent of the official independent floaters actually pursued an exchange rate targeting strategy. 10 per cent intervened to smooth erratic exchange rate movements, and only 13 per cent behaved according to the textbook model of floating exchange rates and rarely made use of their foreign exchange reserves. For the official managed floaters we found that 89 per cent pursued an exchange rate targeting strategy and that 11 per cent intervened to smooth erratic exchange rate movements.

As an additional stylized fact we found that most of the interventions are sterilized. Of those central banks that predominantly used interventions to target a level or a path of the exchange rate our estimates showed that 10 (19) out of 27 countries in the sample sterilized more than

90 (70) per cent of the impact of the change of foreign reserves on the monetary base. These results are in line with those of other studies (Hüfner, 2003, Rhee and Song, 1999, Wu, 1999).

2.3 Three forms of floating

In many policy-related discussions the spectrum for exchange rate arrangements is reduced to the three central options of 'hard pegs', 'intermediate regimes', and 'floating'. While this gives some impression on the main choices, our empirical study has shown that an understanding of managed floating requires a more detailed classification. In our view, the IMF's International Financial Statistics classification of exchange regimes is quite useful in this regard. For the floating corner it uses the following two sub-categories:

- Managed floating: no pre-announced path for the exchange rate; the monetary authority influences the movement of the exchange rate through active intervention in the foreign exchange market without specifying, or pre-committing to, a pre-announced path for the exchange rate.
- Independent floating: the exchange rate is market determined, with any foreign exchange market intervention aimed at moderating the rate of change and preventing undue fluctuations in the exchange rate, rather than establishing a level for it.

At least from a theoretical point of view it seems useful to add an additional category:

- Pure floating: the exchange rate is market determined with no foreign exchange market intervention at all; changes in foreign exchange reserves are due to technical factors only.

Summarizing these three arrangements under the heading of 'floating' can create the impression that their economic rationale is more or less identical. However, a careful reading of the definitions shows a very important difference. While pure and independent floating imply that the exchange rate path is mainly determined by the market, under a managed float the exchange rate path is mainly determined by the central bank. In other words, what distinguishes managed floating from the intermediate solutions (like crawling pegs or fixed pegs) is not a different form of exchange rate determination; rather, it is the fact that there is no preannounced path for the exchange rate. For a theoretical understanding of managed floating it is therefore not sufficient to treat it simply as a variant of independent or pure floating. The very fact that under managed floating central banks try to target the exchange rate requires a positive analysis of this policy, as well as a normative theory designing policy rules for managed floating.

2.4 No role for foreign exchange market interventions in standard open economy macro models

Important models with policy rules for open economies have been presented by Ball (1999) and Svensson (2000). Both authors base their papers on a textbook view of pure floating and an autonomous monetary policy setting in which the central bank targets a short-term interest rate. At the core of these models there is always a stable relationship between the short-term interest rate and the exchange rate. Svensson (2000), for example, assumes that the exchange rate is determined by the market according to uncovered interest rate parity (UIP). Instead of UIP, the paper of Ball (1999) uses a rather simple structure for the international linkages of an open economy which assumes a static and positive relationship between the real exchange rate and the domestic real interest rate.

Concerning the role of foreign exchange market interventions in such models Svensson (2001, p. 48) states: "I see no reason why a transparent inflation-targeter should undertake foreign-exchange interventions". In another paper he explains the reasons for his view: "In practice, flexible inflation targeting, with a longer horizon to meet the inflation target and concern for output-gap variability, will normally mean a more gradual approach and a less activist policy and hence reduced interest rate variability. Since interest rate changes lead to exchange rate changes, everything else equal, this also reduces exchange rate variability. Increased credibility and increasingly stable inflation expectations will reduce a major source of shocks to both interest rates and exchange rates. Thus, successful and credible flexible inflation targeting is likely to contribute to less variability of interest rates and exchange rates" (Svensson, 2002, pp. 272).

However, with their reliance on UIP or any other relationship between the exchange rate and the interest rate, such models rest upon a pillar for which no empirical evidence can be found. In particular the assumption of a valid UIP is thoroughly challenged by the so-called "forward discount bias" (Froot and Thaler, 1990, Lewis, 1995). Thus, if a central bank follows the policy rule prescribed by Ball or Svensson, it has to be aware of the fact that it relies on unrealistic exchange rate theory. In our view, this discrepancy between the two theoretical models and the empirical reality can be regarded as the prime explanation of why there is so much foreign exchange market intervention by central banks. The models by Ball and

Svensson cannot provide a theory of managed floating since they do not take into account the lack of a stable relationship between macroeconomic fundamentals and the exchange rate which is the very rationale for managed floating.

3 A theoretical framework for managed floating

While pure floating (and to some extent also independent floating) are sufficiently discussed in the extensive literature on flexible exchange rates, there has been astonishingly little theoretical discussion of managed floating. Above all it is unclear

- how the exchange rate can be controlled effectively and independently from short-term interest rates (Section 3.1),
- how the exchange rate enters an open economy macro model as an additional and independent operating target (Section 3.2), and
- how the appropriate level of the two operating targets (exchange rate and the short-term interest rate) should be determined simultaneously (Section 3.3).

3.1 Controlling the exchange rate with sterilized interventions

The simultaneous management of the exchange rate and the interest rate implies that the central bank is able to target the exchange rate by means of sterilized interventions. This is possible since the central bank has two independent instruments at its disposal. With open-market operations (or any other refinancing operation) a central bank exchanges short-term domestic notes (or other short-term domestic liabilities) against domestic central bank reserves in order to target a level of the short-term interest rate. As a result the monetary base changes and the central bank balance sheet is extended. With foreign exchange market interventions a central bank exchanges foreign sight deposits against domestic central bank reserves in order to target the exchange rate. If the intervention is sterilized, the monetary base remains constant and also the size of central bank balance sheet. However, the structure of the central bank's assets has changed. It is important to see that when the monetary base remains constant, the short-term interest rate also remains at an unchanged level. In both cases the operating target is controlled directly by interventions in the relevant market (domestic money market, foreign exchange market).

While it is uncontested today that central banks are able to perfectly control short-term interest rates, many economists are in doubt that a direct control of the exchange rate is possible at all. They argue that this due to the sheer size of foreign exchange markets or that a control of the exchange rate can only be achieved with a limited control over the interest rate which is normally not acceptable. Schwartz (2000, p. 26), for example, states: "(...) monetary policy can support either domestic or external objectives. Monetary policy cannot serve both." This is similar to saying that, if both instruments are assumed to be independent from each other due to full sterilization of the foreign exchange market interventions, then these interventions are deemed to be ineffective. In addition to that, it is often argued that sterilized intervention are associated with interest rate costs that a central bank is not willing to accept. In the following we will discuss these points more in detail.

3.1.1 The portfolio-balance channel of sterilized foreign exchange market interventions

The relevant channel for explaining the effectiveness of interventions of central banks that buy and sell foreign reserves on a regular basis and with significant amounts is the portfolio-balance channel. The idea behind this channel is derived from the portfolio-balance models of exchange rate determination according to which international investors are supposed to hold two interest bearing assets in their portfolios: domestic government bonds denominated in domestic currency, and foreign government bonds denominated in foreign currency. For a given supply of assets, in equilibrium the return on domestic bonds i_t has to equal the expected return on foreign bonds which itself is the sum of the foreign interest rate i_t^f, the expected exchange rate change $(E_t s_{t+1} - s_t)$[3] and a time-varying risk premium rp_t:

(1) $$i_t = i_t^f + E_t s_{t+1} - s_t + rp_t \, .$$

This equation is the well-known UIP condition. Its extension by a risk premium stems from the assumption that domestic and foreign assets are imperfect substitutes and that investors are risk-averse. Such a risk premium has to be interpreted as the rationally expected excess return that a domestic investment must offer in order to induce international investors to willingly hold the existing supply of domestic and foreign bonds.

Therefore, in portfolio-balance models, asset holders are not indifferent to the currency composition of their portfolios. Thus, if sterilized interventions are assumed to work through a portfolio-balance channel they affect the exchange rate by inducing investors to rebalance their portfolios. With an exchange of foreign assets against domestic assets the central bank alters the composition of the supply of assets and hence, the stock of domestic relative to foreign assets that the private sector has to hold in its portfolio. As the two assets are imperfect substitutes investors only accept the modified asset stock if the risk premium and with it the spot rate changes (given the interest rate differential[4] and the exchange rate expectations). Suppose, for example, that international investors view domestic bonds to be less risky than foreign bonds (which implies that $rp_t < 0$). The reason why the risk premium must fall (rise) in the case of a sterilized sale (purchase) of foreign assets by the domestic central bank is that asset holders must be compensated by a higher (lower) expected return on foreign assets in order to induce them to buy the increased (decreased) relative supply of foreign to domestic assets.

Thus, instead of viewing the risk premium as purely exogenous, the portfolio-balance approach suggests the following decomposition of rp_t

(2) $$rp_t = \lambda\left[da_t - \left(fa_t - s_t\right)\right] + \varepsilon_t^{rp}$$

where da_t and fa_t are logs of domestic and foreign assets held by the public and ε_t^{rp} is an exogenous risk premium shock (McCallum, 2000). λ reflects the degree of risk aversion. If UIP is for example hit by a positive risk premium shock, leading to an appreciation of the domestic currency, sterilized purchases of domestic assets against foreign assets by the central bank (da_t falls whereas fa_t rises) offset the resulting fall in the spot rate by counteracting the change in the risk premium. Seen from this portfolio-balance perspective sterilized intervention implies a certain commitment by a central bank since the risk of the open position is at least partially determined by the central bank's own actions – irrespective of whether the central bank buys or sells foreign currency. In the case of an appreciating domestic currency, the central bank runs the risk that the domestic value of its foreign exchange reserves is reduced by an appreciation of the domestic currency which the central bank intends to prevent. In the case of a depreciating domestic currency the opposite applies.

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[3] Note that a rise in s_t (which is the log of the nominal exchange rate) represents a depreciation.
[4] Above all the domestic interest rate remains unchanged because of the sterilisation of the sale of foreign assets.

3.1.2 Some critical comments on the effectiveness debate

The effectiveness of foreign exchange market interventions has been discussed in many theoretical and empirical studies. The results are mixed especially for the case of sterilized interventions (Edison, 1993, Sarno and Taylor, 2001). The most serious flaw of this literature is that almost all papers analyze the mark-dollar rate. Interventions in this market have been extremely small so that the lack of a firm empirical evidence for the effectiveness of such interventions can simply be explained with an insufficient dose of intervention. In other words, analyses of the mark-dollar rate cannot be taken as an evidence for the ineffectiveness of managed floating in emerging market economies and other developed countries where the relative amount of interventions is in some case several times higher (see Bofinger and Wollmershäuser, 2001, where we built an index of relative intervention activity, and Canales-Kriljenko, 2003, for a survey of intervention practices among emerging market economies).

In a similar vein, the turnover of foreign exchange market transactions in which the US dollar is involved is incomparably high, especially because of its role as a vehicle currency. For many emerging market economies, however, the relative size of the turnover is much smaller so that central banks can affect the exchange rate with relatively small intervention volumes. In Bofinger and Wollmershäuser (2001) for example, we calculated that the turnover measured as a percentage of the external sector's size was on average more than three times higher in developed market economies compared to emerging markets.

Of course, the ability to target a specific path of the exchange rate crucially depends on the market's pressure on the exchange rate. If the central bank pursues an intervention policy that tries to target a weaker exchange rate than the market rate, its foreign exchange reserve increase. By contrast, an attempt to keep the exchange rate at a stronger than market-clearing level, the central bank loses foreign exchange reserves. Thus, while in the first case there is no limit to the intervention policy since the central bank can always increase the domestic liquidity, in the second case the central bank operates under a 'hard budget constraint' which makes it difficult to pursue such an intervention policy over a prolonged period of time.

The sterilization of interventions requires that the central banks disposes over a set of efficient instruments with which it can mop up the excess liquidity that is created by foreign exchange market interventions. While sales of foreign exchange are easily sterilized without any restriction by an extension of the central bank's credits to the banking system, the case of an intervention that increases domestic liquidity requires an additional instrument. As long as the banking system is a net debtor of the central bank, credits to the banking system can be reduced in parallel with foreign exchange market interventions. However, for the case of interventions that exceed this form of sterilization a central bank has to offer an interest bearing deposit facility so that its sterilization potential is unlimited.

The substitutability between assets denominated in different currencies is a crucial assumption behind the portfolio-balance channel which is often questioned. Sarno and Taylor (2001, p.862), for example, argue that "(...) it is tempting to conjecture that the portfolio balance channel will diminish in importance over time – at least among the major industrial countries – as international capital markets become increasingly integrated and the degree of substitutability between financial assets denominated in the major currencies increases." While this seems plausible for risk-neutral investors, it does not hold if investors are risk-averse. The very fact that investors incur transactions for exchanging a dollar deposit into a euro deposit indicates that the two assets are not regarded as perfect substitutes. With a perfect substitutability of dollar and euro assets it would be also difficult to explain the huge trading volume on foreign exchange markets. Large capital flows are an indication that investors see important qualitative differences in assets that are denominated in different currencies or issued by debtors from different regions. Above all, the microstructure literature that recently attracts considerable attention by exchange rate economists critically hinges on the assumption that portfolio composition matters (Evans and Lyons, 2003).

3.1.3 Avoiding costs of sterilization

Even though a central bank is always able to avoid an unwarranted appreciation of its currency without losing control over the domestic interest rate, the accumulation of sterilization costs (C_t^S) might impose an important budgetary constraint. These costs that are supposed to occur in period t (defined per unit of domestic currency that is supplied in interventions in period t-1) are defined as the sum of interest rate costs (or earnings) (C_t^i) and valuation losses (or returns) from foreign exchange reserves (C_t^V). The interest rate component of the sterilization costs is determined by the difference between the foreign and the domestic interest rate:

(3) $C_t^i = i_{t-1} - i_{t-1}^f$.

This is due to the fact that a sterilized intervention that tries to prevent an appreciation leads to an increase in foreign assets and a decrease in domestic assets; in the case of a deposit facility or the issuance of notes, domestic liabilities increase. Thus, the central bank loses income from domestic assets (or has to pay interest on domestic liabilities) while it receives additional income from an higher amount of foreign assets. It is obvious that sterilized interventions are associated with interest costs (returns) if the domestic interest rate is higher (lower) than the foreign interest rate.

The valuation costs (returns) per unit of sterilization depend on the percentage change of the exchange rate which we express by the difference of the log of the nominal exchange rate:

(4) $C_t^V = -(s_t - s_{t-1}) = -\Delta s_t$.

If the domestic currency depreciates, the value of foreign exchange reserves in terms of the domestic currency increases. The central bank makes a profit from sterilized intervention.

Both cost components can be combined in order to define conditions under which sterilized interventions are free of charge:

(5) $C_t^S = 0 \overset{!}{=} i_{t-1} - i_{t-1}^f - (s_t - s_{t-1})$,

which leads to the ex post formulation of the interest parity condition:

(6) $(s_t - s_{t-1}) = i_{t-1} - i_{t-1}^f$.

In other words, the costs of sterilized intervention are zero if a central bank targets the exchange rate in a way that it follows a path that is determined by the interest rate differential. This guarantees at the same time that there are no profit opportunities for short-term oriented investors which invest in the domestic currency.[5] If the domestic interest rate is higher than the foreign interest rate this advantage is fully compensated by a depreciation of the domestic currency. Thus, the condition of zero costs for sterilized interventions is the mirror image of the condition that the mix of exchange rate and interest policy should not provide profit opportunities for short-term oriented investors. In fact, the profits of these investors are to a large extent nothing else but the sterilization costs paid by the central bank.

3.2 External equilibrium

Section 3.1 showed that the exchange rate can be efficiently targeted by the central bank without costs and without negative side effects on interest rate policy, if the domestic currency is appreciating, if its sterilization potential is unlimited, and if the targeted exchange rate path is compatible with the prevailing interest rate differential. In order to understand the role of the external equilibrium in the context of managed floating it is important to take a deeper look at the behavior of the two major participants of the foreign exchange market: the private investors and the domestic central bank.[6] The private sector's equilibrium condition is captured by UIP:

(7) $$i_t - i_t^f = E_t \Delta s_{t+1} + rp_t .$$

If this condition is met, private market participants should be indifferent between the domestic and the foreign investment, and short-term capital flows do not occur. The equivalent of the private investor's arbitrage condition is the central bank's zero-cost-condition. By augmenting the time subscript in equation (6) we can derive the central bank's external equilibrium condition:

(8) $$i_t - i_t^f = \Delta s_{t+1}^T .$$

According to equation (8) the central bank targets an exchange rate path Δs_{t+1}^T that is equal to the difference of the domestic interest rate (set by the central bank as well) and the exogenous foreign interest rate.

The overall equilibrium condition can be obtained by inserting equation (7) into equation (8):

(9) $$\Delta s_{t+1}^T = E_t \Delta s_{t+1} + rp_t .$$

That is to say, if the central bank's targeted exchange rate path equals the private sector's expected exchange rate change plus the actual risk premium, there is no need for the central bank to intervene in the foreign exchange market.

Otherwise, there is a case for central bank interventions. Two basically different situations have to be distinguished: In the first case, private investors expect to make a profit from an

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[5] In our context the short term refers to a period of one or at most three months which corresponds to the maturity of the interest rates that is normally assumed to be under the control of the central bank.

[6] We will see below that the foreign central bank also has an important impact on our equilibrium conditions, mainly by setting the foreign short-term interest rate i_t^f. But as this will be treated as being exogenous to the domestic central bank's policy decision, it is sufficient to concentrate on these two participants.

investment in the domestic currency which leads to capital inflows. The sum of the private sector's expectations about the future exchange rate path and the required risk premium are more than compensated by the given actual interest differential and the given actual spot rate:

(10) $i_t - i_t^f = \Delta s_{t+1}^T > E_t \Delta s_{t+1} + rp_t$.

In a world of managed floating the central bank intervenes in the foreign exchange market in order to absorb the excess supply of foreign exchange. This guarantees that the central bank achieves the desired exchange rate path Δs_{t+1}^T . At the same time, it is able to keep the interest rate at its level i_t because of the immediate sterilization of the accumulated foreign reserves.

The second case is characterized by capital outflows which can be described as follows:

(11) $i_t - i_t^f = \Delta s_{t+1}^T < E_t \Delta s_{t+1} + rp_t$.

The actual interest rate differential does not compensate for the expected exchange rate change and the required risk premium, and hence, international investors prefer the foreign investment. As the central bank's objective is to realize Δs_{t+1}^T , it has to sell foreign assets in order to satisfy the excess demand for foreign exchange. Here again, the sterilization issue is not a problem as long as the desired exchange rate path is achieved. But in contrast to the capital inflow case, now the central bank is restrained by its stock of foreign reserves. But this does not mean that the central bank is not able to realize Δs_{t+1}^T at all. As long as its reserves exceed a critical threshold, say NFA^c, the central bank can credibly achieve the desired path through sterilized interventions. But as soon as the current stock of foreign reserves is perceived as too low by the international investors, capital outflows will accelerate and the central bank looses its intervention instrument.

In sum, sterilized foreign exchange market interventions can be described by the following implicit function:

(12) $I_t = \Delta NFA_t = f\left(\Delta s_{t+1}^T - E_t \Delta s_{t+1} - rp_t\right)$,

where f(0) is equal to zero and where the first derivative f' is always positive. Theoretically, I_t can adopt values ranging from $-NFA^c$ to infinity. Thus, equation (12) completes our portfolio-balance analysis of foreign exchange market interventions in Section 3.1.1.

In three of the cases described above (the case without interventions, the capital inflow case, and the capital outflow case with sufficient foreign reserves) the central bank is able to realize its target path for the exchange rate:

(13) $i_t - i_t^f = \Delta s_{t+1}^T$.

There is only one, but of course very important, case in which the central bank looses the control over its operating target: the capital outflow case with foreign reserves falling below NFA^c. In this situation the central bank is no longer able to target the exchange rate through sterilized interventions. It rather has to adjust its interest rates in order to stop the capital outflow so that the external equilibrium condition becomes

(14) $i_t = i_t^f + E_t \Delta s_{t+1} + rp_t$.

3.3 Internal equilibrium

The internal equilibrium is characterized by the purpose of the central bank to stabilize its ultimate goals by means of an adequate setting of its operating targets. In order to derive the internal equilibrium condition, we start with the transmission channels of monetary impulses in a small open economy: the exchange rate channel and the interest rate channel.

With the interest rate channel, monetary policy affects aggregate demand via its effect on the short-term real interest rate. Subsequently, aggregate demand affects inflation via the supply-side of an economy which is often described by a Phillips-curve relation. In this respect we follow the current mainstream in monetary macroeconomics according to which the money stock only plays a minor role in describing monetary policy effects. The exchange rate channel can be divided into a direct and an indirect channel. The direct channel explains inflation fluctuations via the pass-through of exchange rate fluctuations to import prices, and hence on inflation. Indirectly, the real exchange rate affects the relative price between domestic and foreign goods, which in turn has an impact on both, domestic and foreign demand for domestic goods, and hence contributes to the aggregate demand channel for the transmission of monetary policy.

Both channels can be summarized in the following simple Neo-Keynesian model of an open economy (see Ball, 1999):

(15) $\pi_{t+1} = \pi_t + \gamma_y y_t + \gamma_q \left(q_t - q_{t-1}\right) + \varepsilon_{t+1}^{\pi}$

(16) $y_{t+1} = \beta_y y_t - \beta_i (i_t - \pi_t) + \beta_q q_t + \varepsilon^y_{t+1}$.

The real exchange rate q_t, the nominal exchange rate s_t and the output gap y_t are expressed in logarithms. The rate of inflation π_t and the nominal interest rate i_t are measured in per cent. Equation (15) represents an accelerationist open-economy Phillips curve. Inflation depends positively on the lag of the output gap, the lagged real depreciation and a supply shock. Equation (16) defines an open-economy IS relation. The output gap is determined by lags of the real interest rate and the real exchange rate, its own lag and a demand shock. The shock terms ε^π_{t+1} and ε^y_{t+1} are i.i.d. with mean zero.

An additional feature of open economy models is a relationship between the two financial variables interest rate and exchange rate. Unlike Ball (1999), we define this relationship by UIP:

(17) $i_t - i^f_t = E_t s_{t+1} - s_t$.

Under managed floating, UIP is assumed to hold perfectly. According to our external equilibrium condition presented in Section 3.2, sterilized foreign exchange market interventions are triggered each time the spot rate departs from the UIP implied path (equation (12)). If interventions are successful (which shall be assumed from now on), UIP shocks are fully absorbed by the central bank's intervention.

The link between the real exchange rate and the nominal exchange rate is finally given by the following identity

(18) $q_t - q_{t-1} \equiv s_t - s_{t-1} + \pi^f_t - \pi_t$

which explicitly takes into account that deviations from purchasing power parity occur in the short-run. For simplicity the foreign inflation rate π^f_t has been set to zero. Thus, by using the Fisher equation the foreign nominal interest rate equals the foreign real interest rate ($i^f_t = r^f_t$) so that equation (17) can be rewritten as

(19) $i_t = r^f_t + E_t s_{t+1} - s_t$.

The foreign real interest rate is modeled as an AR(1) process

(20) $r^f_t = \rho_f r^f_{t-1} + \varepsilon^f_t$

where ρ_f is the coefficient of autocorrelation and ε^f_t is a white noise disturbance.

If a central bank implements its monetary policy decisions with two operating targets it is useful to introduce a comprehensive measure of the actual policy stance of the central bank's two operating targets. This is provided by the Monetary Conditions Index (MCI) which can be defined in a simple form as follows:

(21) $MCI_t = r_t - \psi q_t$.

The coefficient ψ reflects the relative importance of the real exchange rate for measuring monetary conditions. If the monetary policy stance is about to tighten, the MCI rises, and in the opposite case, the index falls. With a positive ψ, a tighter MCI can be achieved by raising the interest rate, by a real appreciation, or by a combination of both.[7] The definition of the MCI in equation (21) corresponds to that by Ball (1999) who derives a monetary policy rule for a central bank in an open economy which is based on the MCI as a "policy instrument". He states that "the rationale for using an MCI is that it measures the overall stance of policy, including the stimulus through both r and e [the real exchange rate in his notation; the authors]. Policy makers shift the MCI when they want to ease or tighten" (Ball, 1999, p. 131). In sharp contrast to our view of the role of the MCI, however, he subsequently specifies his policy rule as follows: "When there are shifts in the e/r relation - shocks in equation (3) [the equation in his paper defining the relationship between the real exchange rate and the real interest rate, see Section 2.4; the authors] - r is adjusted to keep the MCI at the desired level." In other words, even though he accepts the central role of the exchange rate for monetary policy in an open economy, he grounds his theory on a purely floating exchange rate system where the only operating target of monetary policy is the interest rate.

For the monetary policy maker it is now crucial to know which MCI he has to realize. Thus, we need to define the objective of the central bank which is typically characterized by an intertemporal loss function

(22) $$L_t = E_t\left[\sum_{\tau=0}^{\infty}\delta^{\tau}\left(\lambda_{\pi}\left(\pi_{t+\tau}-\pi^{T}\right)^2+\lambda_{y}y_{t+\tau}^2\right)\right]$$

summing up expected current and future period losses. δ denotes the discount factor ($0<\delta<1$). λ_{π} and λ_{y} are the preferences of the central bank with respect to the central

[7] Note that a fall in the real exchange rate is a real appreciation. Of course central banks are only able to directly control the nominal values of their operating targets i_t and s_t. But under the important assumption of price stickiness, r_t and q_t are perfectly correlated with their nominal counterparts i_t and s_t, the operating targets of the central bank.

bank's ultimate goals which are the stabilization of inflation around a preannounced medium-term inflation target π^T and the stabilization of output around potential. For any value of $\lambda_y > 0$ this loss function represents a central bank following a strategy of flexible inflation targeting (Svensson, 1999). It is important to see that with this definition of the ultimate goal a clear anchor for private sector expectations is provided through the announcement of and the commitment to π^T. In particular, there is no conflict with the exchange rate target path Δs_{t+1}^T for two reasons: first, it is not preannounced, and therefore not suitable as an anchor for expectations; second, in the medium-run purchasing power parity holds, meaning that q_t is a stationary variable.

The problem of the central bank is to find an instrument path that minimizes the intertemporal loss subject to the structure and the state of the economy at all dates. As is common in the policy-oriented literature (see for example Rudebusch and Svensson, 1999) we solved this problem by a constrained optimization. Accordingly, the central bank is assumed to follow a simple policy rule for its operating target

(23) $MCI_t = f_\pi \pi_t + f_y y_t$

which prescribes an adjustment of the MCI in response to only a small set of observable variables, namely the actual inflation rate and the actual output gap. The optimization then involves three unknown values: the optimum weighting of the exchange rate term in the MCI (ψ) and the optimum response coefficients (f_π and f_y).

The solution to the problem of the monetary policy maker, i.e. the minimization of (22) subject to the structure of the economy (equations (15), (16), (18), (19) and (20)) and the simple policy rule (equation (23) in conjunction with equation (21)), can be found by applying some well-developed numerical algorithms, as described for example in Söderlind (1999).[8] For this reason, the model has to be calibrated. The parameters of our economy which are shown in Table 2 were chosen in accordance with Ball (1999).

Table 2

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[8] The basic Matlab codes can be downloaded from Söderlind's website (http://www.hhs.se/personal/psoderlind/). The specific codes used for the simulations and the set-up of the model in state-space form are available from

The internal equilibrium rule resulting from the numerical optimization consists of the following two elements:

- the optimum weighting of the real exchange rate in the MCI: $\psi = 0.31$;
- the optimum response of the MCI to shocks: $MCI_t = 1.31\pi_t + 1.36y_t$.

4 Managed floating in action

The two equilibria that are given by the UIP condition and the MCI rule impose two linear constraints on the simultaneous use of interventions in the foreign exchange market and in the domestic money market which together determine the concrete values for i_t and s_t. The setting of the two operating targets within this framework can be demonstrated if we analyze four different shocks: a positive demand and an inflationary supply shock, a shock in the form of an increase of the foreign real interest rate and a UIP shock. The following Figures depict the impulse-response of the variables of interest over 20 periods. The shocks which amount to one standard deviation are assumed to hit the economy in period 1. To demonstrate the necessity of a policy reaction the left panel of Figure 1, Figure 3 and Figure 5 shows the development of inflation and output under the assumption of a constant real interest rate.

Figure 1 shows that a positive demand shock calls for a restrictive MCI. In an open economy framework this is mainly achieved by an increase of the domestic real and nominal interest rate. Since the foreign real interest rate has remained unchanged, UIP requires that the domestic currency follows a depreciation path beginning in period 1. This is realized by an immediate real and nominal appreciation of the domestic currency which exerts an additional degree of monetary restriction in period 1 (see Figure 2). From period 2 on the overall degree of restriction more or less returns to zero. The nominal interest rate gradually returns to its neutral level while the nominal exchange rate converges to a new equilibrium level. The effects of both the nominal depreciation and the decrease in nominal interest rates tend to be neutralized by the positive but declining domestic rate of inflation so that their real counterparts q_t and r_t quickly return to zero.

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the authors upon request. Note that the transformation of the system into a system with the MCI as a control variable draws on appendix F of the working paper version of Svensson (2000).

Figure 1

Figure 2

In the situation of an inflationary supply shock the model shows that also a (slight) tightening of monetary conditions is required (see Figure 3). Unlike in the event of a positive demand shock however the nominal interest rate hike is more pronounced and comes along with a much smaller initial nominal appreciation (see Figure 4). Nonetheless, the UIP condition is perfectly met since the expected depreciation is much higher. Again the real interest rate and the real exchange rate quickly return to zero. Thus, the more pronounced movements in the nominal operating targets are neutralized by a much higher and in particular more persistent rise in the rate of inflation. Similar to the well-known result for closed economy models (see for example Clarida et al., 1999) the positive supply shock faces the central bank with an important short run trade-off between output and inflation. Instead of almost perfectly offsetting the effects of the shock (as in the case of demand shocks) the central bank now creates a significant negative output gap in order to bring down inflation. Since the negative output gap persists over several periods the inflation rate is reduced almost automatically, albeit slowly, without any significant additional monetary restriction.

Figure 3

Figure 4

In an open economy changes in the foreign interest rate can be also treated as a shock. Here we assume that the foreign interest rate is increased by one standard deviation. Initially the shock induces the central bank to adjust its policy mix – i.e. the combination of the two operating targets – without changing the overall monetary conditions in period 1 (see Figure 5). This can be reconciled with UIP if the domestic real interest rate is increased (but less than the foreign rate) and if, at the same time, the exchange rate is depreciated (see Figure 6). While the two components of this change of the policy mix nearly offset each other with respect to their effect on output, the real depreciation (caused by a nominal depreciation) directly leads to an increase in inflation in period 2. From this it follows that the MCI rises in period 2 in order to counteract the inflationary pressure. However this contraction in monetary policy has again almost no feedback on output, so it can be concluded that the consequences of foreign interest rate shocks can be compensated relatively well with the policy rules just described.

Figure 5

Figure 6

It is important to note that the interest rate and exchange rate response to these three shocks would also take place under a system of pure floating as long as the UIP condition is perfectly met. UIP would keep the exchange rate automatically on the target paths delineated here. However, as already mentioned, the empirical evidence for UIP is extremely poor. Thus, the main attraction of managed floating is that it uses foreign exchange market intervention in order to keep the exchange rate on the UIP path. This is demonstrated by Table 3, Figure 7 and Figure 8 which compare the empirical fit of UIP for two purely floating countries (United Kingdom, New Zealand) and for two managed floaters (Peru and Slovenia). The results for the United Kingdom and New Zealand are taken from Hüfner (2003). For the estimations the following standard regression was run:

(24) $$\Delta s_{t,t+3M} = \alpha + \beta\left(i_{t,3M} - i^{f}_{t,3M}\right) + \varepsilon_{t,t+3M}\,.$$

For UIP to be valid, the parameter α has to equal zero, and the parameter β has to equal one. Again, one can see very clearly that UIP does not hold under purely floating rates. For the United Kingdom and New Zealand the 'typical anomaly' of a negative β value can be detected. Moreover, in both cases, the βs are insignificant and the R^2s are close to zero. By contrast, the estimated coefficients show that under managed floating a relatively solid evidence for UIP can be observed. In other words, the exchange rate policy in these cases has indeed contributed to exchange rate paths that were to some degree in line with UIP.

Table 3

Figure 7

Figure 8

Thus, the advantage of managed floating over purely floating can be demonstrated if we assume that a central bank is able to maintain perfect UIP by foreign exchange market intervention. As a consequence the costs of purely floating consist in the social loss that is caused by UIP shocks. In the following, we will evaluate these costs within the framework of our open economy model. Under purely floating exchange rates the central bank controls a single operating target, namely the interest rate, independently of any direct exchange rate developments. Specifically, the central bank is assumed to follow a Taylor-type policy rule:

(25) $i_t = f_\pi \pi_t + f_y y_t$.

In the baseline scenario, purely floating exchange rates enter the model as an autoregressive disturbance

(26) $rp_t = \rho_{rp} rp_{t-1} + \varepsilon_t^{rp}$

to UIP (see equation (7)) with known statistical properties ($\rho_{rp} = 0.3$ and $Var\left[\varepsilon_t^{rp}\right] = 1$). The remaining parameters of the model are policy-independent and identical with those summarized in Table 2. Under this scenario the optimum response coefficients of the central bank's simple policy rule are $f_\pi = 1.82$ and $f_y = 1.17$.[9] Figure 9 depicts the impact of a one standard deviation UIP shock on the goal variables π and y, the operating target, and the nominal exchange rate. The purely floating central bank reacts to this shock by raising nominal interest rates to counteract the expansionary effects of the depreciation. The output gap is reduced to negative levels which helps to bring back inflation to its target level. The cost resulting from this shock stem from both, a persistent deviation of inflation from target and a deviation of output from potential.

Figure 9

Unfortunately, as the empirical evidence on UIP under purely floating exchange rates is so weak (see Table 3), central banks are confronted with a high degree of uncertainty about the true statistical properties of the UIP disturbance rp_t. We take this exchange rate uncertainty into account by modeling substantial deviations of the actual exchange rate behavior from that assumed by the central bank. While the central bank still optimizes its policy rule on the basis of $\rho_{rp} = 0.3$ and $Var\left[\varepsilon_t^{rp}\right] = 1$ so that the optimum response coefficients remain unchanged ($f_\pi = 1.82$ and $f_y = 1.17$), we assume that in reality

- the average extent of the deviation from UIP is much higher (uncertainty about the true value of $Var\left[\varepsilon_t^{rp}\right]$);

[9] See footnote 8 for further information on the determination of the response coefficients.

- the average duration of the deviation from UIP is much higher (uncertainty about the true value of ρ_{rp}).

For this 'real world scenario' Figure 10 shows the impact of a one standard deviation shock to UIP on the model's variables. Compared to Figure 9, the deviation of inflation from target and the deviation of output from potential are both, more pronounced and more persistent, thereby resulting in significantly higher costs in terms of the value of the loss function.

Figure 10

A comprehensive welfare comparison of the two exchange rate strategies can be made on the basis of the so-called policy frontiers. As has been shown by Svensson (2003), the intertemporal loss function given by equation (22) can equally be expressed as the weighted sum of the unconditional variances of inflation and the output gap when δ approaches unity. For a given structure of the policy rule, the policy frontier is then defined as the set of efficient combinations of inflation variance and output variance over the whole spectrum of central bank preferences, ranging from full inflation stabilization ($\lambda_\pi/\lambda_y \to \infty$) to full output stabilization ($\lambda_\pi/\lambda_y \to 0$). Figure 11 shows the policy frontiers of a managed floating central bank and of an purely floating central bank with and without exchange rate uncertainty.

Figure 11

Compared to the strategy of managed floating, purely floating exchange rates result in a higher variance of the goal variables – irrespective of the central bank's relative preferences. The costs of market determined exchange rates therefore consist in the social loss – expressed in terms of output and inflation volatility – that is caused by the unpredictability of the true relationship between interest rates and exchange rates on the international financial markets. Managed floating clearly provides a better outcome than purely market determined exchange rates. Of course this result only holds if foreign exchange market interventions do not cause any additional costs. But as long as the central bank implements its managed floating strategy according to the rules presented in Sections 3.1 and 3.2 (in particular the zero-cost-condition derived in Section 3.1.3) the benefit provided by this strategy is indeed a 'free lunch'.

5 Unresolved issues of managed floating

While managed floating offers several important advantages compared with traditional exchange rate strategies, it is certainly not a panacea which could solve all problems of the international monetary order. The two major weaknesses of this framework are discussed in the following.

5.1 The control over the exchange rate is asymmetric

The most serious flaw of managed floating is the asymmetric control over the exchange rate that stems from the finite level of its foreign exchange reserves. Thus, a central bank could always be confronted with a situation of a major crisis of confidence which forces it to accept a depreciation that exceeds its exchange rate target path by far. A recent example for such a crisis is Uruguay that had to give up its managed float because of very strong capital outflows which were triggered by severe financial spillovers following the collapse of the Argentine currency board. Between March 2002 and September 2002 the Uruguayan peso depreciated by almost 100 % (from 15 to 29 peso per US dollar), and the Banco Central del Uruguay sold 80 % of its foreign reserves in an attempt to stop the fall of the currency.

Thus, under managed floating countries remain vulnerable to crises of confidence which can be generated simply by contagion effects. Some IMF credit facilities – like the Supplemental Reserve Facility and as a precautionary device the Contingent Credit Line (CCL) – provide countries with financial resources that are not subject to the usual limits but are based on the actual financing needs. However, a surcharge of 300 up to 500 basis points is applied for such funds and the member country has to repay these credits within 2 ½ years at the very latest. Given the rather strict eligibility criteria for the CCL[10] one could ask whether countries that are qualified for CCL could be completely or partially dispensed from the repayment of such credits if a clear contagion effect can be diagnosed.

The asymmetry problem of direct managed floating was also addressed in Bofinger and Wollmershäuser (2002). In this paper, we discuss the compatibility of direct managed floating

[10] See IMF (2000, p. 67): "(...) the eligibility criteria confine potential candidates for a CCL to those members implementing policies considered unlikely to give rise to a need to use IMF resources; whose economic performance – and progress in adhering to relevant internationally accepted standards – has been assessed

with the institutional framework of the Exchange Rate Mechanism II (ERM II), which is currently regarded as the adequate framework for the path towards membership in the European Monetary Union (EMU). While some of the constituent elements of the ERM II are well suited for a policy of direct managed floating (in particular, the wide bands around the central rates that provide much flexibility, and the requirement that parity changes have to be mutually agreed, thereby preventing that competitive devaluations take place), the rules for intramarginal interventions, the financing of interventions through provision of credit facilities and the design of the exit option provide relatively little support for a policy of direct managed floating vis-à-vis the euro. While the 'very short-term financing facility' (VSTF) is "in principle automatically available and unlimited in amount" in the case of marginal interventions (see Article 7 of the ERM II agreement[11]), it can also be used for intramarginal interventions, but it requires an agreement of the ECB. In the case of an agreement, however, the cumulative amount made available for such interventions is limited to a ceiling, which is laid down for each ERM II member country. In addition, it is expected that the debtor central bank makes "appropriate use" of its own reserves (Article 8 of the agreement). It is obvious that for a strategy of managed floating which is institutionally embedded in a ± 15 % exchange rate band, intramarginal interventions are much more important than interventions at the margins. Under an effective exchange rate management, the latter should only provide a safety net. We therefore suggested some modifications for the ERM II rules, in particular the automatic access of ERM II members to the VSTF in the case of intramarginal interventions and an enhancement of the credit ceilings, which would make the scheme equally attractive for the accession countries and the present EMU members.

5.2 Managed floating and beggar-my-neighbor policies

With the widespread practice of managed floating by IMF member countries the international monetary order has experienced a profound change. By its very nature managed floating implies unilaterally decided exchange rate policies that are not discussed in the public domain. This gives governments ample scope for exchange rate policies that are not only designed by macroeconomic considerations but also by trade-related aspects. Since exchange

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positively by the IMF in the latest Article IV consultation and thereafter; and which have constructive relations with private sector creditors with a view to facilitating appropriate private sector involvement."

[11] Agreement of 1 September 1998 between the European Central Bank and the national central banks of the Member States outside the euro area laying down the operation procedures for an exchange rate mechanism in

rate changes have similar effects as tariffs, managed floating makes it possible to circumvent the regulations of the WTO.

The very fact that the foreign exchange reserves of developing countries have increased from 330 billions of US-dollar in 1990 to 1,510 billions of US-dollar in 2002[12] shows that in the longer run exchange rate policies were dominated by the desire to keep the national currencies on an undervalued basis. The alarmingly high United States current account deficits reflects the risks for those countries which follow a unilateral policy of benign neglect in a world where most other countries have clear targets for their exchange rate vis-à-vis the dollar. Thus, managed floating would require a comprehensive surveillance of national exchange rate policies by the International Monetary Fund or even by the WTO. Without a clear theoretical framework for managed floating and a 'neutral' exchange rate policy it will be not easy to detect strategic exchange rate policies. We hope that the empirical methods and the theoretical considerations presented in this paper can provide a basis for such an approach.

6 Conclusion

After the experience with the currency crises of the 1990s, a broad consensus has emerged among economists that such events can only be avoided and capital mobility be maintained if countries adopt either purely floating exchange rates or irrevocable pegs. As a consequence of this view all intermediate currency regimes are now regarded as inherently unstable. However, in the last few years a couple of studies detected an anomaly which seriously challenges this new paradigm on exchange rate regimes. Many of those countries which had declared themselves as independent floaters in the IMF statistics actually intervened in the foreign exchange market, oftentimes with huge amounts and on a regular basis. This widespread managed floating is at the core of the present study. While standard open economy models typically used for the evaluation of monetary policy do not provide any rationale for why central banks should undertake foreign exchange market interventions at all, the purpose of this study was to develop a simple theoretical framework for a strategy of

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stage three of Economic and Monetary Union, see Official Journal of the European Communities C 345, 13.11.1998, pp. 6.

[12] These figures are taken from the IFS (line 1l s, country code 200). As they were listed in SDRs, we multiplied them by the end-of-year US-dollar/SDR exchange rate.

managed floating which we define as a monetary policy framework in which central banks target an unannounced exchange rate path together with a short-term interest rate.

In order to guarantee the simultaneous and independent use of the interest rate and the exchange rate as operating targets, the central bank has to control the exchange rate by means of sterilized foreign exchange market interventions. We argue that the rather controversial attitude of the economic profession towards the effectiveness of sterilized interventions stemming from the mixed results of the empirical literature is mainly due to its one-sided focus on the mark-dollar market in which the volume of interventions was small, the daily foreign exchange turnover was huge and interventions took only place as sporadic events. By contrast, in emerging markets the opposite is the case. We show that exchange rate targeting with means of sterilized interventions is perfectly possible if (1) the currency is under an appreciating pressure, (2) the central bank disposes over a set of efficient sterilization instruments, and (3) the costs of sterilization are zero.

The positive analysis of the strategy provides the monetary policy maker with a navigation system for the setting of the two operating targets. It is based on the assumption that the two operating targets are subject to an internal and an external equilibrium condition. According to the external equilibrium, the exchange rate path and the interest rate are set in line with the foreign interest rate so as to avoid short-term profit opportunities of international investors and to prevent speculative inflows. At same time it avoids costs of sterilization. According to the internal equilibrium, both operating targets have to be set in a way that minimizes a typical loss function of a central bank. In contrast to strategies under market-determined exchange rates where the interest rate is the only operating target under managed floating a Monetary Conditions Index serves as a combined measure of the actual monetary policy stance, summarizing the effects from both, the real interest rate and the real exchange rate. Similar to conventional monetary policy strategies, however, the optimum setting of the Monetary Conditions Index is expressed in terms of a policy rule.

With simulations of the strategy within the framework of a simple Neo-Keynesian model we show how the Monetary Conditions Index has to be adjusted if the economy is affected by different shocks. It becomes obvious that the outcome of monetary policy under managed floating only differs in a significant way from a strategy with a single operating target and market-determined exchange rates in the case of UIP shocks. Due to the dismal empirical performance of UIP under purely floating exchange rate such shocks can be very large so that the central bank's ultimate goals are negatively affected. Such an outcome can be avoided under managed floating as long as the central bank is able to keep the exchange rate on a path determined by the interest rate differential. Apart from some institutional shortcomings which we discuss in the last Section and for which we propose a range of straightforward solutions, the comparison with monetary policy under market-determined exchange rate shows that the monetary-exchange rate strategy of managed floating can be viewed as a free lunch as it offers an additional degree of freedom which is provided by sterilized interventions.

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Table 1: Officially declared exchange rate arrangements 1991 and 1999

	Hard Pegs		Intermediate		Floating	
Year	1991	1999	1991	1999	1991	1999
All countries	16%	24%	62%	34%	23%	42%
Emerging market economies	6%	9%	64%	42%	30%	48%
Developing and emerging market economies	5%	25%	65%	27%	29%	47%

Source: Fischer (2001)

Table 2: Calibration of the model's equations

Phillips curve		IS equation			UIP	loss function				uncorrelated shock terms		
γ_y	γ_q	β_y	β_i	β_q	ρ_f	λ_π	λ_y	δ	π^T	$Var\left[\varepsilon_t^\pi\right]$	$Var\left[\varepsilon_t^y\right]$	$Var\left[\varepsilon_t^f\right]$
0.4	0.2	0.8	0.6	0.3	0.3	1	1	1	0	1	1	1

Table 3: Empirical evidence for UIP

	period	α	β	R^2
United Kingdom	1993:1 – 2001:1	-0.003 (0.420)	-0.775 (-0.417)	0.003
New Zealand	1993:1 – 2001:1	0.021 (1.550)	-2.345 (1.283)	0.031
Slovenia	1993:1 – 2001:12	0.005 (1.616)	0.461*** (4.976)	0.189
Peru	1995:1 – 2001:12	-0.016 (-1.636)	1.473*** (3.317)	0.118

Notes: t-values are in parentheses; *** denotes significance at the 1 per cent level; estimation method: OLS. Data: The 3-month ahead exchange rate changes refer to changes of the bilateral nominal exchange rate of the country under consideration against the US dollar, except for Slovenia which manages its parity against the German mark/the euro. The Peruvian nominal interest rate is the average rate offered by commercial banks on 31- to 179-day time deposits in national currency taken from the International Financial Statistics of the IMF. The Slovenian interest rates are average commercial banks' deposit rates with a maturity of 31 to 90 days taken from Bank of Slovenia's monthly bulletin. The remaining nominal interest rates are treasury bill rates taken from the International Financial Statistics of the IMF. The residuals of the estimations were all found to be stationary.

Figure 1: Demand shock

without policy intervention | with policy response

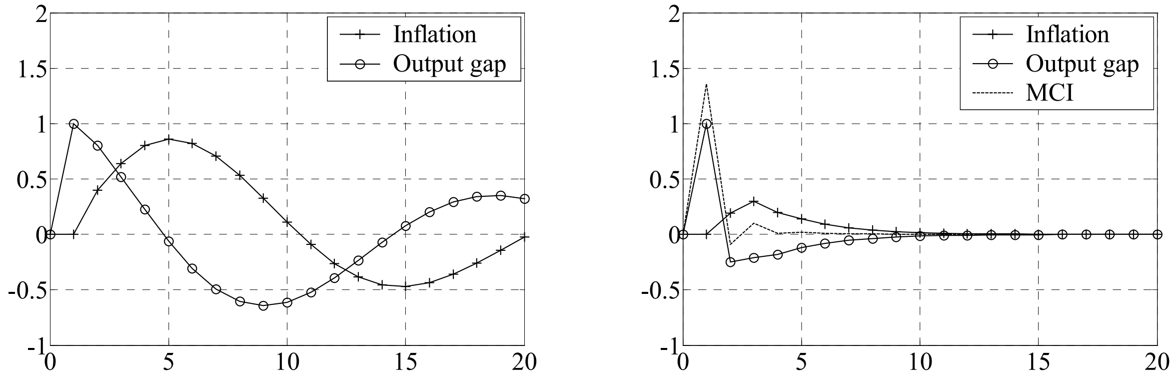


Figure 2: Demand shock and operating targets

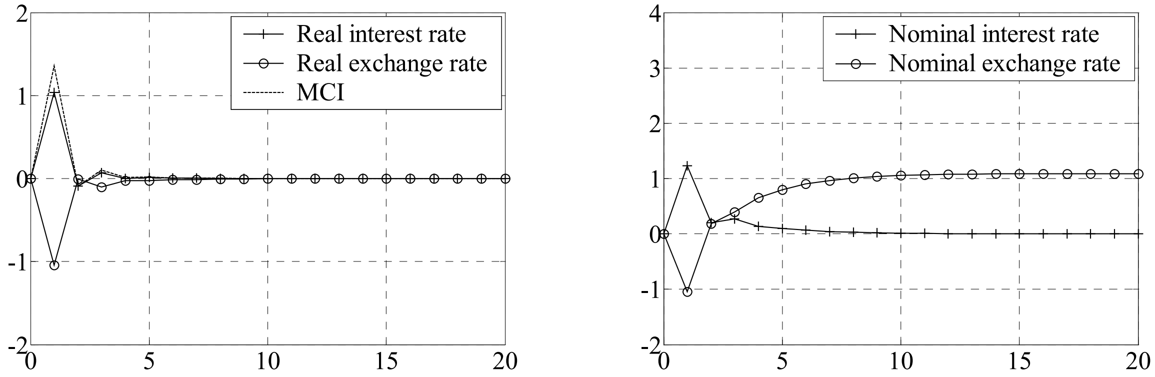


Figure 3: Supply shock

without policy intervention

with policy response

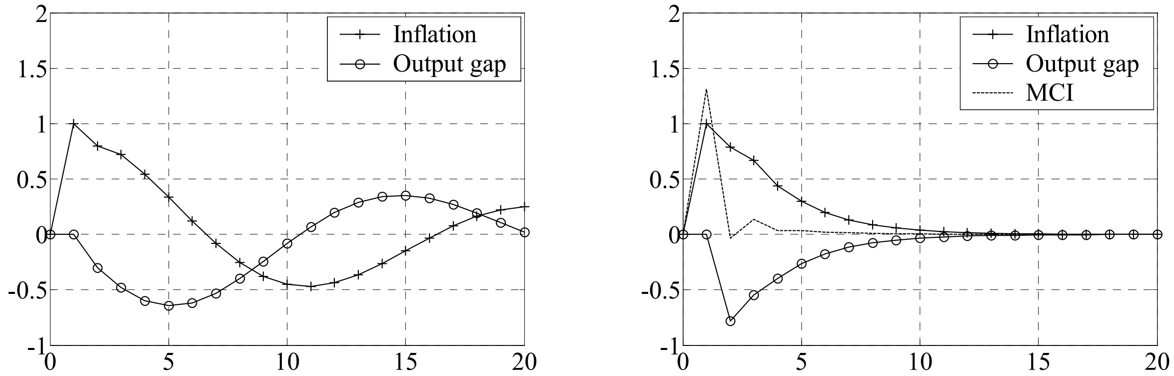


Figure 4: Supply shock and operating targets

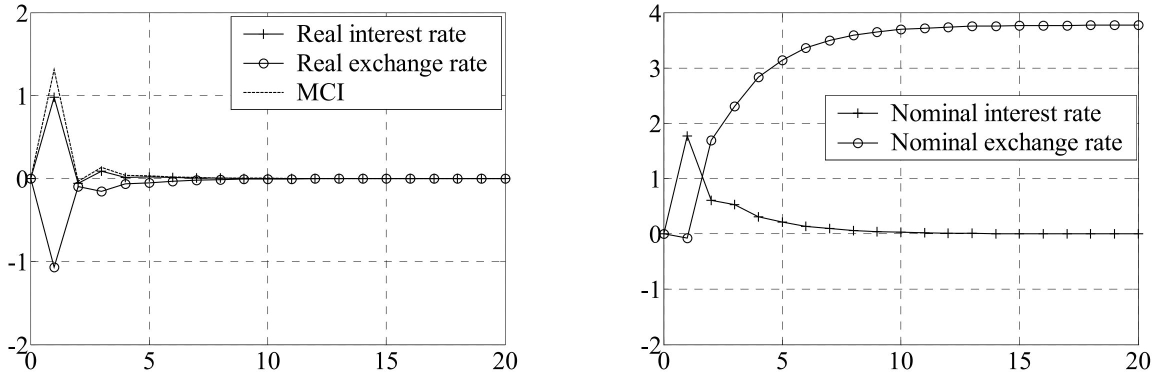


Figure 5: Foreign interest rate shock

without policy intervention | with policy response

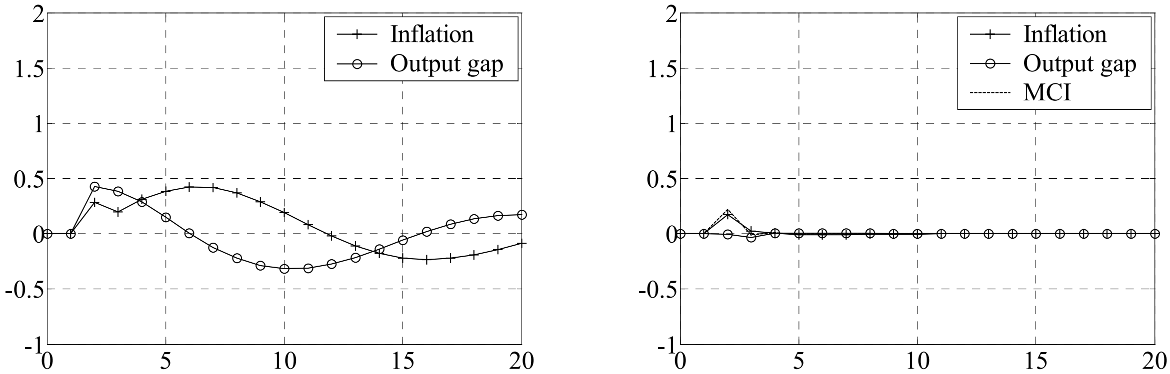


Figure 6: Foreign interest rate shock and operating targets

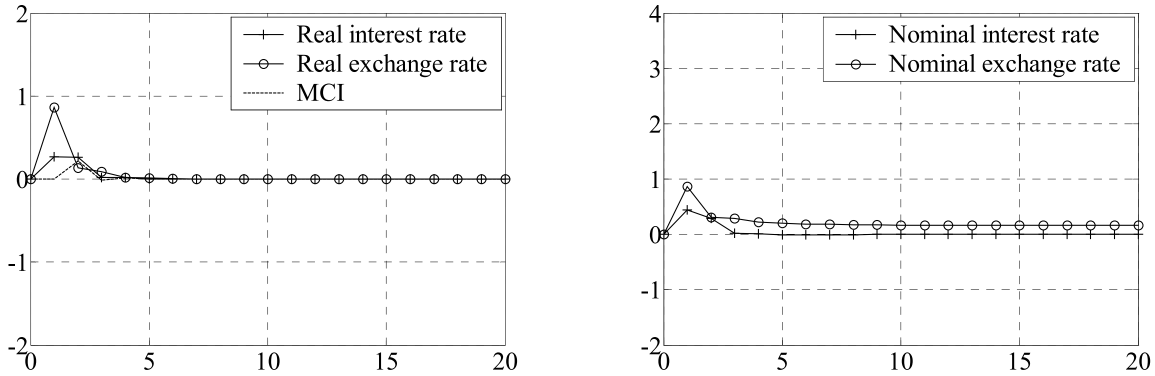
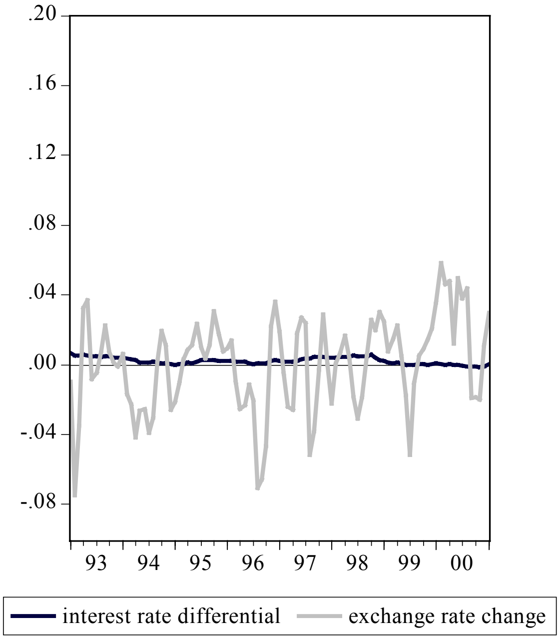


Figure 7: UIP under purely floating exchange rates

United Kingdom



New Zealand

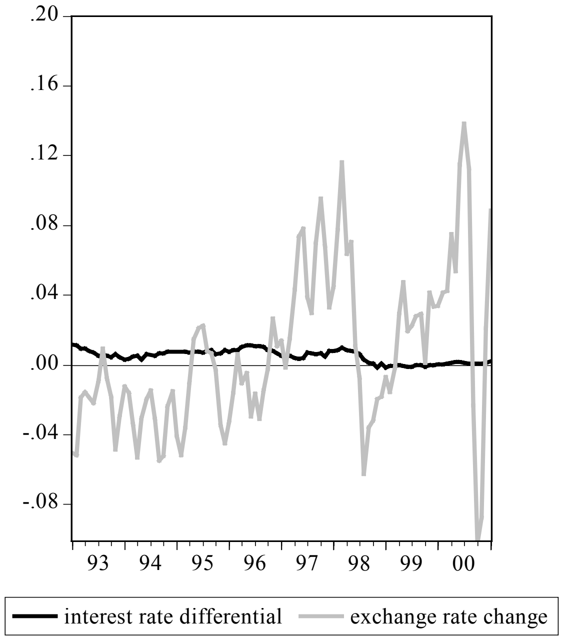


Figure 8: UIP under managed floating exchange rates

Slovenia Peru

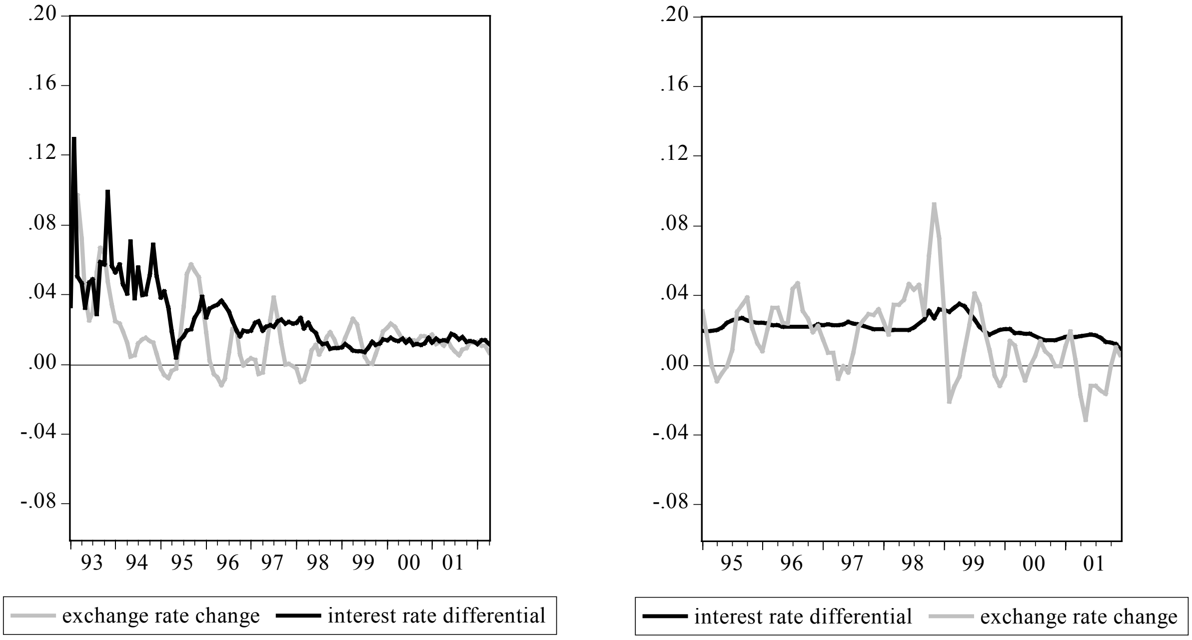


Figure 9: Consequences of UIP shocks under purely floating exchange rates

baseline scenario: $\mathrm{Var}\left[\varepsilon_t^{rp}\right] = 1$, $\rho_{rp} = 0.3$

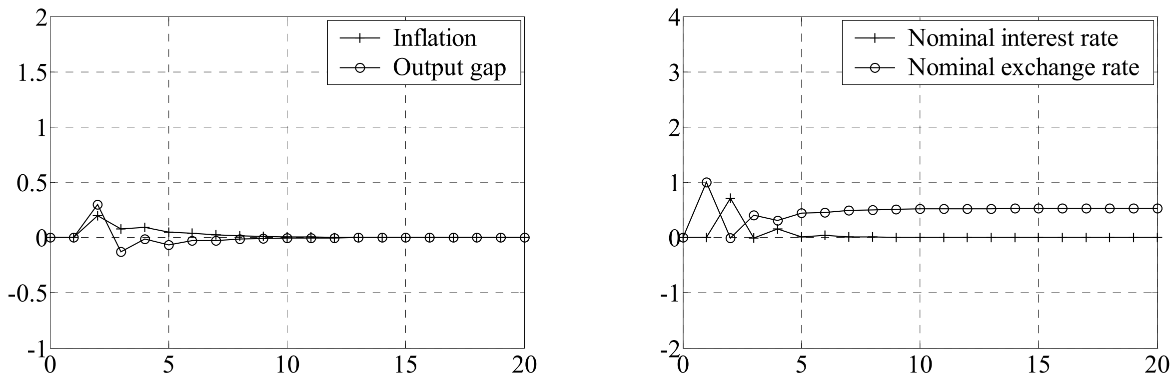


Figure 10: Consequences of UIP shocks under purely floating exchange rates and exchange rate uncertainty

uncertainty about shock variance: $Var\left[\varepsilon_t^{rp}\right] = 5$	uncertainty about shock persistence: $\rho_{rp} = 0.8$

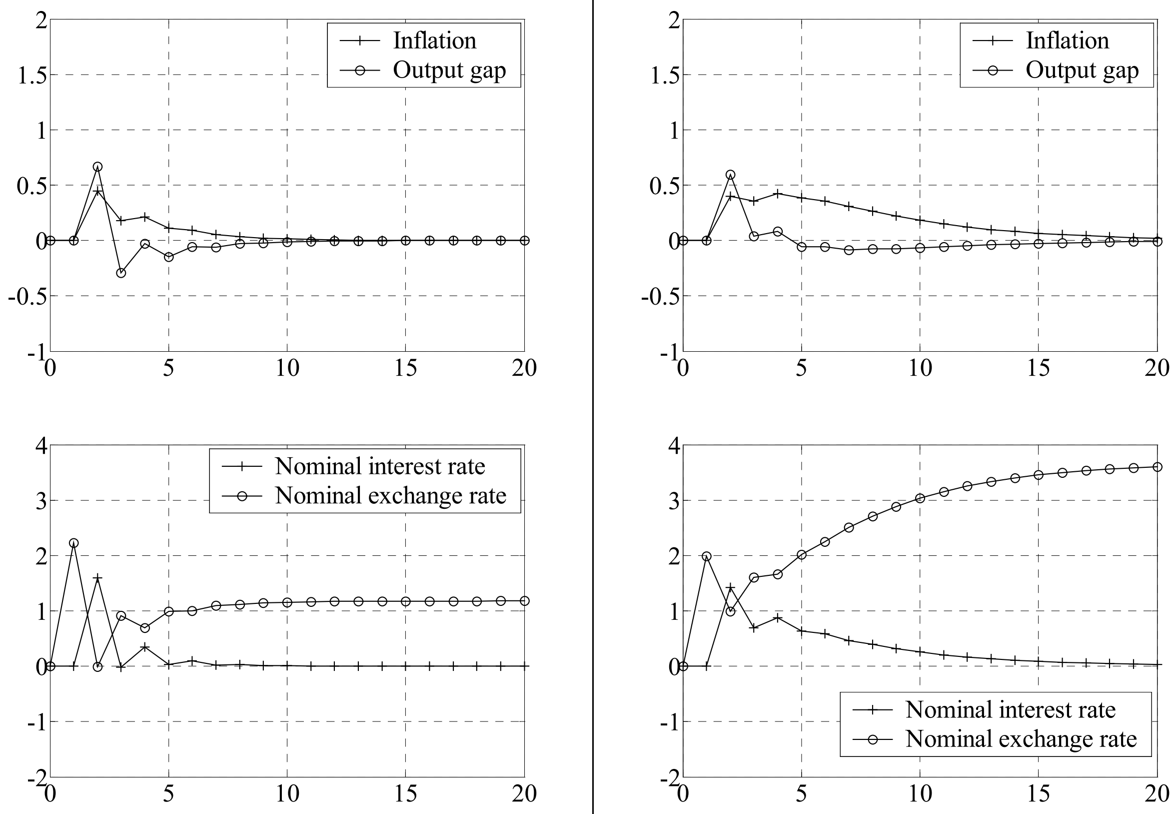


Figure 11: Policy frontiers in the case of UIP shocks