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ABSTRACT

Managed Floating: Understanding the New International Monetary Order

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. Significant foreign exchange market interventions of central banks and a certain degree of exchange rate flexibility characterize these intermediate regimes. We develop a new empirical methodology that identifies three different forms of floating on the basis of a central bank's intervention activity: pure floating (no interventions), independent floating (exchange rate smoothing), and managed floating (exchange rate targeting). Our cross-country study shows that exchange rate targeting is at least as important as exchange rate smoothing. Subsequently we present a monetary policy framework in which central banks use the exchange rate as an operating target of monetary policy. We explain the mechanics of interventions and sterilization and we explain why a central bank has an interest in controlling simultaneously the exchange rate and the short-term interest rate. We derive the monetary policy rules for our 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.

JEL Classification: E52, F31, F33 and F41
Keywords: exchange rate regime, floating, interventions, monetary conditions index, monetary policy and sterilization

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1 Introduction

In spite of their prominence, the exchange rate regimes of "floating" or "managed floating" have so far received relatively little academic interest. Due to this "fear of floating" of many researchers[1], until today even the central terms "floating" and "managed floating" lack a clear and widely shared definition. We will show that this can lead to some confusion which is especially problematic for the option of managed floating. Above all a precise definition would make clear that this approach is conceptually completely different from the textbook model of flexible exchange rates and also the more refined models of open economy inflation targeting. In other words, because of this semantic imprecision it has been overlooked that managed floating lacks a well-developed theoretical framework. As a consequence a central bank which wants to follow the popular approach of managed floating can receive almost no guidance for its concrete monetary and exchange rate policies.[2] The lack of a positive as well as a normative theory of managed floating can also lead to negative effects at the international level. While the international monetary order is now dominated by managed floating, there has been no theoretical discussion whether such uncoordinated national exchange rate and interest rate policies will always lead to optimum outcomes for the global economy.

The paper is organized as follows: In Chapter 2 we present three different definitions of floating:

- *Pure floating* is an arrangement where the exchange rate is almost always market determined; in other words, the central bank normally refrains from exchange market interventions. As a benchmark for pure floating, we use the exchange rate policy of the United States.
- *Independent floating* is characterized by an active intervention policy which aims at a stabilization around a market-determined given trend of the exchange rate.
- *Managed floating* is also characterized by an active intervention policy. In this case a central bank's intervention policy follows an unannounced target path for the exchange rate.

On this basis we develop a simple method for identifying these three different forms of floating. Compared with the methods by Calvo and Reinhart (2000), our approach has the advantage that it allows a clear demarcation between the three variants of floating.

In Chapter 3 we give a short survey of the literature. We show that the Mundell/Fleming model as well as the more refined models for open economy inflation targeting are unable to explain the high intervention activity of many central banks which is geared towards achieving a certain exchange rate path.

In Chapter 4 we present a simple theoretical framework for managed floating. It is based on the somewhat unfamiliar notion of using the exchange rate as an operating target of monetary policy in addition to the short-term interest rate. We analyze the conditions under which such an exchange rate targeting is possible. In the central part of this Chapter we show how in an open economy a central bank has to set its two operating targets in order to achieve simultaneously

[1] While there was some discussion of this issue in the 1980s, in the last few years there are almost no publications with a title that is directly related to exchange rate system of floating or managed floating; for instance, in EconLit since 1990 only 17 publications can be found under "managed float" and 21 publications under "managed floating".

[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."

- internal equilibrium which defined by an MCI which minimizes a social loss function,
- external equilibrium which is defined by a combined interest and exchange rate policy that is compatible with uncovered interest parity.

The last part of Chapter 4 discusses the shortcomings and implications of managed floating. As managed floating is characterized by an unannounced exchange rate path, a separate anchor for private sector expectations is required in small open economies. We argue that – in the same way as in large economies – inflation targeting can provide a substitute for this function. A major shortcoming of managed floating is the limited ability of central banks to defend an exchange rate path in a situation of strong speculative outflows. Such shocks would require a policy-mix with very high real interest rates that can lead to negative effects for the domestic sector of an economy. For this case credit facilities in the form of the IMF's Contingent Credit Line are the only adequate solution. Finally, under an uncoordinated managed floating countries can manipulate the exchange rate in order to improve their international competitiveness. The strong increase in dollar reserves of emerging market economies during the 1990s indicates that such considerations have played an important role in the exchange rate management of these countries.

In Chapter 5 we take a deeper look at the actual monetary and exchange rate policy of a few countries in our sample that we identify as managed floaters in Chapter 2. With a rather descriptive approach we investigate whether these countries effectively pursue a policy according to the rules which we derive formally in Chapter 4.

The last Chapter summarizes the main results and concludes.

2 Defining and identifying three forms of floating

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 (see Table 1). In the group of developing and emerging market economies the decline has been even more pronounced. For the country groupings of all countries and of emerging market economies floating has been the preferred alternative to intermediate regimes. 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: 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)

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). Barry 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 Three forms of floating

As Table 1 shows, 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, 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. It uses the following eight categories:

a. Exchange rate arrangements with no separate legal tender (dollarisation, membership in a currency union)
b. Currency board arrangements
c. Other conventional fixed peg arrangements (formal or de facto peg with a narrow margin of at most ± 1 per cent around a central rate)
d. Pegged rates within horizontal bands (formal or de facto peg with margins that are wider than ± 1 per cent around a central rate)
e. Crawling pegs (the currency is adjusted periodically in small amounts at a fixed, *pre-announced* rate or in response to changes in selective quantitative indicators)
f. Crawling bands (the currency is maintained within certain fluctuation margins around a central rate that is adjusted periodically in small amounts at a fixed, *pre-announced* rate or in response to changes in selective quantitative indicators)
g. 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)
h. 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:

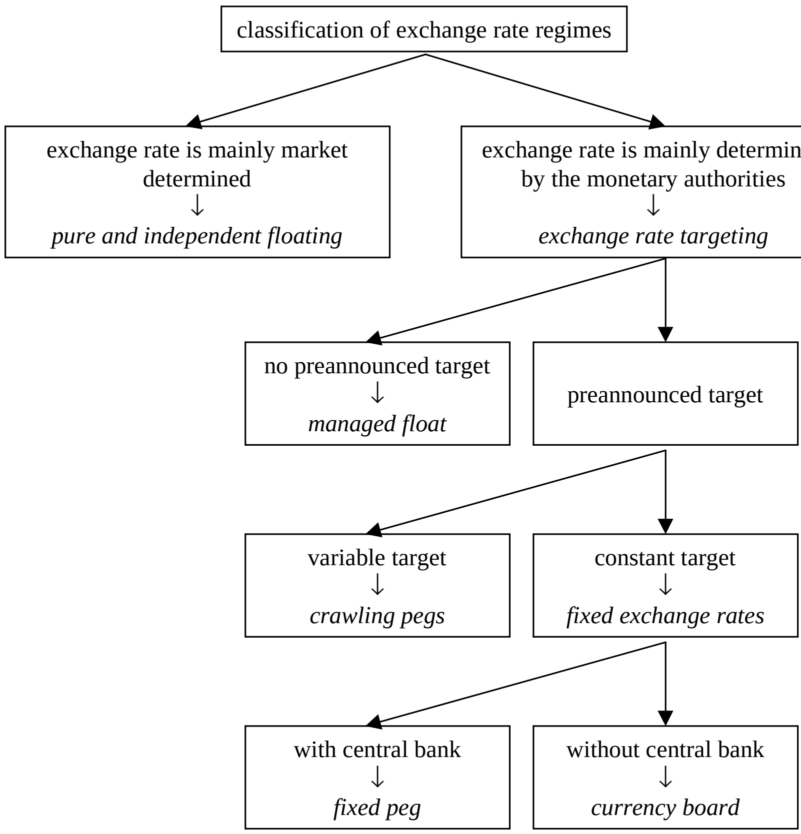
i. Pure floating (the exchange rate is market determined with no foreign exchange market intervention at all; changes in foreign exchange reserves are due to technical factors only).

As already mentioned, many authors summarize the arrangements g), h), and i) under the heading of "floating". This can create the impression that the economic rationale of these three arrangements is more or less identical. However, a careful reading of the IMF's description of g) and h) and of our category i) shows a very important difference:

- Managed floating implies that the exchange rate path is determined by the central bank (or the government).
- Pure and independent floating imply that the exchange rate path is mainly market determined.

In other words, what distinguishes managed floating from the intermediate solutions e) and f) is not a different form of exchange rate determination, it is mainly the fact that there is no *preannounced* path for the exchange rate (see Figure 1).

Figure 1: Exchange rate regimes



As a consequence, for a theoretical understanding of managed floating it is not sufficient to treat it simply as a variant of independent or pure floating, for which the elaborate theories of flexible exchange rates are available. 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.

2.3 Governments do not always tell the truth

The need for a precise definition of floating exchange regimes applies not only to economists. As the research by Calvo and Reinhart (2000) has shown, national governments and/or central banks do not seem to pay too much attention to the exact definitions in the IMF's forms. The starting point for Calvo and Reinhart is the textbook model of flexible exchange rates (or our option "pure floating") which is characterized by a constant level of foreign exchange reserves. Therefore, Calvo and Reinhart identify "*floating*" (in our taxonomy: "pure floating") by a *high* probability that the monthly per cent change in foreign exchange reserves falls within a ± 1 or ± 2.25 per cent band. As there are always technically determined changes in reserves, Calvo and

Reinhart use the data of the United States and Japan as a benchmark. In other words, a lower probability for small reserve changes is regarded as an indication that a country is not following a policy of floating (in or taxonomy; "pure floating"). The polar case of *fixed exchange rates* is characterized by a *low* probability that the monthly per cent change in nominal exchange rate falls within a ± 1 or ± 2.25 per cent band. Again, the United States and Japan are used as a benchmark. Table 2 presents the main results of the study by Calvo and Reinhart

Table 2: Main results of the Calvo and Reinhart (2000) study

Regime	Foreign exchange reserves volatility		Exchange rate volatility	
	+/- 1 per cent band	+/- 2.25 per cent band	+/- 1 per cent band	+/- 2.25 per cent band
Independent floating[3]	16.2	33.9	51.8	79.4
Managed floating	17.8	39.2	60.1	87.5
Limited flexibility	20.8	45.9	64.6	92.0
Fixed	15.4	36.5	83.1	95.9
USA	*28.6*	*62.1*	*26.8*	*58.7*
Japan	*44.8*	*74.3*	*33.8*	*61.2*

Source: Calvo and Reinhart (2000)

The most striking result of this study is the very small difference between the polar options of independent floating and fixed rates as far as the changes in foreign exchange reserve volatility are concerned. In addition the independent floaters behave completely different than the two benchmark countries. The same applies to the category "managed floating". In other words, most of the countries which classify themselves as independent or managed floaters are actively intervening on the foreign exchange market. The exchange rate volatility of independent and managed floaters is also much lower than in the United States and Japan and if is analyzed within the ± 2.25 per cent band, the difference to fixed rates is not very pronounced, especially for managed floating.

In sum, the results of Calvo and Reinhart as well as of a related study by Levy-Yeyati and Sturzenegger (2000) show that it is important to make a clear distinction between the textbook ideal of "free floating" and the reality of "independent" and "managed floating".

2.4 A different approach for identifying three variants of floating

While the study by Calvo and Reinhard has contributed to a much better understanding of "floating", it has the important drawback that it cannot distinguish between the three different forms of floating. Another problem of this study is that it analyses very long periods (up to February 1973 – April 1999). This can have the disadvantage that a singular strong intervention activity or changes in intervention behavior in the more recent past cannot not be identified. Finally the Calvo/Reinhart study normalizes changes in reserves by relating them to reserve levels. This can be misleading if countries start an intervention period with different reserve levels although their overall macroeconomic data are roughly similar or if countries accumulate large reserve levels over time.

2.4.1 A new method for measuring different forms of floating

In order to avoid these short-comings, we present a new methodology for identifying different forms of floating. We start with two different methods to proxy the intervention activity of a country:

[3] Excluding Japan and the United States

1. changes in foreign reserves minus gold (Res) as a ratio of the *external sector's size* measured by a twelve-month moving-average of the arithmetic mean of imports (Im) and exports (Ex);
2. changes in foreign reserves minus gold (Res) as percentage of the *level of reserves* at the beginning of the underlying period.

The first normalization procedure has the advantage that changes in reserves are related to the size of a countries' external sector. To some extend this also takes into account differences in the total economic size. The second method was chosen to produce results that are comparable to those of the Calvo/Reinhart study.

As a first step we want to identify the overall intervention activity of a country. For this purpose we add the absolute values of normalized changes in reserves for a period of n=6 and of n=12 months. Thus, we do not discriminate between the monthly values of net sales and net purchases of foreign exchange reserves. The resulting variable is called *sum of absolute changes* (S^{abs1}, S^{abs2}):

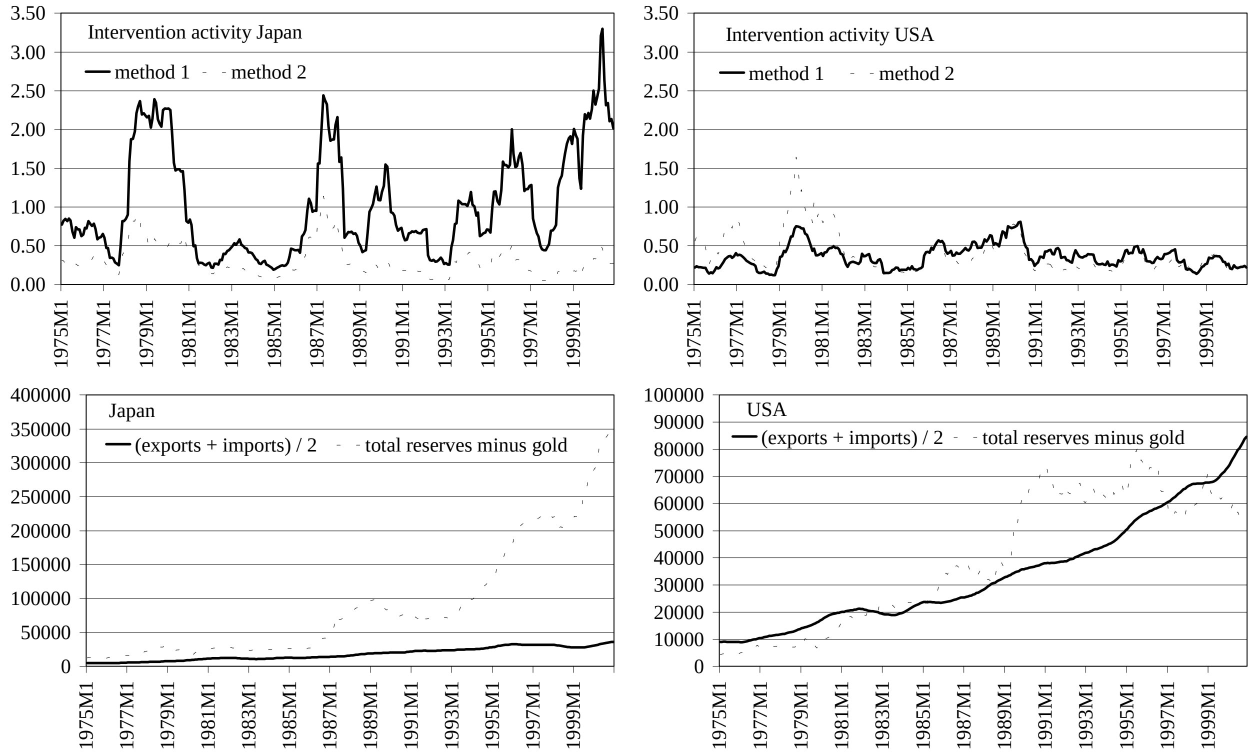
$$(1)\quad S^{abs1}(n)_t = \sum_{i=0}^{n} \left| \frac{Res_{t-i}}{\frac{Ex_{t-i} + Im_{t-i}}{2}} - \frac{Res_{t-i-1}}{\frac{Ex_{t-i-1} + Im_{t-i-1}}{2}} \right|,$$

$$(2)\quad S^{abs2}(n)_t = \frac{\sum_{i=0}^{n} \left| Res_{t-i} - Res_{t-i-1} \right|}{Res_{t-n-1}}.$$

The superscripts 1 and 2 refer to the method of normalization. If S^{abs} is low (i.e. approaching zero), a country's overall intervention activity is low. As in Calvo and Reinhart (2000) we chose the U.S. as a benchmark which we assume to be a pure floater.

The difference between the two methods of normalization can be illustrated quite easily with the four charts of Figure 2. In the upper two charts we depicted the proxies for the intervention activity S^{abs1} and S^{abs2} for Japan and the US. While the two lines differ only slightly in the case of the US, the differences in the conclusion that one would draw in the case of Japan are striking. According to the thin line (method 2) the Japanese exchange rate policy would be judged as a non-interventionist one, similar to what results for the US. In the study of Calvo and Reinhart (2000) which uses a similar technique (monthly change in foreign exchange reserves as a percentage of the level of reserves) Japan is classified as even more independently floating than the US (see Table 2). The major problem with this approach is the bias that emerges with an increasing level of reserves. The same sale or purchase of foreign exchange measured in US dollars becomes less important the higher the base in terms of which the percentage change is measured. From the lower two charts we can see that the Japanese authorities accumulated large amounts of foreign reserves during the last two decades (the figures depicted are in millions of US dollars). The average rate of growth amounted to a multiple of the rate of growth of the external sector. In contrast to this, the two variables seem to have a common long-run trend in the US so that the measurement bias described above does not occur. This explains why the two methods approximately yield the same results for the US. In order to eliminate such a bias, in the following we only use the second normalization method.

Figure 2: Different methods of proxying intervention activity



In a second step we calculate the *sum of effective changes* (S^{eff1}, S^{eff2}) of reserves again for a 6 and a 12 month period:

$$(3)\quad S^{eff1}(n)_t = \sum_{i=0}^{n}\left(\frac{Res_{t-i}}{\frac{Ex_{t-i}+Im_{t-i}}{2}} - \frac{Res_{t-i-1}}{\frac{Ex_{t-i-1}+Im_{t-i-1}}{2}}\right),$$

$$(4)\quad S^{eff2}(n)_t = \frac{\sum_{i=0}^{n}\left(Res_{t-i} - Res_{t-i-1}\right)}{Res_{t-n-1}}.$$

We then divide the sum of effective changes by the sum of absolute changes of reserves for each normalization method and for each time horizon. The resulting ratio allows us to differentiate between independent floaters and managed floaters. We therefore labeled it *index of floating* (I^{float}):

$$(5)\quad I^{float1}(n)_t = \frac{S^{eff1}(n)_t}{S^{abs1}(n)_t},$$

$$(6)\quad I^{float2}(n)_t = \frac{S^{eff2}(n)_t}{S^{abs2}(n)_t}.$$

I^{float} assumes values ranging from minus one to plus one. A value *close to zero* indicates that a central bank has not changed its total level of reserves during an observation period. As this is compatible with a high value of the denominator, a low value of I^{float} shows that interventions were mainly carried out in order to smooth short-term fluctuations around an exogenously determined trend. This behavior is typical for a strategy of independent floating as it is defined by the IMF.

A value of I^{float} *close to plus or minus one* implies that the intervention activity was associated with a change in reserves during the observation period. This can be regarded as an indication that a central bank has tried to influence the trend of the exchange rate. Thus, such values of I^{float} can be regarded as a marker for managed floating. In addition, the sign of this indicator shows whether the central bank has tried to intervene against an appreciation (a positive sign: net purchases of the central bank) or a depreciation (a negative sign: net sales of the central bank) of its currency.

2.4.2 Data description and proceeding

Our sample consists of 14 developed market economies and 30 emerging market economies[4] that have been classified as independent or managed floaters according to the IMF's quarterly Exchange Rate Arrangements published in the International Financial Statistics (IFS). Our data is monthly from January 1975 to November 2000. The variables used in our calculations are all from the IFS. Reserves (Res) are measured by "Total Reserves minus Gold" (line 1l.d), exports and imports by line 70 and 71. If the latter were denominated in national currency, we converted them into US dollars with the average monthly dollar exchange rate (line rf).

For each month during the period that a country reports its exchange rate regime as an independent or a managed floater we calculated the two variables of interest S^{abs} and I^{float}. The periods and the reported regimes are summarized in Table 8 (see Appendix 1: Country coverage). Since some countries followed different exchange rate strategies in the whole period, we get a total of 65 cases for the 6-month horizon and 62 cases for the 12-month horizon. We then computed the frequency distribution of each variable for each period.

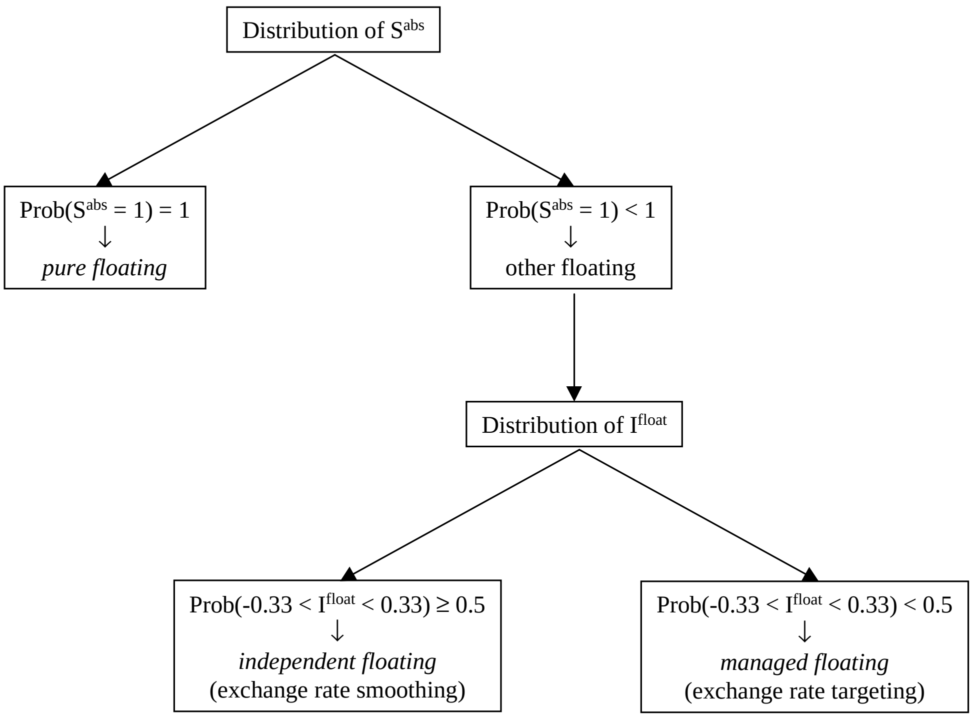
For our classification of exchange rate regimes we proceed as follows. In a first step we try to find out whether a country is a pure floater or not. For this purpose we look at the value of S^{abs} of our benchmark country, the United States. We see that for both time horizons there is a 100 % probability that the sum of absolute reserve changes is less than the average of the sum of monthly imports and exports during the observation periods (i.e. $S^{abs} \leq 1.0$, see Table 10 and Table 11 in Appendix 2: Probability distributions). For the 6-month horizon the United Kingdom (09/92-11/00), Canada and Poland (04/00-11/00) can also be regarded as pure floaters. For the 12-month horizon only the United Kingdom (09/92-11/00) can qualify as a pure floater; for Poland the experience with floating is not long enough.

For those countries which cannot be not classified as pure floaters we try to identify whether their intervention policy can be classified as independent or managed floating. For this purpose we use the index floating. We assume that a range of $-0.33 < I^{float} < 0.33$ describes independent floating; the ranges of $-1 \leq I^{float} \leq -0.33$ and $0.33 \leq I^{float} \leq 1$ are regarded as a policy of managed floating. If the probability of $-0.33 \leq I^{float} < 0.33$ is at least 50 %, we classify a country as an independent floater, if it is lower a country is classified as a managed floater. Since we lack a benchmark country, the interventions of the United States are to small to be used for this

[4] We distinguish between developed market economies and emerging market economies as in Fischer (2001). This restriction allows us to concentrate on the subset of developing countries which are integrated with world capital markets. As we were also interested in the exchange rate policy of the Eastern European accession countries, we additionally included Slovenia in our analysis.

purpose, we had to chose these critical values somewhat arbitrarily. Figure 3 gives an overview of this classification procedure.

Figure 3: A classification of floating exchange rate systems



2.4.3 Main results

A summary of the results of our classification is presented in Table 3 and Table 4 (for the detailed country results see Table 12 and Table 13 in Appendix 2: Probability distributions). For the 6-month observation period they show that most floating countries can be regarded as managed floaters regardless whether we focus on all regimes that were in existence in the whole period from 1975 until 2000 or on those there are still in existence. Only 23 % of the IMF's independent floaters are pure floaters or independent floaters according to our classification. For the 12-month observation period a more even distribution between independent and managed floating emerges. Again there is no strong correlation with the IMF's classification: only 48 % of the IMF's independent floaters were true independent floaters and only 46 % of the managed floaters were true managed floaters. Thus, depending on the observation period our analysis shows first that managed floating is either the most widely used form of floating or a more or less equally important form of floating as independent floating.

Table 3: IMF classification and our classification for floating using 6-month periods

		Our classification			Sum
		Pure float	Independent float	Managed float	
IMF classification	Independent float	4 (4)	3 (2)	24 (15)	31 (21)
	Managed float	-	4 (0)	31 (10)	35 (10)
Sum		4 (4)	7 (2)	55 (25)	66 (31)

Note: The figures in brackets indicate the number of regimes that are still in existence.

Table 4: IMF classification and our classification for floating using 12-month periods

		Our classification			Sum
		Pure float	Independent float	Managed float	
IMF classification	Independent float	2 (2)	11 (8)	14 (10)	27 (20)
	Managed float	-	19 (6)	17 (4)	36 (10)
Sum		2 (2)	30 (14)	31 (14)	63 (30)

Note: The figures in brackets indicate the number of regimes that are still in existence.

The importance of managed floating becomes even more obvious if we use our methodology for the analysis of *time series*. Thus, we can observe for each country how the values of S^{abs} and I^{float} vary over time. Of course this approach has the effect that even with a low overall probability situations with high values of S^{abs} can be reached from time to time. The most interesting case is Japan. According to the cross-section analysis which covers the period from 1975 to 2000 the probability for high interventions in Japan is relatively low so that Japan is not very different from the pure floaters (see Table 10 and Table 11 in Appendix 2: Probability distributions). However, the time series for Japan show a quite different picture (see Figure 2). Especially in the years 1999 and 2000 its intervention activity is very high and it is associated with values of I^{float} that exceed +0.33 for most of the time which clearly indicates that the Japanese authorities targeted an exchange rate path (see Figure 13 in Appendix 6: Selected case studies). In other words, there has been a clear regime change which cannot be detected with the approach of Calvo and Reinhart or any other forms of a cross-section analysis. Thus, an analysis of time series of the two intervention indicators has the advantage to filter out episodes of high intervention activity and episodes of low intervention activity within the whole period considered as well as episodes where exchange rate targeting (managed floating) or exchange rate smoothing (independent floating) prevailed. Moreover it allows us to identify changes in the intervention policy of a country. In Chapter 5 we will present some selected case studies of countries that we identified as managed floaters.

3 What can we learn from the literature?

The empirical analysis shows that there three different approaches under the general heading of floating. While pure floating and independent floating are more or less discussed in the extensive literature on flexible exchange rates, there has been astonishingly little theoretical discussion of managed floating. Above all it is unclear

- why countries try to target the exchange rate directly,
- how the exchange rate can be controlled effectively, and
- how the exchange rate paths should be determined that are targeted under managed floating.

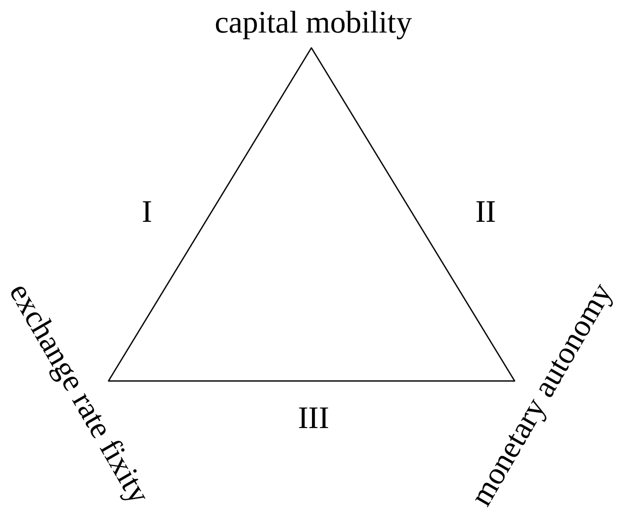
The first question leads to the old debate about fixed versus flexible rates that we do not want to discuss here. In our view an important explanation of the widespread use of managed floating is the very weak statistical relationship between macroeconomic fundamentals and a floating exchange rate. In the words of Jeffrey Frankel and Andrew Rose (1995, p. 1709):

> "To repeat a central fact of life, there is remarkably little evidence that macroeconomic variables have consistent strong effects on floating exchange rates, except during extraordinary circumstances such as hyperinflations."

The low interest in the second and third question seems mainly due to the semantic confusion that was already mentioned. Since most economists do not differentiate between the three forms of floating they seem to believe that the so-called *inconsistency triangle* provides already a sufficient framework for a analysis of the relevant arrangements in exchange rate policy. According to this metaphor a country can choose between the following options (see Figure 4):

- a fixed exchange rate with a lack of an autonomous interest rate policy and free capital mobility,
- an autonomous interest rate policy with a freely floating exchange rate and free capital mobility,
- capital controls and a combination of a fixed exchange rate and an autonomous interest rate policy .

Figure 4: Inconsistency triangle



I: fixed exchange rates
II: pure floating
III: capital controls

As the effectiveness of controls for capital inflows and outflows is very limited, at least on a sustained basis (Ariyoshi et al. 2000), the menu is reduced to the first two options.

The main problem of this presentation is its focus on the polar solutions of either absolutely fixed or absolutely flexible exchange rates (pure or independent floating). In other words it has nothing to say about a policy of managed floating where the exchange is

- neither *fixed*, since it is targeted along an unannounced exchange path,
- nor *flexible* in the sense of a market-determined rate, since the central bank intervenes in order to keep the exchange rate close to the target path.

3.1 The Mundell-Fleming legacy

The theoretical framework for the inconsistency triangle is the well-known Mundell-Fleming model which is the workhorse for almost all textbooks on open economy macroeconomics. But in spite of its popularity the model is not very well designed for a world of managed floating. As a comparative-static model it cannot cope with dynamic processes in exchanges rates, i.e. exchange rate paths and exchange rate expectations. In other words, the polar view presented in the inconsistency triangle is not so much a result of sound theoretical reasoning but rather the outcome of an outdated economic model which by its very nature cannot deal with policy options other than absolutely fixed or absolutely flexible exchange rates.

In addition, the standard textbook presentation of the Mundell-Fleming model only focuses on a domestic monetary policy that tries to follow a more expansionary interest policy than in the anchor currency country. Thus, it overlooks the more interesting situation of a central bank that follows a more restrictive policy which leads to capital inflows and an increase in foreign exchange reserves. In this context the scope for sterilized interventions is also not sufficiently analyzed. We will discuss this in more detail below.

3.2 Open economy inflation targeting

Managed floating is a major challenge not only to the old fashioned but also to more elaborate models of international macroeconomics. Important models with monetary policy rules for open economies have been presented by Ball (1999b) and Svensson (2000). Both authors base their papers on a textbook view of free floating.

Svensson (2000) assumes that the flexible exchange rate is determined even in the short-run by a variant of the absolute purchasing power parity (PPP) and by the uncovered interest rate parity (UIP). As a result, foreign exchange market interventions are not discussed as an independent monetary policy instrument.

However, both textbook assumptions are not compatible with the empirical evidence. It is well-known that pricing-to-market can lead to strong deviations from PPP in the short-run (see Rogoff 1996). The systematic deviations of exchange rate changes ("forward discount bias") from UIP have been discussed in many papers (see Froot and Thaler 1990). In other words, if a central bank follows the policy rule prescribed by Svensson, it has to be aware of the fact that it relies on unrealistic exchange rate theories. This discrepancy between the Svensson model and the reality can be regarded as an explanation of why there is so much foreign exchange market intervention by central banks although the model implicitly assumes that such transactions are not necessary.

The paper by Ball (1999b) uses a rather simple structure for the international linkages of an open economy. Instead of the UIP it simply assumes a positive relationship between the real exchange rate q_t and the domestic real interest rate r_t which can be disturbed by shocks ν_t:

(7) $q_t = \theta\, r_t + \nu_t$.

Of course, this description of the reality is even more problematic than the Svensson model since it disregards the foreign interest rate. In addition, for short-term foreign portfolio investments it is not the real but the nominal interest rate that matters. Real interest rate differentials are relevant for international portfolio decisions only if PPP holds all the time.

Nevertheless, the Ball paper provides an important building bloc for a theory of managed floating. It presents a monetary policy rule for an open economy which is based on the Monetary

Conditions Index (MCI) as a "policy instrument". In Chapter 4.2.1 we will introduce the MCI concept more formally. Ball defines the MCI as a weighted average of the real interest rate and the real exchange rate and derives it from the minimization procedure of a central bank's loss function. He correctly states:

> "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, 1999b, p. 131)

But subsequently he specifies his policy rule as follows:

> "When there are shifts in the e/r relation - shocks in equation (3) [our equation (7); 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 instrument of monetary policy is the interest rate.

In sum, 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 of managed floating. As a consequence, both models disregard the role of foreign exchange market interventions (in the sense of managed floating) as an independent monetary policy instrument. In Chapter 4.4.3 we will come back to their understanding of monetary policy in small open economies and we will present the strategy of independently floating exchange rates and its major flaws within the scope of the open economy model that we are going to introduce in Chapter 4.

3.3 John Williamson's proposals

John Williamson is the most prominent promoter of intermediate exchange rate systems, above all in the form of crawling peg (Williamson 1996), and more recently in the BBC-variant (Williamson 2000) which calls for wide **b**ands, a **b**asket peg and a **c**rawl.

If managed floating is interpreted as a form of a non-announced exchange rate path, Williamson's proposals come relatively close to it. However, there are also some important differences. First, Williamson proposes a very specific form of an exchange rate path: the active crawl, which is characterized by a rule that depreciates the domestic currency vis-à-vis the foreign currency (or a basket of foreign currencies) according to

- the difference between the *targeted* domestic and the foreign inflation rate minus
- a factor which takes into account differences in the domestic and the foreign productivity growth (Ricardo-Balassa-effect).

We will see in Chapter 4.4.2 that the active crawl is only a very specific variant of a managed float which does not necessarily lead to optimum macroeconomic outcomes.

A second difference between the reality of managed floating and Williamson's proposals concerns the role of interventions. Williamson favors a very cautious attitude towards exchange market interventions which becomes evident in his preference for "soft buffers". As our empirical analysis has shown, many central banks follow a much more offensive approach since they do not hesitate to intervene for prolonged period of time and with large amounts of money.

4 A theoretical framework for managed floating

Our very short survey of the literature has shown that so far no comprehensive theory of managed floating is available. In order to explain the actual intervention behavior of central bank such a theory should be able to explain two things:

- the role of the exchange rate as an independent operating target of monetary policy (see Chapter 4.1);
- the interaction of the exchange rate and interest rate policy which is required to guarantee simultaneously the achievement of an internal and an external equilibrium (see Chapter 4.2).

4.1 The exchange rate as an operating target of monetary policy

The starting point for a theory of managed floating is the role of the exchange rate as an operating target of monetary policy. This role, which has not been acknowledged in the literature so far, can be explained in a very direct analogy to the operating target role of the short-term interest rate:

- With *open-market* operations a central bank exchanges short-term domestic notes against domestic central bank reserves in order to target the short-term interest rate.
- With *foreign exchange market interventions* a central bank exchanges foreign sight deposits against domestic central bank reserves in order to target the exchange rate.

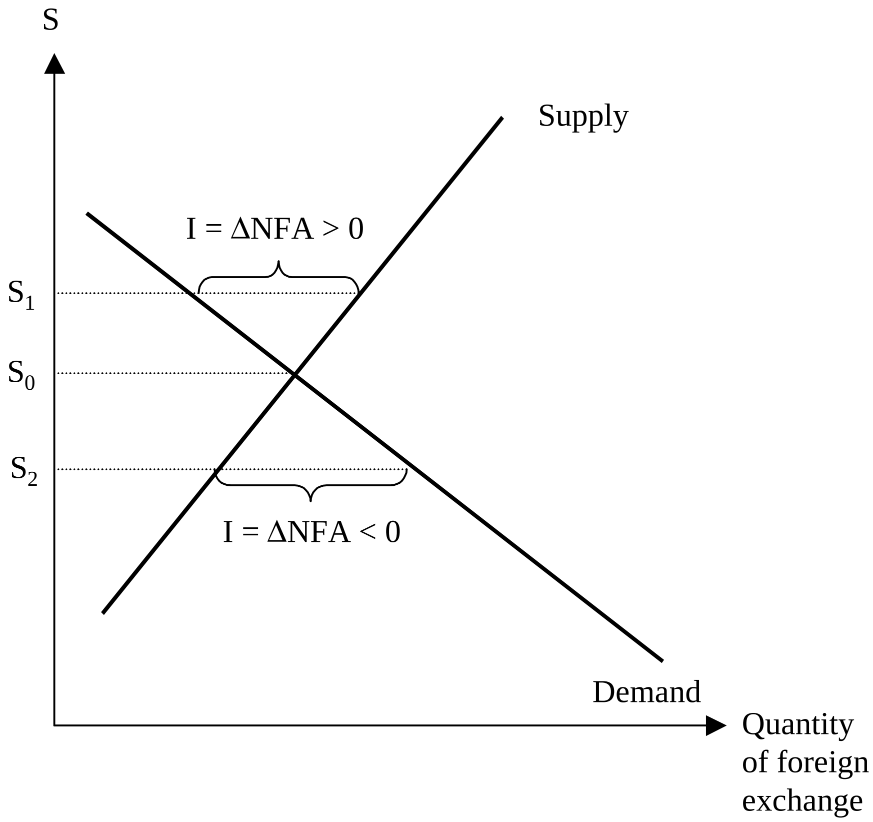
In both cases the operating target is controlled directly by interventions in the relevant market (domestic money market, foreign exchange market).

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 either 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). Or, to put it the other way round, if both instruments are assumed to be independent from each other due to complete sterilization of the liquidity effects of foreign exchange market interventions, then interventions are deemed to be ineffective. Finally sterilized intervention can be associated with interest rate costs that a central bank is not willing to accept. In the following Chapters we will discuss these points more in detail.

4.1.1 The flow channel of interventions matters

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 (Samo and Taylor 2001). The most serious flaw of this literature is that almost all papers analyze the mark-dollar rate. As we have shown in the empirical part of our paper, 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 Table 10 and Table 11 in Appendix 2: Probability distributions).

Figure 5: The flow channel of foreign exchange market interventions



The microeconomics of intervention can be described with a simple diagram for the foreign exchange market (see Figure 5). On the y-axis is the price of foreign exchange in terms of the domestic currency. Thus, there is an upward-sloping supply curve and a downward-sloping demand curve for foreign exchange. The equilibrium exchange rate is S_0. Foreign exchange market intervention implies that the central bank targets a higher or a lower exchange rate than the market-clearing rate. If the central bank targets a rate S_1 that is higher than the equilibrium rate, there is an excess supply of foreign exchange which it has to buy in exchange for domestic reserves. As a result its net foreign assets (NFA) will grow. In the case of a targeted rate S_2 below the market-clearing rate, there is an excess demand for foreign exchange which the central bank has to satisfy by selling foreign assets out of its foreign exchange reserves (ΔNFA<0). As a consequence the commercial banks' reserves decline. As far as the effectiveness of interventions is concerned there is no doubt that the central bank can target a different exchange rate than S_0 as long as it is able to fill the gap between the quantity demanded and the quantity supplied in disequilibrium.

Of course the ability to target S_1 is completely different than the ability to target S_2. In the first case which identifies an intervention policy that tries to target a *weaker* exchange rate than the market rate the, central bank's foreign exchange reserve increase. In the second case which characterizes an attempt to keep the exchange rate at a *stronger* level than market-clearing level, the central bank loses foreign exchange reserves. Thus, 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.

Table 5: Size of local foreign exchange markets

	Average *daily turnover of local currency in the local foreign exchange market* in millions of US-$ (April 1998)	Column 1 as a percentage of *total reserves* minus gold (1998, end of year)	Column 1 as a percentage of the *external sector's size* (1998) as defined in Chapter 2.4	Column 1 as a percentage of the *GDP* (1998, in US-$)
	1	2	3	4
Australia	23600	161.20	39.05	6.47
Austria	3014	13.44	4.62	1.43
Belgium	10706	58.59	6.31	4.28
Canada	25869	110.99	12.43	4.25
Denmark	5564	36.45	12.00	3.20
Finland	2566	26.47	6.82	1.99
France	32634	73.65	10.97	2.26
Germany	62145	83.95	12.27	2.89
Hong Kong	18711	20.87	10.44	11.50
Ireland	3569	37.98	6.53	3.99
Italy	22500	75.28	9.71	1.89
Japan	124045	57.57	37.20	3.26
Luxembourg	1637		21.41	8.93
Netherlands	18651	87.08	9.59	4.92
New Zealand	4928	117.23	39.81	9.23
Norway	5350	28.75	14.12	3.67
Portugal	2983	18.85	9.45	2.79
Singapore	17644	23.55	16.43	21.27
Spain	13007	23.54	0.02	2.35
Sweden	6285	44.58	44.58	44.58
Switzerland	31611	76.74	42.44	12.03
United Kingdom	114817	356.45	39.12	8.12
United States	315872	446.68	38.84	3.59
Argentina	2173	8.78	7.51	0.73
Bahrain	21	1.95	0.61	0.34
Brazil	5127	12.04	9.18	0.65
Chile	1212	7.74	7.21	1.66
China	211	0.14	0.13	0.02
Czech Republic	4169	33.24	15.13	7.48
Greece	5361	30.71	31.55	4.42
Hungary	554	5.95	2.28	1.18
India	1389	5.08	3.64	0.33
Indonesia	972	4.28	2.55	1.03
Malaysia	660	2.58	1.00	0.91
Mexico	8543	26.87	11.61	2.03
Philippines	492	5.33	1.61	0.75
Poland	1315	4.97	3.55	0.83
Russia	4728	60.60	6.82	1.70
Saudi Arabia	1422	10.00	4.14	1.11
South Africa	7289	167.30	0.86	0.18
South Korea	2289	4.40	2.03	0.72
Thailand	2574	8.93	5.29	2.30

Source: BIS (1999), IFS, own calculations

As far as the size of the foreign exchange market is concerned, the figures of a daily transactions volume of about 2,000 billion dollar are related to the *market-maker principle* by which the foreign exchange market is organized. Due to this principle which generates a "hot potato effect" (see Appendix 3: The market maker principle), an individual transaction can lead to a multiple of foreign exchange market turnover. Thus, central bank interventions at much smaller scales can be successful. For instance, in the period from June 1999 to June 2000 the Bank of Japan managed to stop a further appreciation of the yen with a total intervention volume of about 100 billion dollar, which is only 5 % of the daily global transactions volume.

This is also confirmed by the data for *local* foreign exchange turnover. They show that because of its role of a vehicle currency on the foreign exchange market the dollar turnover is extremely high compared to the stock of total foreign reserves or the size of the external sector of the United States. For many emerging market economies, however, the relative size of the turnover is considerably smaller so that central banks can affect the exchange rate with relatively small intervention volumes (see Table 5, columns 2 and 3). We calculated for example 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.

4.1.2 Sterilized interventions can be effective

This leads to the second argument which is raised against foreign exchange market interventions. If a central bank intervenes in order to keep its currency from appreciating (depreciating), it increases (reduces) domestic liquidity which ceteris paribus is identical with a more expansionary (restrictive) monetary policy stance. Due to this direct connection it is often argued that any attempt to control the exchange rate is associated with a reduced control over the interest rate. For instance, Anna Schwartz (2000, p. 26) concludes:

> "(...) monetary policy can support either domestic or external objectives. Monetary policy cannot serve both."

This argument neglects the fact that most central banks dispose over different instruments with which they can mop up the excess liquidity that is created by foreign exchange market interventions. As Table 6 shows such a policy of sterilization is very common in those countries that we identified as managed floaters (see Table 13 in Appendix 2: Probability distributions). For each country we estimated the following sterilization equation:

(8) $\Delta NDA_t = \beta_1 \Delta NFA_t + \beta_2 \Delta NDA_{t-1} + u_t$.

Under complete sterilization the coefficient β_1 of the change in net foreign reserves (ΔNFA_t) is expected to be -1, for net domestic credit (ΔNDA_t) is systematically varied to offset the effect of reserve acquisitions and losses on domestic liquidity.[5] Ten of the 27 managed floaters had a sterilization coefficient smaller than –0.90, and for 19 of them it was less than –0.70.

How does sterilization work in practice? For the case of an intervention that increases domestic liquidity the sterilization can be achieved as follows:

- 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. An instrument which is especially suitable for that purpose are the ECB's security repurchase agreements with a maturity of up to two weeks that are conducted on a weekly basis.
- For the case of interventions that exceed this form of sterilization a central bank has to issue interest-bearing short-term notes with which the excess liquidity can be neutralized. A similar and even more simple instrument is the *deposit facility* which has been established by the European Central Bank (see ECB 2000). Such an interest bearing

[5] The lagged values of ΔNDA were included to capture other effects than the sterilization policy of the central banks. The data is monthly and all taken from the IFS (lines 11 to 17).

facility has the advantage that it provides a sterilization potential that is unlimited, at least in principle. So far, this instrument is not very common with other central banks, but it is not a major technical problem to establish such a facility which is simply an additional interest-bearing account for each commercial bank with the central bank.

In this context it is important to note that the literature uses two different definitions of sterilization which depend on the domestic operating target of the central bank. If a central bank uses the *monetary base* as its operating target, sterilization means that the amount of monetary base is not affected by interventions. Based on this definition the estimation presented in Table 6 was made. If a *short-term interest rate* (overnight rate, one or three month rate) serves as the domestic operating target, sterilization has to guarantee an unchanged level of this rate. As almost all central banks in the world use the interest rate as their domestic operating target, we will use the second definition of sterilization. At first sight both definitions seem almost identical, but in the situation of shocks to the domestic money market, the two control options lead to very different results (Bofinger 2001).

Table 6: Sterilization coefficient in managed floating economies

Dependent variable: ΔNDA_t					
	Explanatory variables		Statistics		
	ΔNFA_t	ΔNDA_{t-1}	R^2	DW	n
Argentina	-1.05 (-17.64)***	0.56 (14.42)***	0.81	2.24	121
Australia 2	-0.66 (-9.89)***	0.13 (2.22)**	0.37	1.89	202
Brazil 1	-0.92 (-19.95)***	-0.12 (-2.50)**	0.89	1.66	53
Brazil 2	-0.88 (-8.21)***	-0.18 (-1.70)*	0.61	2.02	46
Brazil 3	-1.13 (-4.39)***	-0.29 (-2.00)*	0.59	2.32	21
Bulgaria	-0.77 (-29.07)***	-0.27 (-7.25)***	0.98	1.50	21
Chile 1	-0.23 (-3.87)***	-0.21 (-3.06)***	0.06	1.80	200
Colombia 1	-0.76 (-10.20)***	-0.35 (-5.02)***	0.56	2.24	96
Egypt	-1.03 (-18.24)***	-0.04 (-0.87)	0.72	1.94	134
Finland	-0.44 (-5.36)***	-0.14 (-1.28)	0.41	2.01	47
India 1	-0.76 (-3.57)***	-0.19 (-2.53)**	0.03	1.99	167
India 2	-0.26 (-1.65)	-0.13 (-1.26)	0.05	2.02	91
Indonesia 2	-0.91 (-21.81)***	0.00 (0.03)	0.94	2.45	34
Israel 1	-0.77 (-3.85)***	0.18 (1.19)	0.28	1.56	35
Israel 2	-0.67 (-8.88)***	-0.09 (-1.17)	0.43	2.17	106
Japan	-0.94 (-4.91)***	-0.47 (-9.55)***	0.27	2.41	306
Korea 2	-1.09 (-15.75)***	-0.04 (-0.64)	0.85	2.40	34
Malaysia	-0.77 (-4.96)***	0.10 (0.84)	0.37	1.95	56
Mexico 1	-0.95 (-16.11)***	-0.13 (-2.64)***	0.72	1.98	103
Peru	-0.57 (-8.88)***	-0.18 (-2.63)***	0.42	2.18	124
Poland 1	-0.89 (-13.36)***	-0.20 (-3.23)***	0.68	2.17	80
Singapore	-0.83 (-16.88)***	0.02 (0.44)	0.56	2.43	154
Slovenia	-1.01 (-31.40)***	-0.11 (-3.44)***	0.92	2.69	88
Sri Lanka	-0.85 (-18.95)***	-0.20 (-4.78)***	0.59	2.35	262
Thailand 2	-0.29 (-1.20)	0.09 (0.53)	0.06	1.90	31
UK 1	-1.05 (-15.00)***	-0.05 (-0.81)	0.80	2.39	61
Venezuela 1	-0.83 (-6.55)***	-0.04 (-0.40)	0.50	2.09	47

Note: OLS estimation, t-values in parentheses, *** (**) [*] = significant at the 1 (5) [10] per cent level; for Bulgaria, Colombia 1 and UK 1 only quarterly data was available for the whole period;

Many economists are in doubt whether sterilized intervention can have a direct effect on the exchange rate since with such interventions the relative domestic money supplies remain constant. For instance Rosenberg argues:

> "According to the monetary approach to exchange rate determination, central bank intervention that does not alter the supply of money relative to the demand for money will not have a perceptible impact on exchange rates." (Rosenberg 1996, p. 298)[6]

For an understanding of sterilized intervention it is necessary to describe in more detail the transactions and their impact on the balance sheets of the central bank, commercial banks and non-bank investors. We start with a situation where a euro area commercial bank (CB€) holds 100 € reserves with ECB which it has obtained via a repo credit. At the same time a euro area investor (IN€) holds a 100 $ deposit with a United States commercial bank (CB$). We neglect from minimum reserves and assume that the dollar/euro exchange rate is 1:1.

1st round (intervention):
We now assume that the investor wants to exchange his dollar deposit into a euro deposit. For this purpose he sells the deposit to CB€ which in turn sells it on the foreign exchange market. We assume that the ECB intervenes and purchases the dollar deposit from CB€. The counter-value of the deposit is credited to the CB€'s account with the ECB. Thus, the euro reserves increase.

2nd round (sterilization):
The ECB sterilizes the intervention by reducing its repo credits to CB€.

As a result, the monetary base in the euro area and in the United States (which we do not need to present) has remained unchanged. The foreign deposits with CB$ have also not changed, but the ECB has become a depositor instead of IN€. Thus, the dollar deposits held by non-central banks have declined. At the same time, the euro deposits held by non-banks with the CB€ have increased. In other words: even with constant monetary base in both areas, the relative amount of deposits held by the public have changed. This has been compensated by the ECB which holds more dollar assets and less euro assets since it has reduced its euro denominated repo credits. Thus, with sterilized interventions a central bank enters an open position the foreign currency – a long position if it purchases foreign exchange, a short position if it sells foreign exchange.

Seen from this perspective sterilized intervention implies a certain commitment by a central bank since in both cases the risk of the open position is at least partially determined by the central bank's own actions. In the case of an appreciating 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 is able to prevent. In the case of a depreciating currency the opposite applies but the budget constraint of foreign exchange reserves makes the commitment less binding.

As these portfolio adjustments are the driving force of sterilized interventions, the literature obviously suffers from an incorrect identification of the relative monetary bases with the relative amount of deposits held by the public in the two currencies.

A very common assumption in this regard is the assumption of a perfect *substitutability between assets* denominated in different currencies. In the words of Samo and Taylor (2001, p. 27):

[6] See also Samo and Taylor (2001, p. 6)

"(...) 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. Why should banks trade assets of about 2 billion dollar per day if they are complete substitutes? In other words, increasing capital mobility does not mean that the assets traded are substitutes. On contrary, 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.

4.1.3 How can the costs of sterilization be avoided

Thus, we have shown that a central bank is always able to avoid an unwarranted appreciation of its currency without losing control over the domestic interest rate. The remaining problem are the costs of sterilization (C_t^S). 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 made up of two components: the interest rate costs (or earnings) (C_t^i) and the valuation losses (or returns) from foreign exchange reserves (C_t^V):

(9) $C_t^S = C_t^i + C_t^V$.

The interest rate component of sterilization is determined by the difference between the foreign and the domestic interest rate:

(10) $C_t^i = i_{t-1} - i_{t-1}^*$.

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:

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

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:

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

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

(13) $\left(s_t - s_{t-1}\right) = i_{t-1} - i^*_{t-1}$.

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. 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.[7]

4.1.4 Scope and limits of exchange rate targeting

In sum, the exchange rate can targeted by the central bank without a budget constraint, without costs and without negative side effects on interest rate policy, if

- the domestic currency is appreciating vis-à-vis the foreign currency,
- its sterilization potential is unlimited, which can be arranged by offering a deposit facility,
- the targeted exchange rate path is compatible with the prevailing interest rate differential.

A control over the exchange rate is more difficult, if a central banks tries to counteract a depreciation and/or if it follows exchange rate paths that are associated with high sterilization costs e.g. if the domestic currency is kept stable although the domestic interest exceeds the foreign interest rate. The limits of exchange rate targeting are reached in a situation with strong capital outflows that can occur even though the targeted exchange rate is compatible with the prevailing interest rate differential. This can happen if the expected depreciation of the domestic currency exceeds the depreciation that is targeted by the domestic central bank. When the foreign exchange reserves are exhausted, a central bank has to abandon its targeted exchange rate path. We will further discuss this issue in Chapter 4.2.2.

4.2 Internal and external equilibrium under exchange rate targeting

We have shown that a central bank is to a certain degree able to control the exchange rate together with domestic interest rate. The interesting question for a normative theory of managed floating is how to combine these two operating targets of monetary policy. A useful starting point is the logic of the Mundell-Fleming model. It is designed for identifying combinations of fiscal policy, monetary policy, and exchange rate policy[8] that allow the simultaneous achievement of internal and external equilibrium. Internal equilibrium is defined as an output level that implies full employment. External equilibrium is defined as a situation where the central bank's foreign exchange reserves remain constant. In the Mundell-Fleming model, capital mobility implies that the domestic interest rate equals the foreign interest rate. In other words, external equilibrium is reached if the domestic interest rate policy is compatible with UIP since the expected exchange rate change $E[\Delta s_t]$ equals by assumption always zero.

[7] As far as domestic commercial banks receive deposits denominated in the domestic currency and grant credits in the foreign currency, they also pay for the profits of short-term oriented investors.

[8] Remember that the Mundell-Fleming model only captures the two polar cases of either completely fixed or independently floating exchange rates (see Chapter 3.1).

For a theory of managed floating this basic logic can be also applied. In other words, the policy instruments have to be set in order to allow a simultaneous achievement of internal and external equilibrium. The main difference to the Mundell-Fleming model is that in the latter there are three policy instruments: the exchange rate, the interest rate, and fiscal policy. While it may be interesting to develop a model to includes all three instruments, for the sake of simplicity it is useful to discuss a model that deals with the interest rate and the exchange rate only. Thus, we will show how the exchange rate and the interest rate have to be targeted in order to achieve both equilibria. In this sense, our model is limited to monetary policy aspects, and accordingly the strategy of managed floating has to be interpreted as a comprehensive monetary policy strategy within the two extreme cases of absolutely fixed and independently floating exchange rates.

4.2.1 Internal equilibrium

In order to derive the internal equilibrium condition, we start with the transmission channels of monetary impulses in a small open economy. For the conduct of monetary policy it is important to differentiate between two channels: the *exchange rate channel* and the *interest rate channel* (see Svensson 2000).

With the *interest rate channel*, monetary policy affects aggregate demand via its effect on the short-term real interest rate (and possibly on the availability of credit). 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 (see Romer 2000 for an illustrative paper). Monetary policy is thus assumed to follow an interest rate policy rather than a money supply policy. We will come back to this issue at the end of this Chapter.

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. The inflation rate of a small open economy π_t (measured by consumer price inflation) with a share of imported goods ω is a weighted sum of domestic inflation π_t^d and imported foreign inflation (expressed in domestic currency terms) π_t^f:

(14) $$\pi_t = (1-\omega)\pi_t^d + \omega\pi_t^f .$$

The foreign inflation π_t^* is assumed to be transmitted to domestic inflation via changes of the exchange rate Δs_t:

(15) $$\pi_t^f = \pi^* + \Delta s_t .$$

Inserting equation (15) into equation (14) finally describes the direct exchange rate channel in a simple way:

(16) $$\pi_t = (1-\omega)\pi_t^d + \omega\left(\pi^* + \Delta s_t\right).$$

Indirectly, a change in 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. From standard macroeconomics we know that the national income Y_t can be separated into consumption C, investment I, government purchases G, and net exports NX:

(17) $Y_t = C(Y_t) + I(Y_t, r_t) + G + NX(Q_t, Y_t, Y_t^*)$.

The inclusion of net exports extends a closed economy analysis (where central monetary policy variable is the real interest rate r_t which determines planned investment) to the open economy. The key determinant of net exports is the real exchange rate Q_t[9]

(18) $Q_t = \frac{S_t P_t^*}{P_t}$,

where S_t is the nominal exchange rate and P_t^* / P_t is the price of foreign (import) goods in relation to (home) export goods. Standard textbooks in monetary economics now reduce the definition of aggregate demand to the relevant variables r_t and Q_t. It is common to adopt a relationship that is linear in these two variables. We therefore solve our aggregate demand equation for output and write it in logarithms (except for the real interest rate). This finally yields the following open economy IS function:

(19) $y_t = \delta_0 - \delta_1 r_t + \delta_2 q_t + \varepsilon_t^D$.

y_t is the log of output, q_t the log of the real exchange rate, and ε_t^D a random white noise disturbance (demand shock) which captures shocks in domestic government spending, domestic saving and investment behavior, and foreign income. The parameter δ_0 incorporates all autonomous components of aggregate demand. δ_1 is the interest rate elasticity of aggregate demand, and δ_2 the exchange rate elasticity. All three parameters are assumed to be positive.

Although most often introduced that way, for our purposes the IS equation (19) suffers from its inability to capture the effects of exchange rate *changes* which is central for a theory of managed floating. For this reason we modified the IS function as follows. Due to the flow character of aggregate demand, the time subscript t refers to a period of time, say a quarter of a year. Thus, for quantifying how much aggregate demand is affected by the real exchange rate, it is important to take into account

- the percentage change of the real exchange rate Δq_t from the beginning of the period to its end, and
- the average level of the real exchange rate q_t during that period.

Accordingly, a modified description of the IS function in an open economy is given by

(20) $y_t = \delta_0 - \delta_1 r_t + \delta_2 \Delta q_t + \delta_3 q_t + \varepsilon_t^D$.

In a next step, to get an expression for the output gap $\tilde{y}_t$, we subtract the natural rate of output $\hat{y}$ from both sides of equation (20):

(21) $\tilde{y}_t = y_t - \hat{y} = \delta_0 - \delta_1 r_t + \delta_2 \Delta q_t + \delta_3 q_t - \hat{y} + \varepsilon_t^D$.

This allows us to eliminate the "neutral" components of aggregate demand, i.e. those which are determined by (long-run) factors other than monetary policy ones:

(22) $\hat{y} = \delta_0 - \delta_1 \hat{r} + \delta_3 \hat{q}$,

[9] Another determinant is real income abroad (Y_t^*).

where $\hat{r}$ denotes the neutral real short-term interest rate and $\hat{q}$ is the log of the neutral real exchange rate. Thus, the output gap in equation (21) can be written as

(23) $\tilde{y}_t = -\delta_1(r_t - \hat{r}) + \delta_2 \Delta q_t + \delta_3(q_t - \hat{q}) + \varepsilon_t^D$.

For the sake of simplicity, we now normalize $\hat{r}$ to zero. $\hat{q}$ is assumed to adopt the value of q_t so that we arrive at the final definition of the output gap:

(24) $\tilde{y}_t = -\delta_1 r_t + \delta_2 \Delta q_t + \varepsilon_t^D$.

The reason for the different treatment of the neutral values will be explained in the next paragraph.

4.2.1.1 Measuring the actual monetary policy stance: the concept of the actual MCI (MCI_t)

If one aims at concentrating on the demand-side effects of monetary policy (interest rate channel and exchange rate channel), a comprehensive measure of the actual policy stance of the central bank's two operating targets is provided by the so-called *Monetary Conditions Index* (MCI) which can be defined in a simple form as follows:

(25) $MCI_t = \delta_1 r_t - \delta_2 \Delta q_t$.

If the monetary policy stance is about to tighten, the MCI rises, and in the opposite case, the index falls. With positive elasticities δ_2 and δ_2, a tighter MCI can be achieved by raising the interest rate, by a real appreciation, or by a combination of both.[10] In particular, we refer to this MCI as to the "actual" MCI_t (with the subscript t) as it perfectly reflects the actual monetary policy stance. In contrast to the MCI that Ball (1999b) uses in his paper (see also Chapter 3.2) our index is a linear combination of the real short-term interest rate r_t and the *change* of the real exchange rate Δq_t. The reasoning behind this modification can be explained as follows:

- First, as already pointed out by McCallum (1999) who defined the MCI in a similar way, it can be argued that, in order to get a "dimensionally coherent definition" of the MCI, the *level* of the real exchange rate q_t is not an adequate measure as it does not refer to a period of time (like interest rates do). This point becomes even more obvious when the real variables are transformed into their nominal counterparts. For the level of the real exchange rate it suffices to know the actual price level (see equation (18)), whereas the change in the real exchange rate has to be transformed into Δs_t via the inflation rate, similar to what the Fisher equation postulates for interest rates (see equations (45) and (46) in Chapter 4.3).
- Second, various econometric studies show that q_t and r_t are of different orders of integration. While r_t is a stationary variable, q_t is generally found to be integrated of order one. Here again, coherence is required to avoid undesirable properties of the MCI (see Eika et al. 1996, p. 784 who emphasize this point). Thus, the first difference of the real exchange rate variable seems to be a more suitable measure of the exchange rate channel.

Of course this formulation of the MCI neglects the fact that, for example, an already overvalued real exchange rate still has effects on aggregate demand even though it remains unchanged.

[10] Note that a negative change 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 Δs_t. But under the important assumption of price stickiness, r_t and Δq_t are perfectly correlated with their nominal counterparts i_t and Δs_t, the operating targets of the central bank. We will further discuss this issue in Chapter 4.3.

Hence, by setting $\hat{q}$ equal to q_t, we always assume that our monetary policy analysis starts in a situation where the real exchange rate is on its neutral level. As a compromise the empirical literature on aggregate demand in small open economies often uses a relatively long Δ with up to eight quarters. The coefficients δ_1 and δ_2 are equal to the estimated effects of these two financial variables on aggregate demand, and hence, on inflation (for a comprehensive overview of the use of MCIs see Mayes and Virén 2000). The MCI is thus conditional on the structural characteristics and on the underlying model of the economy.

4.2.1.2 *Deriving the optimal monetary policy stance: the concept of the optimal MCI (MCI_t^{opt})*

For the monetary policy maker it is now crucial to know which actual MCI (MCI_t) he has to realize. The purpose of this Chapter is to derive the optimal monetary policy stance. We asume a model of a small open economy similar to the one applied by Gerlach and Smets (2000) where the so-called optimal MCI (MCI_t^{opt}) is the result of the minimization procedure of an intertemporal loss function. The behavior of the private sector is described with two equations:

(26) $$\tilde{y}_t = \beta(p_t - E_{t-1}p_t) + \varepsilon_t^S$$

(27) $$\tilde{y}_t = -\delta_1 r_t + \delta_2 \Delta q_t + \varepsilon_t^D .$$

Equation (26) is a simple Phillips curve relation for the supply side with a random white noise disturbance ε_t^S (supply shocks). $\tilde{y}_t$ denotes the output gap and the term in brackets is the deviation of the actual price level from the expected price level. Equation (27) describes the demand side of an economy with a traditional IS relation. ε_t^D is again a random white noise disturbance (demand shock). Equating (26) and (27) and solving for a linear combination of r_t and Δq_t defines an expression for the real MCI as introduced in equation (25):

(28) $$\delta_1 r_t - \delta_2 \Delta q_t = MCI_t = (\varepsilon_t^D - \varepsilon_t^S) - \beta(p_t - E_{t-1}p_t).$$

To simplify things, we divide equation (28) by δ_1 and we replace δ_2/δ_1 by δ:[11]

(29) $$r_t - \delta \Delta q_t = MCI_t = 1/\delta_1 (\varepsilon_t^D - \varepsilon_t^S) - \beta/\delta_1 (p_t - E_{t-1}p_t).$$

The optimal MCI is then generated through the minimization of a central bank's loss function which is given by

(30) $$L_t = \chi_1 (\tilde{y}_t - \varepsilon_t^S)^2 + \chi_2 (\pi_t - \pi^T)^2 .$$

π^T is the inflation target set by the central bank. χ_1 and χ_2 denote the relative weights assigned to output deviations from equilibrium and inflation deviations from target. With the first-order condition of equation (30) and a few assumptions (full information and rational expectations) Gerlach and Smets derive the following expression for the price forecast error

(31) $$p_t - E_{t-1}p_t = \gamma(\pi^T - E_{t-1}\pi^T),$$

where $\gamma = \chi_2 / (\chi_1 \beta^2 + \chi_2)$.[12] Inserting equation (31) into equation (29) finally yields the optimal MCI:

[11] Note that the MCI in equation (29) formally differs from that in equation (28) (by a factor δ_1). But as the MCI is an index, its information content is resistant to linear transformations. We therefore hold on using the expression "MCI_t" and keep in mind that from now on we refer to the definition in equation (29).

[12] See Appendix 4: Derivation of the optimal MCI based on the minimization of a central bank's loss function.

(32) $\quad MCI_t^{opt} = 1/\delta_1 \left(\varepsilon_t^D - \varepsilon_t^S\right) - (\beta\gamma)/\delta_1 \left(\pi^T - E_{t-1}\pi^T\right).$

According to equation (32) the *optimal MCI* changes due to changes of the parameters on the right-hand side of the equation. Accordingly, if the optimal MCI shall be exogenous to the monetary authorities, then we have to assume that their inflation target is fully credible so that $\pi^T - E_{t-1}\pi^T = 0$. Thus, the optimal MCI depends solely on real shocks affecting the economy.

4.2.1.3 The internal equilibrium rule

The internal equilibrium condition can finally be described as follows:

(33) $\quad r_t - \delta\Delta q_t = MCI_t \overset{!}{=} MCI_t^{opt} = 1/\delta_1 \left(\varepsilon_t^D - \varepsilon_t^S\right) - (\beta\gamma)/\delta_1 \left(\pi^T - E_{t-1}\pi^T\right)$

In other words, the MCI serves as combined measure of the monetary policy stance which has to be controlled and adjusted in response to changing macroeconomic conditions. As a simple rule the actual MCI shall rise (the monetary policy stance becomes more restrictive) if the domestic economy is affected by excess demand shocks (the optimal MCI rises); in the opposite case, when the domestic economy signalizes deflationary pressures (the optimal MCI declines), the actual MCI shall decline (the monetary policy stance becomes more expansionary). The domestic constraint to monetary policy therefore is the strict observation of this rule, independently of the exchange rate regime chosen. A deviation from this rule leads to either an overheating or a recession of the domestic economy.

The idea behind such a rule is similar to the well-known and widely accepted monetary policy rules for closed economies. This type of rules is mostly formulated in terms of a short-term (real or nominal) interest rate. A common feature is that the optimal interest rate policy of a central bank responds positively to output gaps and deviations of the inflation rate from its target value (for a theoretical derivation see Ball 1999a and Svensson 1997; for an empirical application see Clarida et al. 1998). For our purpose, it is sufficient to reduce the rule to a linear equation which is given, in a general form, as follows:

(34) $\quad r_t^{opt} = f\left(\pi_t, \tilde{y}_t\right) = \hat{r} + a\left(\pi_t - \pi^T\right) + b\tilde{y}_t,$

where $\hat{r}$ represents the equilibrium (or neutral) real interest rate, and the coefficients a and b incorporate structural parameters of the economy as well as the monetary policy maker's weights χ_1 and χ_2 (see equation (30)).[13] Transforming our open economy rule of equation (33) into a rule similar to the closed economy formulation of equation (34) yields

(35) $\quad MCI_t^{opt} = f\left(\pi_t, \tilde{y}_t\right) = M\hat{C}I + a\left(\pi_t - \pi^T\right) + b\tilde{y}_t.$

Such a transformation is allowed as long as one assumes that the real shocks ε_t^D and ε_t^S of equation (33) are reflected in output gaps unequal zero and/or deviations of the inflation rate from its target value. As the MCI is simply an index, the neutral level $M\hat{C}I$ can be set to zero. The major difference to a closed economy rule is thus the extension of the central bank's instruments by interventions in the foreign exchange market, and consequently, the consideration of a double-operating-target framework.

[13] The most famous type of this kind of rules is the Taylor rule where the coefficients a and b are supposed to be equal to 0.5.

4.2.2 External equilibrium

For the discussion of the external equilibrium in an open economy we *assume free capital mobility*. This assumption can be justified with the very weak evidence for the effectiveness of capital controls (see Ariyoshi et al. 2000) and with the high allocative and administrative costs of a comprehensive system of capital controls. As already mentioned, in such a world of free capital mobility the external equilibrium is characterized by an equilibrium in the balance of payments which means that the current account is fully financed by the capital account so that the foreign exchange reserves of the central bank remain constant. That is to say, foreign exchange market interventions by the central bank do not occur. In the following we will derive the condition under which this equilibrium holds. We will further see that each time when deviations take place there is a case for foreign exchange market interventions of the central bank. For this purpose 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.[14]

4.2.2.1 The private investor's external equilibrium

The private sector's equilibrium condition is captured by the well-known uncovered interest parity:

(36) $i_t = i_t^* + E[\Delta s_t] + \alpha_t$.

According to UIP, in equilibrium the return on domestic investment i_t equals the expected return on foreign investment which itself is the sum of the foreign interest rate i_t^*, the expected exchange rate change $E[\Delta s_t]$ and, depending on the underlying monetary and exchange rate regime, a time-varying risk premium α_t. If this condition is met, private market participants should be indifferent between the domestic and the risky foreign investment. Hence, short-term[15] capital flows do not occur.

4.2.2.2 The central bank's external equilibrium

The equivalent of the private investor's arbitrage condition is the central bank's zero-cost-condition. In Chapter 4.1 we explained the mechanics of sterilized foreign exchange market interventions. One basic result was that if central banks want to make independent and efficient use of the short-term interest rate and the exchange rate as operating target, the costs of sterilization have to be zero. This led to the ex post interest parity condition which we formulated in equation (13). By augmenting the time subscript by 1 we can now derive the central bank's external equilibrium condition:

(37) $i_t - i_t^* = \Delta s_t^T$.

According to equation (37) the central bank targets an exchange rate path (Δs_t^T) that is equal to the difference of the domestic interest rate i_t (set by the central bank as well) and the exogenous foreign interest rate i_t^*.

[14] We will see later on 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^*. 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.

[15] 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.

4.2.2.3 The overall external equilibrium and the central bank's intervention response function

The overall equilibrium condition can be obtained by inserting equation (36) into equation (37):

(38) $\Delta s_t^T = E[\Delta s_t] + \alpha_t$.

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, then there is no need for the central bank to intervene in the foreign exchange market, and the balance of payments is in equilibrium as defined in the introduction of Chapter 4.2.2.

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 surplus through an investment in the domestic economy 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:

(39) $i_t - i_t^* = \Delta s_t^T > E[\Delta s_t] + \alpha_t$.

The central bank now 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^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. It is important to underline that in this case the central bank is neither restrained by its stock of foreign reserves (the bank is able to buy unlimited amounts of foreign reserves) nor by any costs of sterilization (by achieving Δs_t^T, the bank perfectly fulfills the zero-cost-condition).

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

(40) $i_t - i_t^* = \Delta s_t^T < E[\Delta s_t] + \alpha_t$.

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^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 first case (the capital inflow case), now the central bank is restrained by its stock of foreign reserves. In Chapter 4.1.1 we labelled this the hard budget constraint. But this does not mean that the central bank is not able to realize Δs_t^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:

(41) $I_t = \Delta NFA_t = f(\Delta s_t^T - E[\Delta s_t] - \alpha_t)$,

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 (41) completes our flow channel analysis of foreign exchange market interventions in Chapter 4.1.1.

In most of the cases described above (the capital inflow case, the case without interventions, and the capital outflow case with sufficient foreign reserves) the central bank is able to realize its external equilibrium:

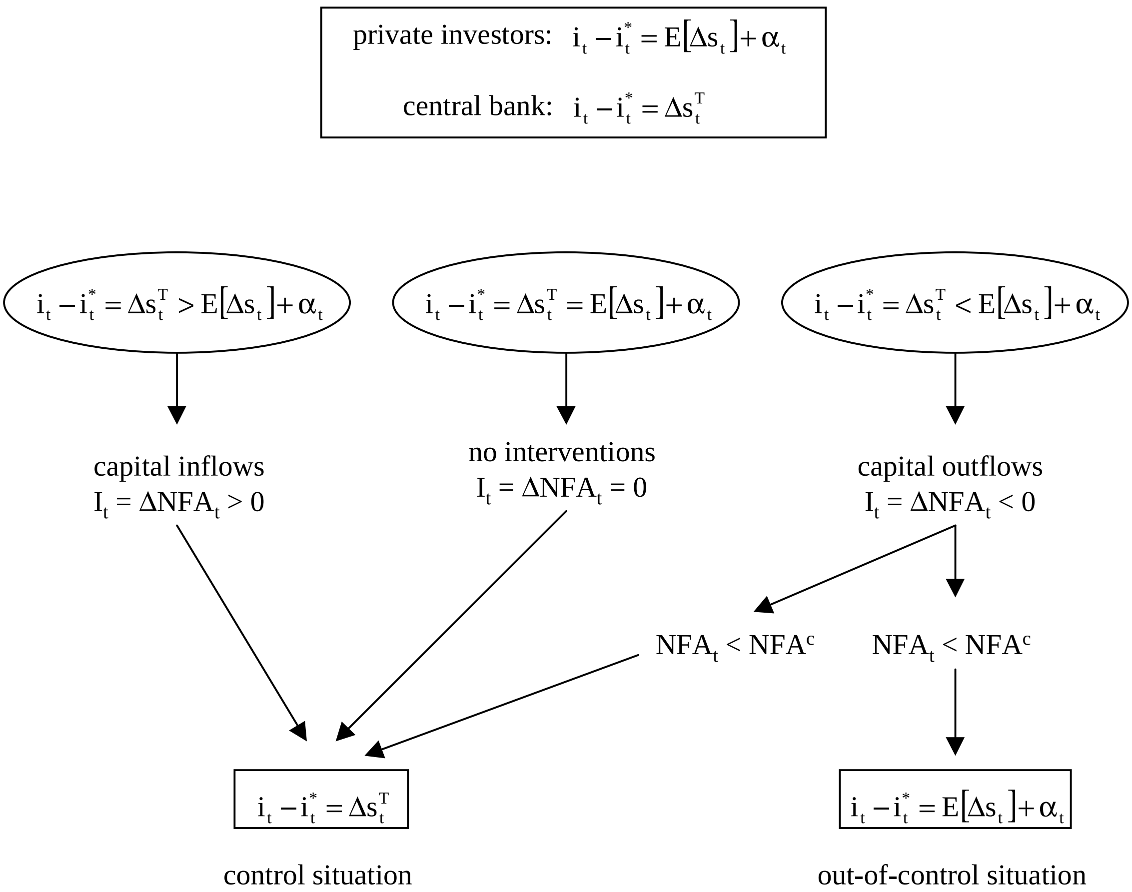
(42) $i_t - i_t^* = \Delta s_t^T$.

We call this the "control situation". There is only one case in which the central bank looses the control over its operationg target: the capital outflow case with foreign reserves falling below a critical threshold. In this situation which we call "out-of-control 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. This adjustment can be achieved by either reducing the domestic part of the monetary base, or by non-sterilized foreign exchange market interventions which lowers the foreign part of the monetary base. Independently of how domestic interest rates are raised, the external equilibrium condition in the out-of-control situation becomes

(43) $i_t = i_t^* + E[\Delta s_t] + \alpha_t$.

We will further discuss the consequences of this situation for the overall monetary policy strategy of managed floating in the end of the next Chapter. Figure 6 summarizes again the major relationships underlying the external equilibrium of our strategy.

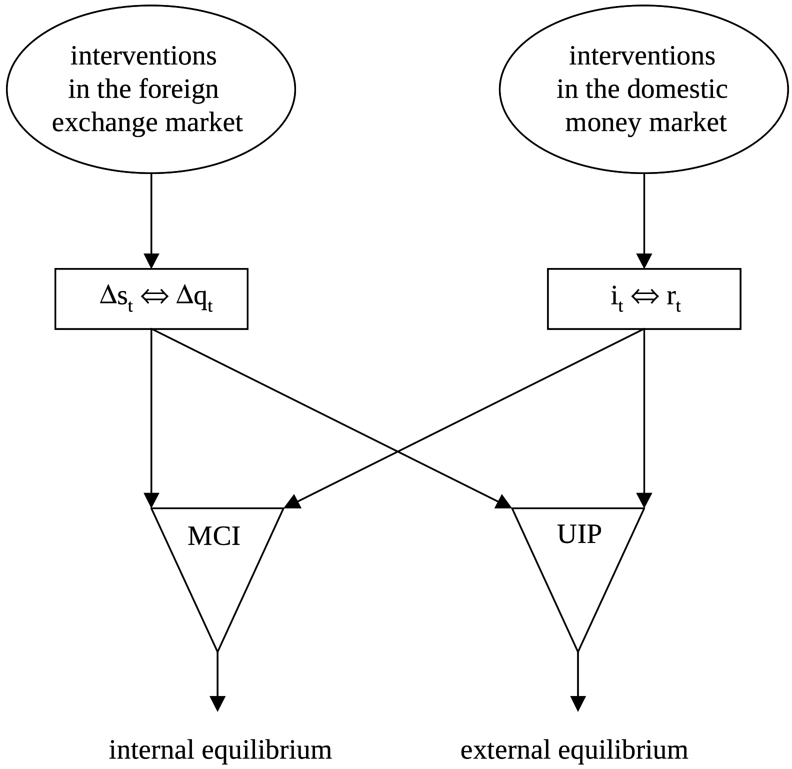
Figure 6: The external equilibrium



4.3 A monetary policy framework for small open economies

In the following we develop a simple policy framework for managed floating which is based on the dual requirement of internal and external equilibrium. Its main structure is presented in Figure 7. It shows the instruments, the operating targets and the final targets of monetary policy. While the external equilibrium is by itself not a final target of monetary policy, one can assume that a violation of this condition will lead to a currency crisis and thus to output losses in the future.

Figure 7: Monetary policy in small open economies



Our framework is a typical example for the analysis of economic policy by Tinbergen (1952) who has shown that in order to meet two independent targets two instruments are required that need to be efficient and independent from each other.

This framework can now be analyzed with a very simple set of equations: The two equations for external and internal equilibrium have to be solved for the two policy variables: the nominal interest rate and the target path for the nominal exchange rate. For reasons of simplicity we omit the T superscript for the exchange rate target since for the interest rate target this is also not the common practice. Moreover, for the moment, we only analyze situations where the exchange rate path and the interest rate are under perfect control of the central bank. The other case, when the central bank runs out of foreign reserves, is discussed in detail in the end of this Chapter.

Internal equilibrium is defined by a combination of the two operating targets that generate the optimum MCI which has been derived as mentioned above:

(44) $MCI_t^{opt} = r_t - \delta \Delta q_t$.

Using the definition of the real exchange rate (variables for the foreign country are marked with an asterisk)

(45) $\Delta q_t = q_{t+1} - q_t = \Delta s_t + \pi_t^* - \pi_t$

and the Fisher equation

(46) $r_t = i_t - \pi_t$ and $r_t^* = i_t^* - \pi_t^*$

we can show how the two operating targets have to be set in order to generate the optimum MCI:

(47) $MCI_t^{opt} = (i_t - \pi_t) - \delta(\Delta s_t + \pi_t^* - \pi_t)$.

External equilibrium is defined by equation (48) which also has to be met by the setting of the operating targets:

(48) $\Delta s_t = s_{t+1} - s_t = i_t - i_t^*$.

All variables in these two equations with the exception of the two operating targets (i_t and Δs_t) are either exogenous or predetermined. For the framework of managed floating which applies above all to smaller countries, it is obvious that the domestic central bank has no influence on the foreign variables (i_t^*, π_t^*, r_t^*). The same applies to the structural parameter of the domestic economy (δ) –at least in the short-run. We assume that in the short-run π_t is predetermined because of price rigidities. Finally, at the level of operating targets the optimum MCI which has been derived according to equations (32) and (35) can also be regarded as an exogenous variable.

Within the limits discussed in the previous Chapter the instrument variables of monetary policy (i_t and Δs_t) are directly controllable by the central bank. With equations (45) and (46) and the assumption of short-term price rigidities, we can also consider their real counterparts r_t and Δq_t as instruments.

The model which consists of the two equations for internal and external equilibrium can now be solved for the optimum values of the two operating targets. This can be obtained by inserting equations (45), (46) and (48) into equation (44) which yields the optimum MCI that is compatible with the external equilibrium condition:

(49) $MCI_t^{opt} = (1-\delta)i_t - (1-\delta)\pi_t + \delta r_t^*$.

From this we can calculate the optimum interest rate:

(50) $i_t = \frac{1}{1-\delta}\left(MCI_t^{opt} - \delta r_t^*\right) + \pi_t$.

Inserting equation (50) into equation (48) and solving for Δs_t yields an MCI dependent expression of the policy rule for the second instrument:

(51) $\Delta s_t = \frac{1}{1-\delta}\left(MCI_t^{opt} - r_t^*\right) + \pi_t - \pi_t^*$.

Thus, our model provides two simple rules for the choice of the operating targets under a system of managed floating. It shows that the two domestic policy variables are determined by

- the required degree of monetary policy restraint according to MCI_t^{opt},

- the real interest rate in the anchor currency country (or in the basket currency countries),
- the domestic inflation rate, and
- the structural parameters of the economy.

The target path for the exchange rate is additionally dependent on the foreign inflation rate (or the inflation differential) vis-à-vis the anchor country. The two equations show that the sign with which the optimum MCI and the foreign real interest rate influence the two operating targets depends on the value of the structural parameters δ. Its concrete value depends on the relative weight of the interest rate and the exchange rate channel in an open economy. Empirical estimates show that in most cases δ_1 exceeds δ_2 (thus $\delta<1$) while the opposite holds only for very small economies ($\delta>1$) (see Mayes and Virén 2000 and the literature cited there). Thus, for the standard cases,

- the nominal interest rate has to be increased with the optimum MCI, the domestic inflation rate, and reduced with the foreign real interest rate;
- the nominal exchange rate has to be depreciated ($\Delta s_t>0$) with the optimum MCI, the domestic inflation rate, and appreciated ($\Delta s_t<0$) with the foreign real interest rate and the foreign inflation rate.

The latter is the most important result of this simple model. It shows that the optimum exchange rate strategy is a policy where the exchange target path is determined on a ongoing basis depending on the domestic and foreign determinants of equation (51). In other words, managed floating as a strategy where the central bank targets the exchange rate along a non-announced and adjustable path is exactly the optimum approach that is required to achieve internal and external equilibrium in a world of capital mobility.

A somewhat confusing result is the sign of the first partial derivatives of i_t and Δs_t with respect to r_t^*:

(52) $$\frac{\partial i_t}{\partial r_t^*} = \frac{-\delta}{1-\delta};$$

(53) $$\frac{\partial \Delta s_t}{\partial r_t^*} = \frac{-1}{1-\delta}.$$

This shows that the effect of a change of the foreign real interest rate depends on the size of the structural parameter δ. If $\delta<1$, which seems to be the case for most countries, a *decline* of the foreign real interest rate requires a change in the policy with a higher domestic interest rate and a stronger targeted depreciation of the domestic currency. For instance, in the case of the strong reduction in the dollar real interest rate in 1992/1993 the Asian countries should have reacted with a higher targeted depreciation of the currencies (which would have implied that the de facto fixed pegs had to be abandoned) while raising the domestic interest rate. This change in the policy mix would have allowed them to maintain a constant optimum MCI.

The optimum monetary policy response is more difficult to implement in the case of a more than temporary *increase* of the foreign real interest rate. In order to maintain a given MCI, this would require a shift to lower interest rates and to an appreciation or a reduced depreciation of the domestic currency. But this policy response is limited by the central bank's stock of foreign reserves. Thus, it could additionally increase the risk premium which accelerates the capital outflow (see equation (41)). In other words, a country could be forced to accept a policy mix that stops the capital outflow and that restores external equilibrium by increasing the domestic interest rates. In the preceding Chapter we called this an out-of-control situation.

To illustrate the overall macroeconomic consequences of such a situation, let us first recall the optimal MCI that can be achieved under perfect control:

(54) $MCI_t^{opt} = (1-\delta)r_t + \delta r_t^*$.

The optimal interest rate r_t, and thus the optimal nominal interest rate $i_t = r_t + \pi_t$ strictly fulfills the central bank's external equilibrium condition:

(55) $i_t = i_t^* + \Delta s_t^T$.

The out-of-control situation was characterized by the following external equilibrium condition:

(56) $i_t^{out} = i_t^* + E[\Delta s_t] + \alpha_t$,

where i_t^{out} typically exceeds the optimal i_t in order to stop the ongoing capital outflow. The resulting MCI of the out-of-control situation is finally defined by[16]

(57) $MCI_t^{out} = (1-\delta)r_t^{out} + \delta r_t^*$.

We can now compare the out-of-control situation with the optimal situation by simply subtracting equation (54) from equation (57):

(58) $MCI_t^{out} - MCI_t^{opt} = (1-\delta)(r_t^{out} - r_t^{(opt)})$.

This shows that in general, with $(r_t^{out} - r_t^{(opt)}) > 0$ and $\delta < 1$, the out-of-control situation leads to an overly restrictive MCI.

4.4 The advantages of managed floating in comparison with traditional exchange rate strategies

The advantages of managed floating can be demonstrated if we use our model for an analysis of traditional exchange rate strategies: fixed nominal exchange rates, an active and a passive crawl and pure floating.

We proceed as follows. We assume that a country always tries to maintain external equilibrium. Thus, for each exchange rate strategy we use the UIP equation and calculate the required domestic interest rate. With this rate and the exchange rate target defined by the exchange rate strategy we can calculate an actual MCI. It obvious that the actual MCI in this context is not necessarily identical with the optimum MCI that we have used so far. Finally this exercise allows us to identify the main determinants of the actual MCI under different exchange rate regimes and to show why "no single currency regime is right for all countries and at all times" (Frankel 1999) – except for managed floating.

4.4.1 Absolutely fixed exchange rates

For absolutely fixed exchange rates, the policy rule for the exchange rate is:

(59) $s_{t+1} = s_t$ or $\Delta s_t = 0$.

[16] We assume that the expected exchange rate change $E[\Delta s_t]$ yields a real exchange rate change Δq_t.

The interest rate rule is obtained by using the UIP condition of equation (36). In a typical fixed rate system there is no room for sterilized interventions, and thus, the central bank's external equilibrium is subordinated to the private sector's equilibrium condition. Inserting equation (59) into equation (36)yields the equilibrium domestic interest rate

(60) $i_t = \alpha_t + r_t^* + \pi_t^*$.

The two instrument rules given in equations(59) and (60) finally yield the actual MCI:

(61) $MCI_t^{fix} = (1-\delta)(\pi_t^* - \pi_t) + \alpha_t + r_t^*$.

This shows that under a system of fixed exchange rates the actual MCI is entirely determined by factors that are exogenous to the monetary authorities: the actual inflation differential, the risk premium, and the foreign real interest rate. Of course, this policy mix does not guarantee that the central bank achieves the optimal MCI which is irrespective of the currency regime chosen. A general expression was derived in Chapter 4.2.1 as follows:

(62) $MCI_t^{opt} = a(\pi_t - \pi^T) + b\tilde{y}_t$.

By subtracting equation (62) from equation (61) we can now analyze situations in which the MCI of a fixed rate regime corresponds to the optimal MCI:

(63) $MCI_t^{fix} - MCI_t^{opt} = (1-\delta)(\pi_t^* - \pi_t) + \alpha + r_t^* - a(\pi_t - \pi^T) - b\tilde{y}_t \overset{!}{=} 0$.

For our calculation of the MCI we have assumed that the anchor currency central bank sets its nominal interest rate according to the Fisher equation. In reality however, the nominal interest rate can be higher or lower depending on the cyclical situation in the anchor country. If we assume that the anchor country follows a real interest rate rule for a relatively closed economy (see equation (34) with $\hat{r}$ set to zero for simplicity[17]), equation (63) becomes:

(64) $MCI_t^{fix} - MCI_t^{opt} = (1-\delta)(\pi_t^* - \pi_t) + \alpha_t + a^*(\pi_t^* - \pi^{*T}) + b^*\tilde{y}_t^* - a(\pi_t - \pi^T) - b\tilde{y}_t \overset{!}{=} 0$,

where π^{*T} is the inflation target of the anchor currency and $\tilde{y}_t^*$ is the log of its output gap. Based on this condition, we can now examine two situations where the fixed exchange rate strategy seems to be an optimal strategy in the sense of our optimality condition presented in Chapter 4.2.

A *first* case can often be observed in countries that are in the early stages of a stabilization program. As the inflation differential to the anchor country is high, the cyclical components of equation (64) (the terms that are proceeded by a*, b*, a or b) are of minor importance. Accordingly, a strategy of fixed exchange rates can be applied

- if δ exceeds 1,
- as long as there is a high risk premium.

The condition of $\delta > 1$ is only met in the case of very open and/or little monetizised economies. Table 7 presents the degree of openness and the monetization of several countries that adopted a fixed exchange rate regime in recent years. It is important to note, however, that equation (64) also prescribes that an exit strategy is needed as soon as the risk premium declines faster than the inflation differential.

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[17] This simplification is analogous to the simplification that the "neutral" $\hat{MCI}$ is zero (see equation (35)).

Table 7: Structural characteristics of fixed exchange rate regimes

	Date of introduction	Inflation rate in the year of introduction	Degree of openness	Monetization
Currency Boards				
Argentina	03/91	172%	5%	11%
Estonia	06/92	1076%	41%	30%
Lithuania	04/94	72%	52%	26%
Bulgaria	07/97	1082%	48%	34%
Fixers				
Czech Republic	12/90	57% (91)	42% (93)	70% (93)
Mexico	11/91	23%	10%	25%
Euro area			*13% (99)*	*70% (99)*

Sources: IFS, EBRD (1999)

The *second* case can best be illustrated by the successful exchange rate policy of the Netherlands and Austria in the 1980s and the 1990s which maintained a fixed exchange rate vis-à-vis the D-mark and which had similarly low inflation rates as Germany. Accordingly we assume that the anchor country and the small open economy have similar inflation targets ($\pi^{*T} = \pi^T$). Moreover, the parameters a and b are also assumed to be similar in both countries. This finally reduces equation (64) to

$$(65) \quad MCI_t^{fix} - MCI_t^{opt} = (1 - \delta + a)(\pi_t^* - \pi_t) + b(\tilde{y}_t^* - \tilde{y}_t) + \alpha_t \overset{!}{=} 0 .$$

Under these assumptions fixed exchange rates seem to be the optimal strategy if

- there is no inflation differential,
- the countries have the same output gap,
- there is no risk premium.

The first two conditions are perfectly met if the countries have relatively similar economic cycles and if they are subject to the same real disturbances. In this respect Austria and the Netherlands with their strong economic ties with Germany are good examples for a successful fixed peg. However, if one of these conditions is violated, then countries have a real incentive to deviate from the rules prescribed by our monetary policy framework. In the Appendix (Appendix 5: A simple framework for the explanation of currency crises) we show that our model is able to capture these macroeconomic reasons that led to the outbreak of currency crises.

4.4.2 Crawling pegs

A crawling peg system is characterized by the fact that the path of the exchange rate is determined by a formula that in most cases includes the domestic and the foreign inflation rate. In the case of an *active crawl* the exchange rate path is determined by the difference between a target value for the domestic inflation rate (π^T) and the actual foreign inflation rate (π_t^*):

$$(66) \quad \Delta s_t = \pi^T - \pi_t^* .$$

A passive crawl is defined by an exchange rate policy that compensates for the actual inflation differential:

$$(67) \quad \Delta s_t = \pi_t - \pi_t^* .$$

Here again, the interest rate rule is the strict observance of the private sector's external equilibrium condition. A crawling peg where the future exchange rate path is typically preannounced is therefore under this respect quite similar to a fixed rate strategy. For an active crawl the actual MCI becomes

$$(68) \quad MCI_t^{active} = (1-\delta)(\pi^T - \pi_t) + \alpha_t + r_t^* .$$

For a passive crawl the actual MCI is:

$$(69) \quad MCI_t^{passive} = \alpha_t + r_t^* .$$

Thus, we can see that also under a crawling peg domestic monetary conditions are to a large extent determined by the real interest rate in the anchor country. Again we can compare the actual and the optimum MCI:

$$(70) \quad MCI_t^{passive} - MCI_t^{opt} = \alpha + a^*(\pi_t^* - \pi^{*T}) + b^*\tilde{y}_t^* - a(\pi_t - \pi^T) - b\tilde{y}_t \overset{!}{=} 0 ,$$

$$(71) \quad MCI_t^{active} - MCI_t^{opt} = (1-\delta)(\pi^T - \pi_t) + \alpha + a^*(\pi_t^* - \pi^{*T}) + b^*\tilde{y}_t^* - a(\pi_t - \pi^T) - b\tilde{y}_t \overset{!}{=} 0 .$$

The main difference between the fixed rate and the crawls is the tem preceding α_t which is $(1-\delta)(\pi_t^* - \pi_t)$ in the case of fixed exchange rates, 0 for the passive crawl, and $(1-\delta)(\pi^T - \pi_t)$ for the active crawl.

4.4.3 Purely floating exchange rates

The currency crises that occurred under fixed and crawling pegs have led many economists to favor a system of flexible exchange rates. As pronounced by the floating corner of the inconsistency triangle, the advantage of this system is that interest rates can be set autonomously. Thus, if the exchange rate behaved as predicted by economic theory (e.g. $s_t = f(i_t, \pi_t, ...)$, the degree of monetary restriction would be perfectly controllable by the central bank's interest rate policy.

However, the experience with freely floating exchange rates since 1973 has led to the clear result that in the short and medium-run there is no systematic relationship between economic fundamentals (however defined) and the development of the exchange rate. Isard (1995, p. 138) summarizes this evidence as follows:

> "In short, neither the behavioral relationships suggested by theory, nor the information obtained through autoregression, provided a model that could forecast significantly better than a random walk. And furthermore, while the random walk model performed at least as well as other models, it predicted very poorly."

In particular, empirical studies do not find any systematic relationship between the volatility of exchange rates and the underlying "fundamental" volatility (see Flood and Rose 1995).

For the conduct of monetary policy in a small open economy the unpredictable behavior of the exchange rate represents an important, but random determinant of its monetary conditions.[18] If we apply the institutional setting of freely floating exchange rates (i.e. no interventions in the

[18] Note that one of the major failures of exchange rate theory is the well known fact that real exchange rate movements are largely determined by nominal exchange rate changes.

foreign exchange market) together with the open economy aspects of Chapter 4.2.1 to our monetary policy framework, we get the following MCI-based policy rule:

(72) $r_t = MCI_t^{opt} + \delta \Delta q_t$.

The central bank sets the interest rate according to

- changing domestic macroeconomic conditions (MCI_t^{opt}, see equation (35)), and
- the assumed relationship between interest rates and exchange rates (see for example equation (7) in Chapter 3.2).

However, the crucial variable in equation (72) is Δq_t. If the relationship between r_t and Δq_t is stable and predictable, then the monetary policy makers have complete monetary autonomy, in the sense that they can always generate the monetary conditions that are optimal. Otherwise, and somewhat more realistic, the autonomy of independently floating exchange rates can be doubted. To show this we follow the literature and assume that the exchange rate follows a random walk in the short-run:

(73) $\tilde{q}_{t+1} = q_t + \eta_{t+1}$,

where η_{t+1} is independently and identically distributed with $E[\eta_{t+1}]=0$ and a constant variance $Var[\eta_{t+1}]=\sigma_\eta^2$. The tilde on q_{t+1} signifies that it is a random variable. Inserting equations (72) and (73) into the basic MCI equation yields the following expression for the actual MCI:

(74) $MCI_t = r_t - \delta(\tilde{q}_{t+1} - q_t) = MCI_t^{opt} + \delta(\Delta q_t - \tilde{q}_{t+1} + q_t)$.

Thus, the apparent advantage of an independent monetary policy is questionable and decreases with a rising impact of real exchange rate changes on domestic monetary conditions. Instead of achieving full control over the MCI, the actual MCI becomes a random variable for the monetary policy authority that has the following properties:

(75) $E[MCI_t] = MCI_t^{opt}$ and $Var[MCI_t] = \delta^2 \sigma_\eta^2$.

Such an outcome can have different implications for the conduct of monetary policy. If the central bank accepts the randomness of the MCI, this leads to a violation of the internal equilibrium since the optimal MCI is only achieved randomly. On the other hand the central bank can also react to changes of the actual MCI caused by exchange rate variations. This requires that the interest rate is adjusted so that domestic equilibrium can be attained. But this implies that the central bank has to give up its autonomous interest rate policy. Alternatively, the central bank could temporarily adjust its inflation target (see equation (32)).[19] But a discretionary deviation of the inflation target from its long-term value is only a synonym for the inability of minimizing the central bank's loss function, and hence a violation of the internal equilibrium.

[19] This option was perceived by the literature on inflation targeting in open economies. Ball (1999b, p. 139) writes: "In practice, countries with inflation targets do not formally adjust for exchange rates in the way suggested here. However, adjustments may occur implicitly. For example, a central-bank economist once told me that inflation was below his country's target, but that this was desirable because the currency was temporarily strong, and policy needed to 'leave room' for the effects of depreciation." Unfortunately, authors like Svensson and Ball never discuss the possibility of foreign exchange market interventions in cases of fundamentally not justified deviations of the exchange rate path. This reluctance seemingly stems from the conviction that the strategy of inflation targeting is characterized by the abandonment of traditional intermediate targets, and that every attempt to target a certain kind of exchange rate or exchange rate path would undermine this strategy.

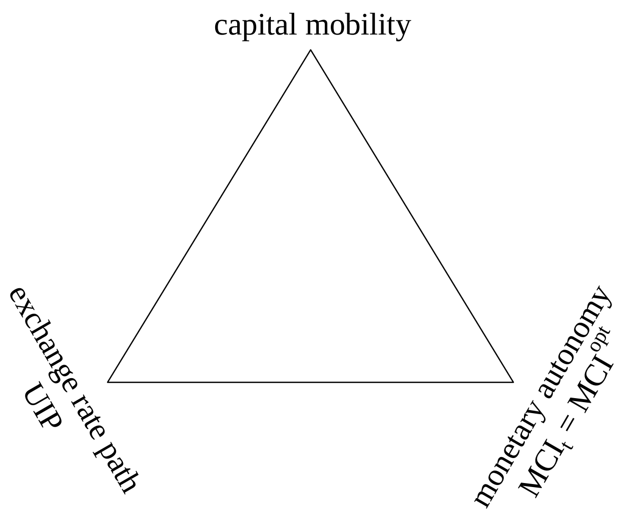
4.5 Overcoming the inconsistency triangle through managed floating

As already mentioned, the inconsistency triangle postulates that a country can only attain one side (i.e. one pair of attributes) of the triangle: capital controls, fixed exchange rates or pure floating. But it says nothing about the possibility of adopting some sort of intermediate regime. Frankel (1999, p. 7) has mentioned this flaw of the current debate:

> "There is nothing in existing theory, for example, that prevents a country from pursuing a managed float in which half of every fluctuation in demand for its currency is accommodated by intervention and half is allowed to be reflected in the exchange rate."

Our discussion has shown that the solution to the inconsistency triangle is not a halfway house between half-stability and half-independence. Instead an integrated approach is required where the optimum interest rate level and the optimum exchange rate path are determined simultaneously. Thus, managed floating allows to convert the inconsistency triangle into a *consistency triangle* with the following three corners: capital mobility, an autonomously determined monetary conditions index and an exchange rate path which follows the interest rate differential.

Figure 8: Consistency triangle



4.6 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 main weaknesses of this framework are the following:

- As the central bank does not announce an exchange rate path, the exchange rate can no longer be used as an anchor for private sector expectations which is especially useful in the situation of a disinflation.
- As a the control over the exchange rate is asymmetric, a central bank can lose the control over the macroeconomic situation if it is confronted with very strong capital outflows.
- As each central bank or government decides autonomously over the exchange rate, there is a serious risk that managed floating is misused for a beggar-my-neighbor policy which can undermine the aims of the WTO.

We will shortly discuss these three topics.

4.6.1 In search of a new anchor for private sector expectations

In the 1980s monetary targeting and exchange rate targeting were regarded as ideal devices for establishing a transparent and credible monetary framework in larger and smaller currency areas respectively. As far as monetary targeting is concerned, many central banks decided to substitute it by inflation targeting as a more comprehensive strategic approach (Bernanke et al 1999, Bofinger 2001). Our analysis of traditional exchange rate strategies has shown that the conditions under which a fixed or a crawling peg can constitute an optimum policy strategy are rather restrictive. Especially as an approach for disinflation a fixed rate can be applied only as long as there is a sufficiently high risk premium. But if the risk premium declines faster than the inflation differential, a fixed rate offers a potential for speculative inflows and makes it at the same time very costly for a central bank to defend the peg with sterilized interventions. This was exactly the situation with which many emerging market countries were confronted in the 1990s.

While managed floating can avoid such problems, by its very nature it cannot provide an anchor for private sector expectations. Thus, if managed floating is regarded as an optimum solution in terms of achieving internal and external equilibrium, an additional institutional device is required. The most obvious solution is inflation targeting which provides an anchor for expectations by a public announcement of the inflation target that the central bank intends to achieve.

There is nothing that prevents a combination of managed floating and inflation targeting. As shown by Ball (1999b), inflation targeting in an open economy requires that the central bank sets monetary conditions in way that a given inflation target can be achieved. Managed floating provides a framework that allows to generate such monetary conditions in way that is compatible with external equilibrium.

As Schaechter et al. (2000) have shown there are already several emerging market countries that have adopted this approach: Brazil, Chile, the Czech Republic, Israel, Poland, and South Africa. All of them are now independent or managed floaters according to the IMF’s classification.

4.6.2 The control over the exchange rate is asymmetric

The most serious flaw of managed floating as we have described it here is the asymmetric control over the exchange rate. As we have shown in the previous Chapters, a central bank’s ability to avoid an unwanted depreciation is limited by the stock of its exchange reserves (and the availability of balance of payments credits). 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. An example for such a crisis is the depreciation of the rupiah in 1997/98 from 2,500 rupiah per US-dollar in July 1997 to over 15,000 rupiah per US-dollar in mid-July 1998.

The monetary conditions index shows that a very strong depreciation leads by itself to an inflationary stance of monetary policy. From the logic of the MCI such a shock must be counteracted by a strong increase of the interest rate. As the MCI is constructed under the assumption of a perfect substitutability of the interest rate and the exchange rate lever, such a policy switch would not be problematic.

In reality, this substitutability is questionable, above all if the required degree of substitution is very high. While the exchange rate mainly affects the international sector of the economy (exporters and import substitution), the interest rate affects the whole economy. A policy shift leading to a strong real depreciation and a very high real interest rates implies an extremely restrictive impulse for the domestic sectors of the economy (the banking system because of its maturity transformation, the services and the construction sector, and the government which is often heavily indebted and often also in a foreign currency). As the Asian crises has shown, such an overly restrictive effect on the domestic sectors of the economy can transform a currency crisis into a financial sector crisis.

Thus, under managed floating countries remain vulnerable to crises of confidence which can be generated simply by contagion effects. The newly created IMF credit facilities (the Supplemental Reserve Facility and as a precautionary device the Contingent Credit Line) can 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[20] 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.

4.6.3 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 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 1,170 billions of US-dollar in 2000[21] shows that in the longer run exchange rate policies were dominated by the desire to keep the national currencies on an undervalued basis. The increasing 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 requires 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.

[20] 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 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."

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

5 Selected case studies

In the preceding Chapter we presented a rather normative approach for explaining the behavior of central banks that operate within the two extremes of the broad spectrum of exchange rate regimes. Our managed floating framework considered the exchange rate as an independent monetary policy tool in addition to the traditional short-term interest rate. Moreover, we defined two equilibrium conditions that shall be guaranteed by the contemporaneous interaction of the central bank's exchange rate and interest rate policy. However, one questions still remains unanswered: Do countries really behave the way we propose?

In Chapter 2 a central result of our cross-country study was, that an important number of countries makes intensive use of its foreign reserves to manage a certain path for the exchange rate. Chapter 4.1 showed that most of the managed floaters that we identified as such with our methodology, indeed controlled both operating targets at the same time. We found that the overwhelming part of the liquidity effects of interventions were sterilized by the monetary policy authority. In Chapter 4.2 we finally specified the conditions that the exchange rate path and the interest rate have to meet. Thus, in this Chapter we concentrate on these two remaining aspects:

- do the countries really follow an exchange rate path that is compatible with UIP, and
- do the countries manage their instruments in order to create the appropriate domestic monetary conditions?

In the following, we pick out four of the most interesting managed floaters and present their strategies in a descriptive approach. Clearly, our choice is somewhat arbitrary, but for the purpose of demonstrating our ideas most convincingly, Slovenia, Peru, Poland, and Japan appeared to be quite instructive. The figures that we refer to can all be found in Appendix 6: Selected case studies.

5.1 Slovenia

The Slovenian monetary and exchange rate policy is an excellent example for a strategy of managed floating. Since the beginning of the transition process the Bank of Slovenia followed a kind of shadow targeting of the tolar with an undeclared path and margin and the German mark as reference currency. In June 1993 it officially appeared as a managed floater for the first time in the IMF classification. As can be seen from the UIP chart in Figure 11, the depreciation path D(s) of the Slovenian currency was for the most part of the period under consideration in line with the interest rate differential vis-à-vis Germany, adjusted by a positive, but small risk premium. As long as there was an excess supply of foreign currency in the foreign exchange market, the Bank of Slovenia intervened with a view to realizing the desired exchange rate path. Our index of floating characterizes these periods with a value of around +0.67. In the second half of 1995 the tolar started to depreciate substantially. Intervention activity was reduced, and the interest rate differential was widened so as to stop a further depreciation. But this change in the policy mix that was triggered by the asymmetric control option over the exchange rate, did not lead to a violation of the internal equilibrium condition. Even though real interest rates rose, this restrictive stance was counteracted by a real effective depreciation so that the MCI still reflected the underlying macroeconomic situation (see the MCI chart in Figure 11).

From 1999 on the rate of depreciation of the tolar exceeded the interest rate differential for the first time. Being aware of the limited effectiveness of prolonged foreign exchange market interventions in such circumstances, the Bank of Slovenia again sharply reduced its intervention activity with a tendency of net sales of foreign reserves. The nominal depreciation directly resulted in an expansionary impulse from the exchange rate channel of monetary transmission which is reflected in a decline of the MCI. As a consequence, inflation rates immediately rose from 5 to over 10 per cent, and real growth was stimulated. In terms of our model presented in Chapter 4, both equilibrium conditions, the internal equilibrium and the external equilibrium, were clearly violated. But what would have been the appropriate policy response, given the inability of the central bank to directly stop the depreciation of the domestic currency? In our view the Bank of Slovenia should have raised its interest rates as it has done likewise in 1995/96. Such a step would directly balance the external disequilibrium through an increase of the demand for domestic currency. But also domestic monetary conditions would become more restrictive.

5.2 Peru

Peru started its stabilization program in the early 1990s after several years of extremely high inflation rates. The official Peruvian exchange rate strategy according to the IMF publications was an independent float since June 1990. But a short look at the intervention activity chart in Figure 12 indicates with no doubt that the management of the exchange rate played a major role in the monetary policy strategy of the Central Reserve Bank of Peru. From 1994 on, as inflation rates fell back on moderate levels, the interest rate policy and the exchange rate path were permanently in accordance with the requirements of the external equilibrium condition. The difference between the two lines in the UIP chart of Figure 12 can be interpreted as a rough proxy for the risk premium that investors demand for Peruvian assets as opposed to US investments. The index of floating shows that the intervention instrument was mainly used to realize the desired exchange rate path. The peak in the interest rate differential in 1998 is again a good example for the asymmetric ability of central banks to control the exchange rate. Capital outflows (triggered by the Russian and Brazilian crisis which exacerbated the anxiety of investors towards emerging market economies) induced a strong depreciation of the sol which could only be stopped by raising short-term interest rates. As soon as the depreciation came to rest, the interest rates were returned to old levels. Interestingly, it seems that since that time interventions were mainly used to smooth exchange rate movements since I^{float} hardly left the $\pm$ 0.33 band.

5.3 Poland

Poland is also a very interesting example of an analysis of a central bank's exchange rate policy. The underlying sample of our study covers two de jure exchange rate regimes: From December 1991 to March 2000 Poland officially declared its exchange rate regime as managed floating (Poland 1 in our classification), whereas from April 2000 on the Polish authorities decided to let the Polish currency float freely without any foreign exchange market interventions (Poland 2). Within the managed floating period, Poland started with a crawling peg against a basket of five currencies. In May 1995, it introduced a crawling band which was gradually widened from $\pm$ 7 per cent to finally $\pm$ 15 per cent. This increased flexibility of the exchange rate system is directly reflected in the behavior of the exchange rate of the Polish zloty vis-à-vis the currency basket (see Figure 13, lower chart) which started to fluctuate considerably from 1998 on. But also the charts of our two indices S^{abs} and I^{float} yield the same results. After a period of heavy intervention activity in the mid 1990s which was aimed at perfectly controlling the depreciation path of the Polish currency, interventions seemed to be more and more a tool to simply smooth out undue exchange rate swings. Finally, from late 1998 on, intervention policy was entirely banned from the central bank's set of instruments so that the de facto switch to a purely floating exchange rate regime was already completed more than one year before the official change.

From the UIP chart we can see that the external equilibrium condition was violated for most part of the period considered. The average rate of depreciation of the zloty exceeded the interest rate differential vis-à-vis Germany significantly until mid 1994. Intervention activity remained rather low during that time which again reflects the asymmetry already mentioned earlier. But also interest rates remained low if one judges this on the basis of the real rates from the upper right hand chart in Figure 13. Thus, the overall policy stance as measured by the MCI was quite expansionary which was certainly due to the low growth performance in the first years. The situation changed with the beginning of the second half of 1994 as capital flows discovered Poland. The National Bank absorbed only a part of the foreign exchange excess and therefore tolerated a gradual reduction of the depreciation of the zloty. As a result, monetary conditions became more restrictive, the disinflation process sped up, and output losses occurred in the first two quarters of 1996. From late 1996 on, with the beginning of a capital flow reversal, the central bank tried to counteract the depreciation pressure by augmenting its nominal interest rates. The MCI further rose and real growth dropped. In 1998, the situation turned again, and as before, the Polish authorities accepted the appreciating pressure on the zloty. From late 1998 on, the National Bank even stopped all intervention activity. Since that time, the UIP chart additionally reveals another typical feature of purely floating exchange rate systems: The relationship between the interest rate differential and the exchange rate path became very unstable, and sometimes, even though the interest rate differential remained positive in the order of 10 to 15 per cent, the nominal exchange rate of the zloty appreciated vis-à-vis the basket currencies.

To summarize, in our view the major deficit of the Polish strategy was simply the disregard of the external constraint. Each time when capital inflows exerted appreciating pressure on the zloty (1995, first half of 1998), the National Bank made no attempts to guarantee a UIP compatible exchange rate path. The correct policy mix according to our framework would have been

- either a reduction of the interest rate differential without directly influencing the exchange rate path
- or the maintenance of an exchange rate path via sustained interventions (purchases of foreign exchange) that is compatible with a risk premium adjusted interest rate differential
- or a mixture of both.

In all cases, the change in the policy mix should have avoided the overly restrictive monetary policy stance that is reflected in our MCI line.

5.4 Japan

As last example for managed floating activity we shortly present Japan (see Figure 14). As we already mentioned in Chapter 2.4.3, a closer analysis of the time series of our two indices can lead to interesting results, especially if the underlying observation period is long. In the right hand chart of Figure 14 we depicted the index of floating only if the overall intervention activity exceeded 1.00. The results are striking: Each time when the Bank of Japan decided to intervene in the foreign exchange market, either to stop an appreciation of the yen ($I^{float} > 0$) or to avoid a depreciation ($I^{float} < 0$), it maintained this policy over period of at least several months so that the absolute value of I^{float} almost always exceeded 0.33. In other words, if the Bank of Japan made use of its intervention instrument, its objective was clearly to target a certain path of the exchange rate rather than smoothing some form of excessive volatility. These findings are clearly in contrast to the results of the Calvo and Reinhart (2000) study who classified the

Japanese exchange rate policy as independently floating, that is to say with a very low overall intervention activity.

6 Conclusion

After the experience with the currency crises of the 1990s, a broad consensus has emerged among economists that such shocks can only be avoided and capital mobility be maintained if countries adopt either floating exchange rates or very hard pegs (currency boards, dollarization). As a consequence of this view which has been enshrined in the so-inconsistency triangle (or "unholy trinity") all intermediate currency regimes are now regarded as inherently unstable. As far as economic theory is concerned, this view has the attractive feature that it not only fits nicely with the logic of the traditional Mundell-Fleming model but also that for both corner solutions (flexible exchange rates with a domestically oriented interest rate policy; hard pegs with a completely exchange rate oriented monetary policy) solid theoretical frameworks have been developed. Finally the IMF's statistics seem to confirm that indeed intermediate regimes are less and less in fashion by both industrial countries and emerging market economies.

However, in the last few years an anomaly has been detected which seriously challenges this new paradigm on exchange rate regimes. In their influential cross-country studies, Calvo and Reinhart (2000) and Levy-Yeyati and Sturzenegger (2000) have shown that many of those countries which had declared themselves as "independent floaters" in the IMF statistics were indeed heavily intervening on foreign exchange markets. Thus, in most cases "floating" means "managed floating".

This insight and the lack of literature about "managed floating" was the starting point for our study. We first developed a set of indicators that allows us to differentiate further between three forms of floating:

- *Pure floaters* completely refrain from foreign exchange market intervention.
- *Independent floaters* intervene in order to smoothen short-term swings in exchange rates but they allow the market to determine the path of the external value of their currency.
- *Managed floaters* are characterized by the fact that also the exchange rate path is mainly determined by the central bank.

Our empirical analysis which extends and refines the Calvo/Reinhart approach comes to the result that many developed and emerging market economies can be regarded as managed floaters. In other words, the international monetary order is currently dominated by managed floating. This has important implications for economic theory and economic policy. As far as theory is concerned, managed floating is very different from the textbook versions of both fixed and flexible exchange rates.

- Compared with *flexible exchange rates* (or pure floating) the central intervenes sometimes very often and also with high quantities on the foreign exchange market in order to target a path for the exchange rate.
- Compared with *fixed exchange rates* (or also crawling pegs) the central bank does not announce its target path. In other words, there is no pre-commitment in the exchange rate policy. Instead of such a rule-based approach, a completely discretionary exchange rate management is adopted.

Thus, managed floating can no longer be explained with the Mundell-Flemig model (above all because it is a comparative static model) nor with standard theories of fixed exchange rates or flexible exchange rates (including the more refined models of open economy inflation targeting). Therefore, we have tried to develop a simple theoretical framework for managed floating. At the level of a central bank's *operating targets* it is based on the assumption that to some extent a simultaneous targeting of the nominal short-term interest rate and the nominal exchange rate is possible. Since the latter is rather controversial, above all because of the literature on sterilized interventions, we show in detail under which conditions a targeting of the exchange rate is possible. This is the case above all, if

- the currency is under a pressure of strong inflows, i.e. it is appreciating by more than a target rate set by the central bank;
- the central bank disposes over a large sterilization potential;
- the costs of intervention are low; this is the case if the target path for the exchange rate is compatible with the interest rate differential.

In the next step we develop a monetary and exchange rate policy framework which is grounded on the general logic of the Mundell-Fleming, but which neglects fiscal policy. It is based on the assumption that the two levers of a central bank (exchange rate, interest rate) have to be so as to fulfill internal and external equilibrium simultaneously:

- As for the *internal equilibrium*, both operating targets have to be set in a way that minimizes a typical loss function of a central bank. We introduced an MCI as a combined measure of the actual monetary policy stance that results from both, the real interest rate and the real exchange rate.[22] More precisely, we define the internal equilibrium condition as an MCI rule which we derive in accordance with a real interest rate rule for a closed economy. In other words, internal equilibrium requires that the short-interest rate and the exchange rate path are set in way that an optimum MCI is realized.
- As for the *external equilibrium*, the exchange rate path and the interest rate have to be set in a way that they correspond with the interest rate differential vis-à-vis the anchor currency. This avoids short-term profit opportunities of international investors and thus helps to prevent speculative inflows (which can often turn into outflows). At same time this rule keeps the cost of sterilization as low as possible.

Thus, given two equations and two endogenous policy variables we can derive target values for the exchange rate path and the interest rate. They show above all that the optimum path for the exchange rate depends on the foreign real interest rate, the inflation differential, the optimum MCI and the risk premium. In other words, exchange rate paths determined by a simple rule (fixed rates, active or passive crawls) as well as pure floating are always inferior to such a discretion in exchange rate policy.

We show this by comparing the strategy of managed floating to absolutely fixed exchange rates and purely floating. We come to the result that both extreme cases are only optimal (in the sense of our internal equilibrium condition) under country-specific conditions. In contrast to this, managed floating offers an integrated approach where the advantages of both corner solutions, namely control over the exchange rate and control over domestic monetary conditions, can be combined.

[22] As we assume sticky prices in the short-run, we assume that the real exchange rate and the real interest rate can be perfectly controlled by the nominal interest rate and the nominal exchange rate

In a final section we discuss several unresolved issues of managed floating. First, as the central bank does not announce an exchange rate path, the exchange rate can no longer be used as an anchor for private sector expectations. Thus, in the same way as the abandonment of rules for the money supply has paved the way for inflation targeting, a discretionary approach towards exchange rate targeting could also be accompanied with a switch to inflation targeting. In fact, same of the countries which manage their exchange rate have already introduced inflation targeting. Second, as a the control over the exchange rate is asymmetric, a central bank can lose the control over the macroeconomic situation if it is confronted with very strong capital outflows. This shows that managed floating is not a complete substitute for international co-operation in exchange rate policy. The newly introduced credit lines (contingent credit line) of the IMF can be regarded as an important step into this direction. Third, as each central bank or government decides autonomously over the exchange rate, there is a serious risk that managed floating is misused for a beggar-my-neighbor policy which can undermine the aims of the WTO. The very strong increase in the foreign exchange reserves of developing countries in the 1990s is a strong indication that such incentives are rather strong. At the same time the growing current account surplus of the United States shows the negative consequences for those countries that follow a completely passive exchange rate policy in an environment that is dominated by managed floating. Thus, managed floating is also not a prefect substitute for international coordination of exchange rate polices. On contrary, it makes this even more urgent than fixed rates or purely flexible rates.

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Appendix 1: Country coverage

Table 8: IMF exchange rate classification of developed and emerging market economies

Country	Period	IMF	data availability	Country	Period	IMF	data availability
Argentina	10/78 - 12/90	if		Mexico 3	12/94 - 11/00	if	12/94 - 09/00
Australia 1	07/82 - 11/83	mf		Morocco	09/80 - 03/90	mf	
Australia 2	12/83 - 11/00	if		New Zealand	04/85 - 11/00	if	04/85 - 10/00
Brazil 1	03/90 - 09/94	if		Nigeria 1	07/82 - 08/86	mf	
Brazil 2	10/94 - 09/98	mf		Nigeria 2	09/86 - 12/93	if	
Brazil 3	01/99 - 11/00	if		Nigeria 3	03/98 - 11/00	mf	not available
Bulgaria	02/91 - 06/97	if	06/94 - 06/97	Norway 1	12/92 - 06/95	if	
Canada	01/75 - 11/00	if		Norway 2	09/95 - 11/00	mf	
Chile 1	09/82 - 06/99	mf		Pakistan	02/82 - 09/99	mf	02/82 - 04/99
Chile 2	09/99 - 11/00	if		Peru	06/90 - 11/00	if	
Colombia 1	01/75 - 06/99	mf		Philippines 1	10/78 - 12/84	mf	
Colombia 2	09/99 - 11/00	if		Philippines 2	12/84 - 11/00	if	12/84 - 10/00
Czech Republic	06/97 - 11/00	mf	06/97 - 10/00	Poland 1	12/91 - 09/98	mf	
Ecuador 1	03/89 - 11/95	mf		Poland 2	04/00 - 11/00	if	
Ecuador 2	12/95 - 01/99	mf		Portugal	01/75 - 03/92	mf	
Ecuador 3	04/99 - 01/00	if		Russia 1	07/92 - 06/95	if	not available
Egypt	06/87 - 09/98	mf		Russia 2	07/95 - 12/97	mf	
Finland	09/92 - 09/96	if		Russia 3	09/99 - 11/00	if	
Greece 1	12/82 - 12/95	mf		Singapore	12/87 - 11/00	mf	
Greece 2	01/96 - 12/97	mf		Slovenia	06/93 - 11/00	mf	
Hungary	06/95 - 08/00	mf	06/95 - 08/00	South Africa	01/83 - 11/00	if	
India 1	02/79 - 02/93	mf		Spain	07/82 - 12/87	mf	
India 2	03/93 - 11/00	if		Sri Lanka	10/78 - 11/00	mf	10/78 - 10/00
Indonesia 1	05/83 - 06/97	mf		Sweden	12/92 - 11/00	if	
Indonesia 2	09/97 - 11/00	if	09/97 - 04/00	Switzerland	04/79 - 11/00	if	04/79 - 10/00
Israel 1	03/84 - 03/87	mf		Thailand 1	06/97 - 03/98	mf	
Israel 2	12/91 - 11/00	mf	12/91 - 09/00	Thailand 2	03/98 - 11/00	if	
Italy	09/92 - 09/96	if		Turkey	01/80 - 11/00	mf	01/80 - 09/00
Japan	01/75 - 11/00	if		United Kingdom 1	01/75 - 09/90	if	
Korea 1	03/80 - 10/97	mf		United Kingdom 2	09/92 - 11/00	if	09/92 - 09/00
Korea 2	12/97 - 11/00	if		United States	01/75 - 11/00	if	
Malaysia	06/93 - 03/98	mf		Venezuela 1	03/89 - 03/93	if	
Mexico 1	02/83 - 10/91	mf		Venezuela 2	06/93 - 06/94	mf	
Mexico 2	11/91 - 11/94	mf		Venezuela 3	06/96 - 11/00	mf	06/96 - 08/00

Table 9: Number of observations

	n = 6		n = 12			n = 6		n = 12	
normalization method	1	2	1	2	normalization method	1	2	1	2
Argentina	142	142	136	136	Mexico 2	37	37	37	37
Australia 1	12	12	6	6	Mexico 3	65	67	59	61
Australia 2	199	199	193	193	Morocco	109	109	103	103
Brazil 1	50	50	44	44	New Zealand	182	182	176	176
Brazil 2	46	46	40	40	Nigeria 2	82	82	76	76
Brazil 3	18	18	11	11	Nigeria 3	46	46	40	40
Bulgaria	13	32	7	26	Norway 1	26	26	20	20
Canada	311	311	311	311	Norway 2	58	58	52	52
Chile 1	197	197	191	191	Pakistan	202	202	196	196
Chile 2	10	10	4	4	Peru	121	121	115	115
Colombia 1	294	294	294	294	Philippines 1	70	70	64	64
Colombia 2	10	10	4	4	Philippines 2	186	187	180	181
Czech Republic	36	36	30	30	Poland 1	89	89	83	83
Ecuador 1	76	76	70	70	Poland 2	3	3	0	0
Ecuador 2	38	38	38	38	Portugal	207	207	207	207
Ecuador 3	5	5	0	0	Russia 2	25	25	19	19
Egypt	131	131	125	125	Russia 3	10	10	4	4
Finland	44	44	38	38	Singapore	151	151	145	145
Greece 1	152	152	146	146	Slovenia	85	85	79	79
Greece 2	24	24	24	24	South Africa	210	210	204	204
Hungary	58	58	52	52	Spain	60	60	54	54
India 1	164	164	158	158	Sri Lanka	260	260	254	254
India 2	88	88	82	82	Sweden	91	91	85	85
Indonesia 1	165	165	159	159	Switzerland	254	254	248	248
Indonesia 2	27	34	21	28	Thailand 1	6	6	0	0
Israel 1	32	32	26	26	Thailand 2	28	28	22	22
Israel 2	101	101	95	95	Turkey	244	244	238	238
Italy	44	44	38	38	United Kingdom 1	189	189	189	189
Japan	311	311	311	311	United Kingdom 2	92	92	86	86
Korea 1	207	207	201	201	United States	311	311	311	311
Korea 2	31	31	25	25	Venezuela 1	44	44	38	38
Malaysia	53	53	47	47	Venezuela 2	8	8	2	2
Mexico 1	100	100	94	94	Venezuela 3	46	46	40	40

Appendix 2: Probability distributions

Table 10: Probability distribution of $S^{abs1}(6)$

	S≤0.5	S≤1.0	S≤1.5	S≤2.0		S≤0.5	S≤1.0	S≤1.5	S≤2.0
United States	99.04	100.00	100.00	100.00	India 1	3.05	17.07	57.32	85.98
United Kingdom 2	89.13	100.00	100.00	100.00	Ecuador 2	2.63	26.32	57.89	84.21
Canada	73.63	100.00	100.00	100.00	Colombia 1	2.38	23.47	42.52	62.93
Poland 2	33.33	100.00	100.00	100.00	Switzerland	1.97	17.32	39.37	62.99
United Kingdom 1	64.02	84.66	95.24	98.94	Spain	1.67	33.33	75.00	91.67
Japan	60.45	86.50	96.78	100.00	New Zealand	1.65	32.97	56.04	71.43
Colombia 2	60.00	60.00	100.00	100.00	Chile 1	1.52	15.23	40.10	70.05
South Africa	50.00	93.81	100.00	100.00	Philippines 1	1.43	40.00	74.29	94.29
Korea 1	49.76	93.72	100.00	100.00	Philippines 2	0.54	29.57	63.44	80.65
Singapore	40.40	88.08	100.00	100.00	Pakistan	0.50	26.73	51.98	79.70
Mexico 3	32.31	86.15	89.23	93.85	Portugal	0.48	30.43	71.50	90.82
Malaysia	28.30	54.72	64.15	79.25	Chile 2	0.00	30.00	100.00	100.00
Australia 2	28.14	71.36	87.94	94.47	Hungary	0.00	29.31	56.90	77.59
Indonesia 1	26.06	73.94	86.06	95.76	Venezuela 2	0.00	25.00	37.50	62.50
Slovenia	22.35	76.47	94.12	100.00	Russia 2	0.00	24.00	56.00	96.00
Czech Republic	16.67	80.56	100.00	100.00	Mexico 1	0.00	24.00	49.00	69.00
Egypt	16.03	25.19	33.59	41.98	Finland	0.00	22.73	50.00	72.73
Bulgaria	15.38	53.85	69.23	76.92	Israel 2	0.00	18.81	43.56	83.17
Indonesia 2	14.81	29.63	40.74	62.96	India 2	0.00	18.18	56.82	84.09
Thailand 2	14.29	53.57	96.43	100.00	Australia 1	0.00	16.67	50.00	91.67
Italy	13.64	79.55	100.00	100.00	Peru	0.00	13.22	38.84	61.98
Israel 1	12.50	25.00	37.50	62.50	Nigeria 2	0.00	12.20	30.49	57.32
Norway 1	11.54	30.77	46.15	65.38	Venezuela 1	0.00	11.36	34.09	45.45
Greece 1	11.18	24.34	39.47	59.21	Norway 2	0.00	6.90	46.55	63.79
Sri Lanka	10.77	58.46	80.77	93.85	Ecuador 1	0.00	6.58	21.05	44.74
Russia 3	10.00	30.00	80.00	100.00	Venezuela 3	0.00	6.52	13.04	32.61
Mexico 2	8.11	32.43	54.05	64.86	Argentina	0.00	2.11	6.34	12.68
Poland 1	6.74	40.45	87.64	97.75	Brazil 1	0.00	0.00	14.00	44.00
Sweden	6.59	48.35	78.02	94.51	Brazil 3	0.00	0.00	11.11	11.11
Nigeria 3	6.52	50.00	80.43	93.48	Brazil 2	0.00	0.00	10.87	23.91
Turkey	3.69	25.82	60.25	80.33	Ecuador 3	0.00	0.00	0.00	80.00
Morocco	3.67	58.72	75.23	88.07	Greece 2	0.00	0.00	0.00	0.00
Korea 2	3.23	54.84	70.97	83.87	Thailand 1	0.00	0.00	0.00	0.00

Table 11: Probability distribution of $S^{abs1}(12)$

	S≤0.5	S≤1.0	S≤1.5	S≤2.0		S≤0.5	S≤1.0	S≤1.5	S≤2.0
United States	85.53	100.00	100.00	100.00	Colombia 1	0.00	0.00	4.76	15.65
United Kingdom 2	62.79	100.00	100.00	100.00	Pakistan	0.00	0.00	4.59	22.45
Japan	27.65	60.13	73.95	85.53	Israel 2	0.00	0.00	3.16	10.53
United Kingdom 1	20.63	59.79	76.72	87.30	Philippines 1	0.00	0.00	3.13	21.88
Canada	18.33	74.92	98.71	100.00	Portugal	0.00	0.00	2.90	20.77
South Africa	4.41	41.18	86.27	99.02	India 1	0.00	0.00	1.90	10.76
Korea 1	2.99	48.76	82.59	96.52	Chile 1	0.00	0.00	0.52	8.38
Egypt	2.40	15.20	21.60	22.40	Hungary	0.00	0.00	0.00	25.00
Indonesia 1	1.89	22.64	51.57	68.55	Spain	0.00	0.00	0.00	20.37
Mexico 3	1.69	28.81	84.75	86.44	Philippines 2	0.00	0.00	0.00	18.89
Australia 2	1.04	18.13	56.48	76.68	Mexico 1	0.00	0.00	0.00	10.64
Singapore	0.00	37.24	66.90	88.97	Finland	0.00	0.00	0.00	10.53
Malaysia	0.00	17.02	46.81	59.57	Switzerland	0.00	0.00	0.00	5.65
Slovenia	0.00	7.59	45.56	77.21	Nigeria 2	0.00	0.00	0.00	5.26
Greece 1	0.00	7.53	17.81	18.49	Russia 2	0.00	0.00	0.00	5.26
Sri Lanka	0.00	3.54	25.59	50.79	India 2	0.00	0.00	0.00	4.88
Sweden	0.00	2.35	21.18	34.12	Peru	0.00	0.00	0.00	3.48
Morocco	0.00	0.97	34.95	55.34	Venezuela 1	0.00	0.00	0.00	2.63
Korea 2	0.00	0.00	32.00	56.00	Australia 1	0.00	0.00	0.00	0.00
Czech Republic	0.00	0.00	30.00	100.00	Norway 2	0.00	0.00	0.00	0.00
Colombia 2	0.00	0.00	25.00	100.00	Argentina	0.00	0.00	0.00	0.00
Italy	0.00	0.00	23.68	89.47	Brazil 1	0.00	0.00	0.00	0.00
Nigeria 3	0.00	0.00	20.00	37.50	Brazil 3	0.00	0.00	0.00	0.00
Ecuador 2	0.00	0.00	18.42	23.68	Chile 2	0.00	0.00	0.00	0.00
Poland 1	0.00	0.00	15.66	40.96	Russia 3	0.00	0.00	0.00	0.00
Bulgaria	0.00	0.00	14.29	42.86	Brazil 2	0.00	0.00	0.00	0.00
Thailand 2	0.00	0.00	13.64	77.27	Ecuador 1	0.00	0.00	0.00	0.00
Indonesia 2	0.00	0.00	9.52	19.05	Greece 2	0.00	0.00	0.00	0.00
Turkey	0.00	0.00	7.14	24.37	Israel 1	0.00	0.00	0.00	0.00
Mexico 2	0.00	0.00	5.41	21.62	Venezuela 2	0.00	0.00	0.00	0.00
New Zealand	0.00	0.00	5.11	23.86	Venezuela 3	0.00	0.00	0.00	0.00
Norway 1	0.00	0.00	5.00	30.00					

Table 12: Probability distribution of $I^{float1}(6)$

	I^-	I^0	I^+	rank	result	IMF		I^-	I^0	I^+	rank	result	IMF
Thailand 1 (*)	16.67	83.33	0.00	1	if	mf	Chile 1	25.89	35.03	39.09	32	mf	mf
Switzerland	15.35	71.26	13.39	2	if	if	Philippines 2	28.49	34.95	36.56	33	mf	if
Morocco	16.51	65.14	18.35	3	if	mf	Greece 1	27.63	34.21	38.16	34	mf	mf
Ecuador 1	18.42	59.21	22.37	4	if	mf	Israel 2	34.65	33.66	31.68	35	mf	mf
Mexico 3	21.54	50.77	27.69	5	if	if	Australia 2	41.21	33.17	25.63	36	mf	if
Italy	20.45	50.00	29.55	6	if	if	Argentina	38.03	33.10	28.87	37	mf	if
Philippines 1	45.71	50.00	4.29	7	if	mf	Sri Lanka	43.46	32.69	23.85	38	mf	mf
Turkey	22.54	48.77	28.69	8	mf	mf	Bulgaria	38.46	30.77	30.77	39	mf	if
Sweden	39.56	48.35	12.09	9	mf	if	Peru	20.66	30.58	48.76	40	mf	if
Nigeria 3	26.09	47.83	26.09	10	mf	mf	Spain	20.00	30.00	50.00	41	mf	mf
Slovenia	18.82	47.06	34.12	11	mf	mf	Poland 1	25.84	29.21	44.94	42	mf	mf
New Zealand	29.12	46.70	24.18	12	mf	if	UK 1	46.03	28.04	25.93	43	mf	if
Norway 2	34.48	46.55	18.97	13	mf	mf	India 2	25.00	27.27	47.73	44	mf	if
Nigeria 2	24.39	45.12	30.49	14	mf	if	Finland	50.00	27.27	22.73	45	mf	if
Ecuador 2	44.74	44.74	10.53	15	mf	mf	Colombia 1	38.44	26.19	35.37	46	mf	mf
Brazil 3	33.33	44.44	22.22	16	mf	if	Egypt	29.01	25.95	45.04	47	mf	mf
Russia 2	20.00	44.00	36.00	17	mf	mf	Singapore	34.44	25.17	40.40	48	mf	mf
Greece 2	33.33	41.67	25.00	18	mf	mf	Venezuela 2 (*)	50.00	25.00	25.00	49	mf	mf
South Africa	24.29	41.43	34.29	19	mf	if	Mexico 1	29.00	24.00	47.00	50	mf	mf
Pakistan	32.18	40.59	27.23	20	mf	mf	Brazil 2	39.13	23.91	36.96	51	mf	mf
Mexico 2	35.14	40.54	24.32	21	mf	mf	Israel 1	37.50	21.88	40.63	52	mf	mf
Korea 1	28.02	40.10	31.88	22	mf	mf	Japan	29.26	21.86	48.87	53	mf	if
Colombia 2 (*)	50.00	40.00	10.00	23	mf	if	Venezuela 1	25.00	20.45	54.55	54	mf	if
Hungary	43.10	39.66	17.24	24	mf	mf	Australia 1 (*)	0.00	16.67	83.33	55	mf	mf
Czech Republic	38.89	38.89	22.22	25	mf	mf	Korea 2	9.68	16.13	74.19	56	mf	if
Norway 1	15.38	38.46	46.15	26	mf	if	Indonesia 2	22.22	14.81	62.96	57	mf	if
Indonesia 1	21.82	38.18	40.00	27	mf	mf	Malaysia	60.38	11.32	28.30	58	mf	mf
Portugal	28.99	37.20	33.82	28	mf	mf	Thailand 2	39.29	10.71	50.00	59	mf	if
Venezuela 3	32.61	36.96	30.43	29	mf	mf	Russia 3 (*)	0.00	0.00	100.00	60	mf	if
India 1	46.95	36.59	16.46	30	mf	mf	Ecuador 3 (*)	20.00	0.00	80.00	61	mf	if
Brazil 1	10.00	36.00	54.00	31	mf	if	Chile 2 (*)	100.00	0.00	0.00	62	mf	if

Note:
- An asterisk (*) behind the country's name indicates a limited number of observation (see Table 9).
- I^-, I^0 and I^+ stand for Prob($I^{float1} \leq -0.33$), Prob($0.33 < I^{float1} < 0.33$) and Prob($I^{float1} \geq 0.33$) respectively.
- The ranking was made according to I^0.

Table 13: Probability distribution of $I^{float1}(12)$

	I^-	I^0	I^+	rank	result	IMF		I^-	I^0	I^+	rank	result	IMF
Morocco	3.88	93.20	2.91	1	if	mf	Brazil 1	0.00	47.73	52.27	32	mf	if
Czech Republic	3.33	90.00	6.67	2	if	mf	Brazil 2	25.00	47.50	27.50	33	mf	mf
Nigeria 3	5.00	90.00	5.00	3	if	mf	Israel 2	20.00	47.37	32.63	34	mf	mf
Switzerland	7.26	87.50	5.24	4	if	if	Singapore	18.62	46.90	34.48	35	mf	mf
Ecuador 1	0.00	84.29	15.71	5	if	mf	Sri Lanka	33.07	46.46	20.47	36	mf	mf
Norway 2	17.31	78.85	3.85	6	if	mf	Australia 2	36.79	45.08	18.13	37	mf	if
Mexico 2	2.70	78.38	18.92	7	if	mf	India 1	43.67	44.94	11.39	38	mf	mf
Greece 2	12.50	75.00	12.50	8	if	mf	Argentina	33.09	43.38	23.53	39	mf	if
Turkey	7.56	72.27	20.17	9	if	mf	Poland 1	15.66	40.96	43.37	40	mf	mf
Italy	10.53	71.05	18.42	10	if	if	Mexico 1	26.60	37.23	36.17	41	mf	mf
South Africa	9.31	68.63	22.06	11	if	if	Slovenia	15.19	36.71	48.10	42	mf	mf
Russia 2	5.26	68.42	26.32	12	if	mf	Peru	13.91	35.65	50.43	43	mf	if
New Zealand	19.89	66.48	13.64	13	if	if	Israel 1	19.23	34.62	46.15	44	mf	mf
Portugal	12.56	65.22	22.22	14	if	mf	Finland	42.11	34.21	23.68	45	mf	if
Korea 1	14.93	65.17	19.90	15	if	mf	Colombia 1	33.33	30.61	36.05	46	mf	mf
Venezuela 3	15.00	65.00	20.00	16	if	mf	India 2	20.73	30.49	48.78	47	mf	if
Canada	18.65	63.99	17.36	17	if	if	Egypt	23.20	30.40	46.40	48	mf	mf
Pakistan	19.90	63.78	16.33	18	if	mf	Venezuela 1	10.53	28.95	60.53	49	mf	if
Greece 1	10.27	63.70	26.03	19	if	mf	UK 1	46.03	28.04	25.93	50	mf	if
Sweden	35.29	63.53	1.18	20	if	if	Japan	26.37	27.33	46.30	51	mf	if
Hungary	36.54	61.54	1.92	21	if	mf	Brazil 3	72.73	27.27	0.00	52	mf	if
Ecuador 2	31.58	60.53	7.89	22	if	mf	Malaysia	59.57	25.53	14.89	53	mf	mf
Norway 1	5.00	60.00	35.00	23	if	if	Thailand 2	40.91	18.18	40.91	54	mf	if
Mexico 3	13.56	59.32	27.12	24	if	if	Indonesia 2	0.00	14.29	85.71	55	mf	if
Philippines 2	18.33	56.67	25.00	25	if	if	Bulgaria	42.86	14.29	42.86	56	mf	if
Philippines 1	43.75	56.25	0.00	26	if	mf	Korea 2	0.00	12.00	88.00	57	mf	if
Indonesia 1	13.21	55.97	30.82	27	if	mf	Australia 1 (*)	0.00	0.00	100.00	58	mf	mf
Nigeria 2	22.37	53.95	23.68	28	if	if	Russia 3 (*)	0.00	0.00	100.00	59	mf	if
Spain	5.56	53.70	40.74	29	if	mf	Chile 2 (*)	100.00	0.00	0.00	60	mf	if
Colombia 2	50.00	50.00	0.00	30	if	if	Venezuela 2 (*)	100.00	0.00	0.00	61	mf	mf
Chile 1	16.75	49.74	33.51	31	mf	mf							

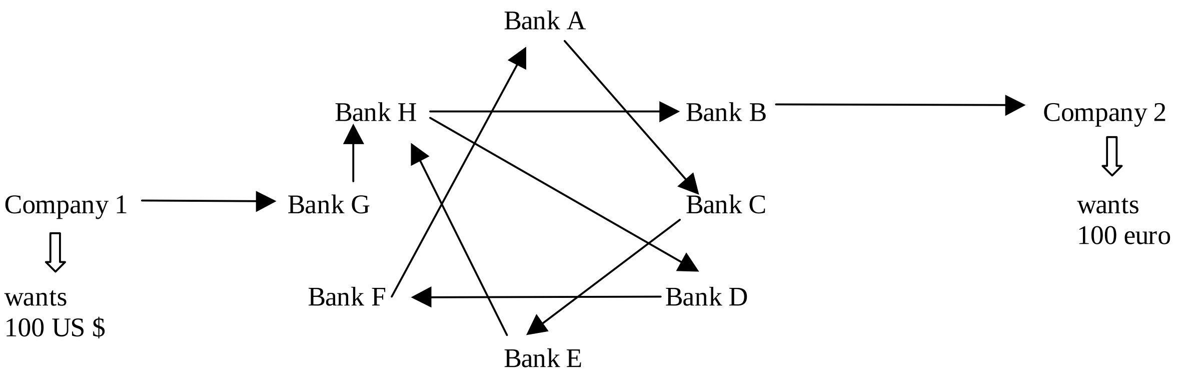
Note:

- An asterisk (*) behind the country's name indicates a limited number of observation (see Table 9).
- I^-, I^0 and I^+ stand for Prob($I^{float1} \leq -0.33$), Prob($0.33 < I^{float1} < 0.33$) and Prob($I^{float1} \geq 0.33$) respectively.
- The ranking was made according to I^0.

Appendix 3: The market maker principle

For a clear understanding of daily turnover figures on foreign exchange markets it is important to know how these markets are organized. The most important feature is the "*market-maker*" principle. It means that all participants at the interbank foreign exchange market are ready to buy and sell foreign exchange without limit at any moment, irrespective whether they are actually in need of additional positions in foreign or domestic currency. As each participant is able to get rid of an unwanted position immediately, the risks of being a market maker is very limited. This organization of the foreign exchange market has the effect that it blows up the total turnover. As the chart below shows, the order e.g. of a German firm that wants to sell 100 euro for dollars can lead to many intermediate transactions between the market markers until this position reaches a bank that needs euro deposits for its customer.

Figure 9: Illustration of the market maker principle



Sequence:

Company 1 ► G ► H ► D ► F ► A ► C ► E ► H ► B ► Company 2

Multiplier: 9
Turnover: 900 US $

Because of the speed with which the intermediate transactions are carried out, the multiplier between an outside transaction and the internal transactions can be very high. By the same token, any foreign exchange intervention by a central bank will also have a strong multiplier effect.[23] Thus, it makes very little sense to compare the stock of foreign exchange reserves with daily turnover on foreign exchange markets.

[23] See Vitale (1997, p. 7): "In the week 3-7 August 1992, in which particular events were not reported in the press, the average daily volume of transactions with clients of Merrill Lynch in D-marks for dollars was around $ 1 billion, while their average size was about $ 4 million. These figures indicate that with a relatively small market order the central bank can affect the quotes of a single market maker. Then, if this market maker has the reputation of receiving market orders form the central bank, inter-dealer transactions will propagate this effect on the quotes of other dealers."

Appendix 4: Derivation of the optimal MCI based on the minimization of a central bank's loss function

The loss function was defined in equation (30) as follows:

$$(76)\quad L_t = \chi_1 \left(\tilde{y}_t - \varepsilon_t^S\right)^2 + \chi_2 \left(\pi_t - \pi^T\right)^2 .$$

Under full information we can replace $\tilde{y}_t - \varepsilon_t^S$ by $\beta\left(p_t - E_{t-1}p_t\right)$ (see equation (26)). The loss function becomes

$$(77)\quad L_t = \chi_1\beta^2\left(p_t - E_{t-1}p_t\right)^2 + \chi_2\left(\pi_t - \pi^T\right)^2 = \chi_1\beta^2\left(\pi_t - E_{t-1}\pi_t\right)^2 + \chi_2\left(\pi_t - \pi^T\right)^2 .$$

From the first-order condition of equation (77) we get

$$(78)\quad \pi_t = (1-\gamma)E_{t-1}\pi_t + \gamma\pi^T ,$$

where $\gamma = \chi_2 / \left(\chi_1\beta^2 + \chi_2\right)$. Assuming rational expectations ($E_{t-1}\pi_t = E_{t-1}\pi^T$) the optimal inflation rate is

$$(79)\quad \pi_t^{opt} = E_{t-1}\pi^T + \gamma\left(\pi^T - E_{t-1}\pi^T\right).$$

The associated price forecast error is

$$(80)\quad p_t - E_{t-1}p_t = \gamma\left(\pi^T - E_{t-1}\pi^T\right).$$

Thus the optimal MCI is defined as

$$(81)\quad MCI_t^{opt} = 1/\delta_1 \left(\varepsilon_t^D - \varepsilon_t^S\right) - (\beta\gamma)/\delta_1 \left(\pi^T - E_{t-1}\pi^T\right).$$

Appendix 5: A simple framework for the explanation of currency crises

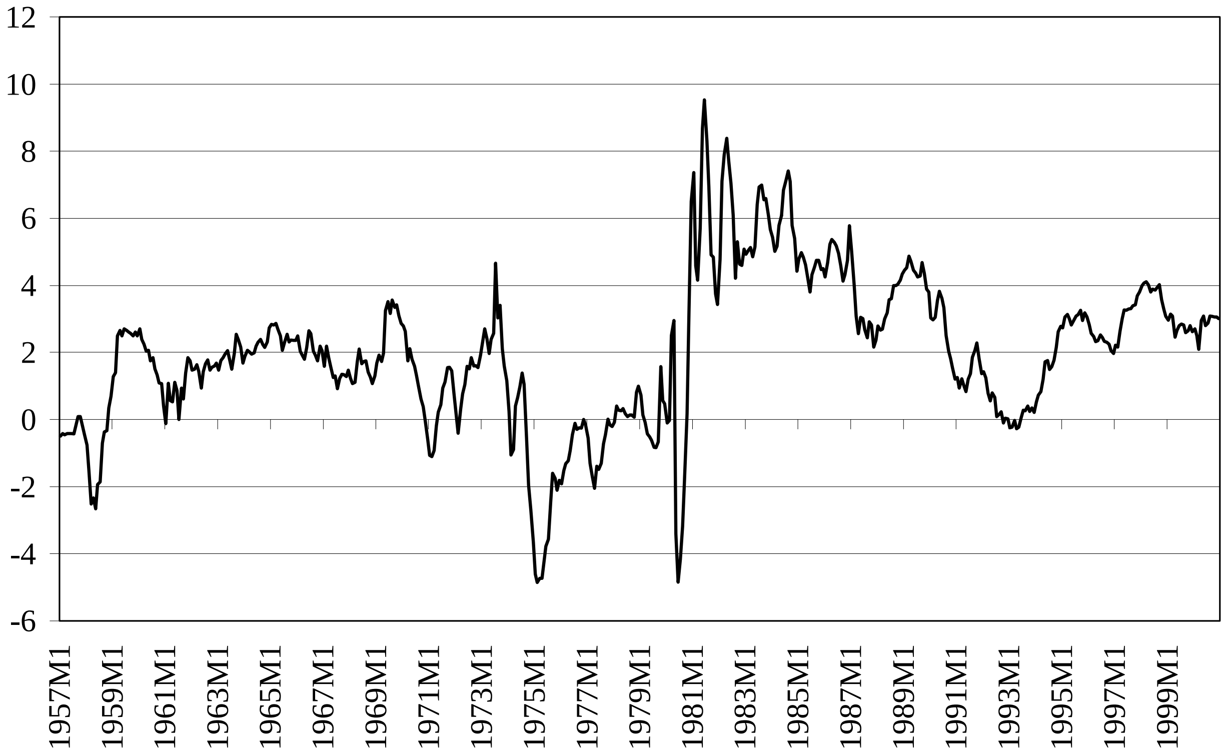
Our model provides relatively simple explanations for the emergence of currency crises under a framework of fixed exchange rates. An obvious reason for a crisis is a monetary policy that violates the *external equilibrium* by pursuing an interest rate policy that leads to a domestic interest rate that is lower than the rate required by UIP. The result are capital outflows and a loss of reserves. As soon as the central bank's reserve stock is exhausted the peg has to be abandoned. Since this can be anticipated by the markets, a speculative attack will occur and require a premature exit. All this is captured in the first generation currency crisis models (see Krugman 1979) with the only difference that these models are normally written for the monetary base (or net domestic assets) as the operating target of the central bank.

An alternative explanation refers to the internal equilibrium. We can see from equation (61) that under fixed rates the actual monetary conditions index of a country is given by

(82) $$MCI_t^{fix} = (1-\delta)(\pi_t^* - \pi_t) + \alpha_t + r_t^* .$$

Thus, the stance of monetary policy depends on the inflation differential, the risk premium, and the cyclical situation in the anchor currency. If we look at the short-term real interest rate in the United States which reflects such cyclical effects we can see that in the early 1970s and the years 1991 –1994 the stance of the Federal Reserve's monetary policy was extremely expansionary (see Figure 10).

Figure 10: US short-term real interest rates



Source: IFS

In other words, countries pegging to the dollar were in principle forced to pursue a similarly lax monetary policy. However, one can observe that e.g. the Bundesbank in 1970-73 and several

Asian countries in 1992-96 tried to keep their interest rates at higher levels by sterilized interventions. As a result a compromise solution emerged which violated both equilibria simultaneously: interest rates were too low for domestic macroeconomic stability, they were too high for avoiding speculative inflows. This made the pegs highly vulnerable, especially since in the Asian cases domestic investors used the low dollar rates for the financing of investment expenditures.

A similar logic, but in the opposite direction was at work in the European Exchange Rate Mechanism (ERM) crises in 1992/93. Because of German unification the Bundesbank pursued a very restrictive interest rate policy. The other ERM members gave priority to external equilibrium, since an autonomous interest rate policy with lower rates would have led to reserve losses (see Table 14). The result was a severe violation of the internal equilibrium since the other members had much less cyclical overheating than Germany. The markets realized that this policy stance was unsustainable and increased the risk premium for countries like France and Belgium. This caused a further divergence between the actual and the optimum MCI and made the peg even less sustainable. In the literature these processes are described in the second generation currency crisis models.

Table 14: Taylor interest rates and actual short-term interest rates in 1991

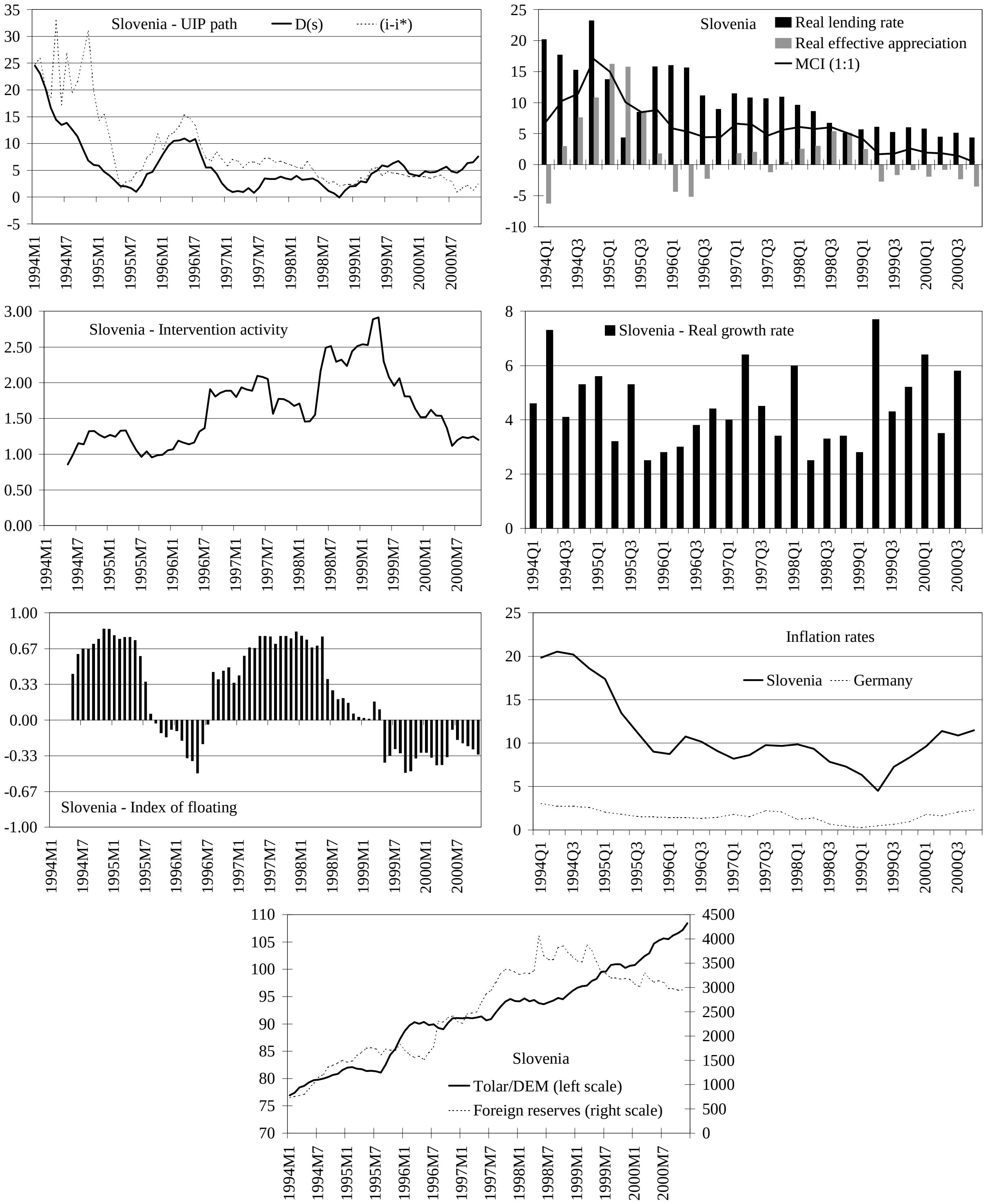
Country	Taylor interest rate	Actual interest rate
Belgium	**6.5**	**9.3**
Denmark	**3.0**	**9.7**
France	**5.8**	**9.6**
Germany	**8.9**	**9.2**
Ireland	**5.7**	**10.4**
Italy	**11.0**	**12.2**
Netherlands	**6.5**	**9.3**

Note: Taylor interest rate calculated with the original Taylor formula $i_t = 2 + \pi_t + 0.5(\pi_t - 2) + 0.5\tilde{y}_t$.

Data source: OECD, Economic Outlook

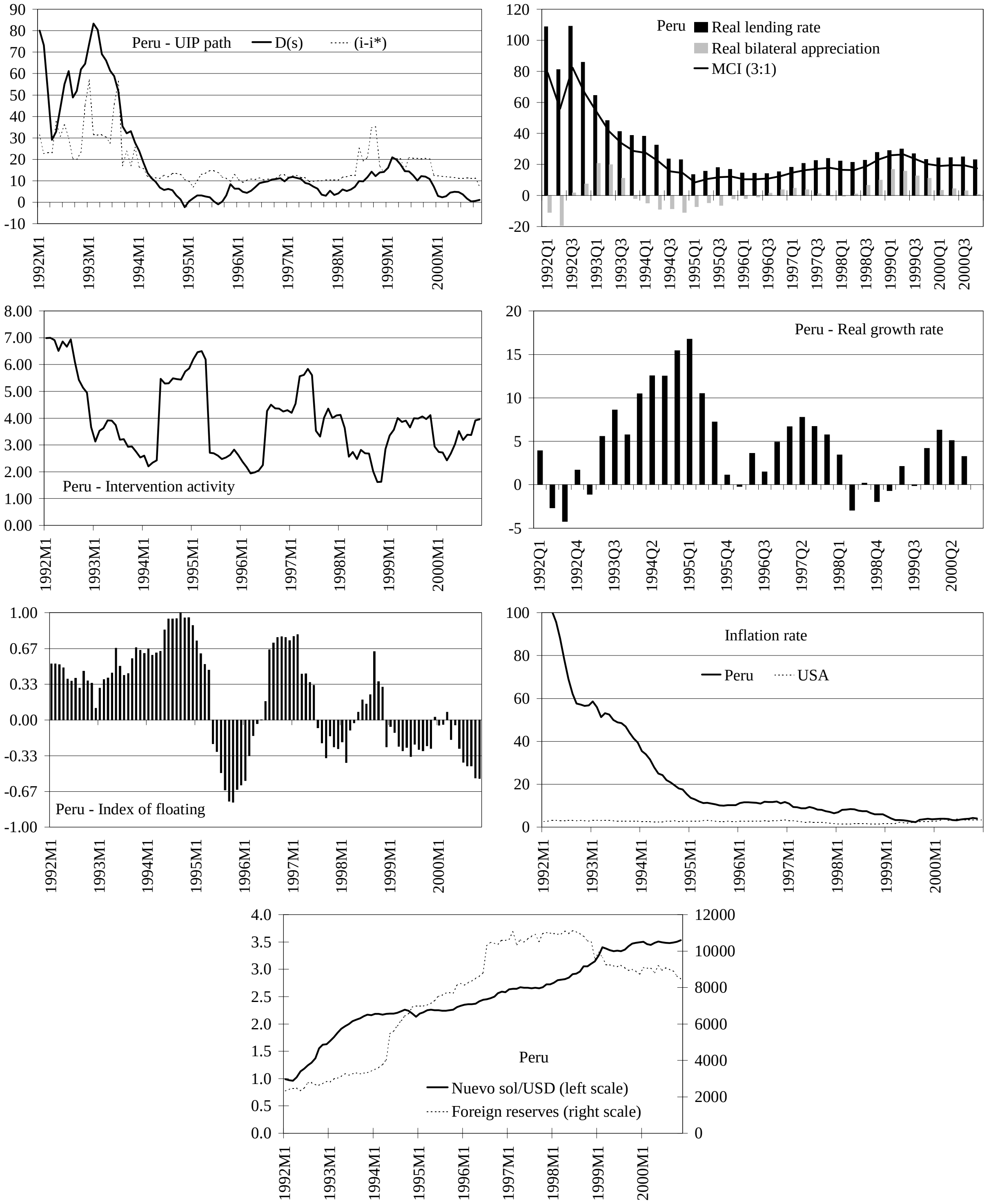
Appendix 6: Selected case studies

Figure 11: The case of Slovenia



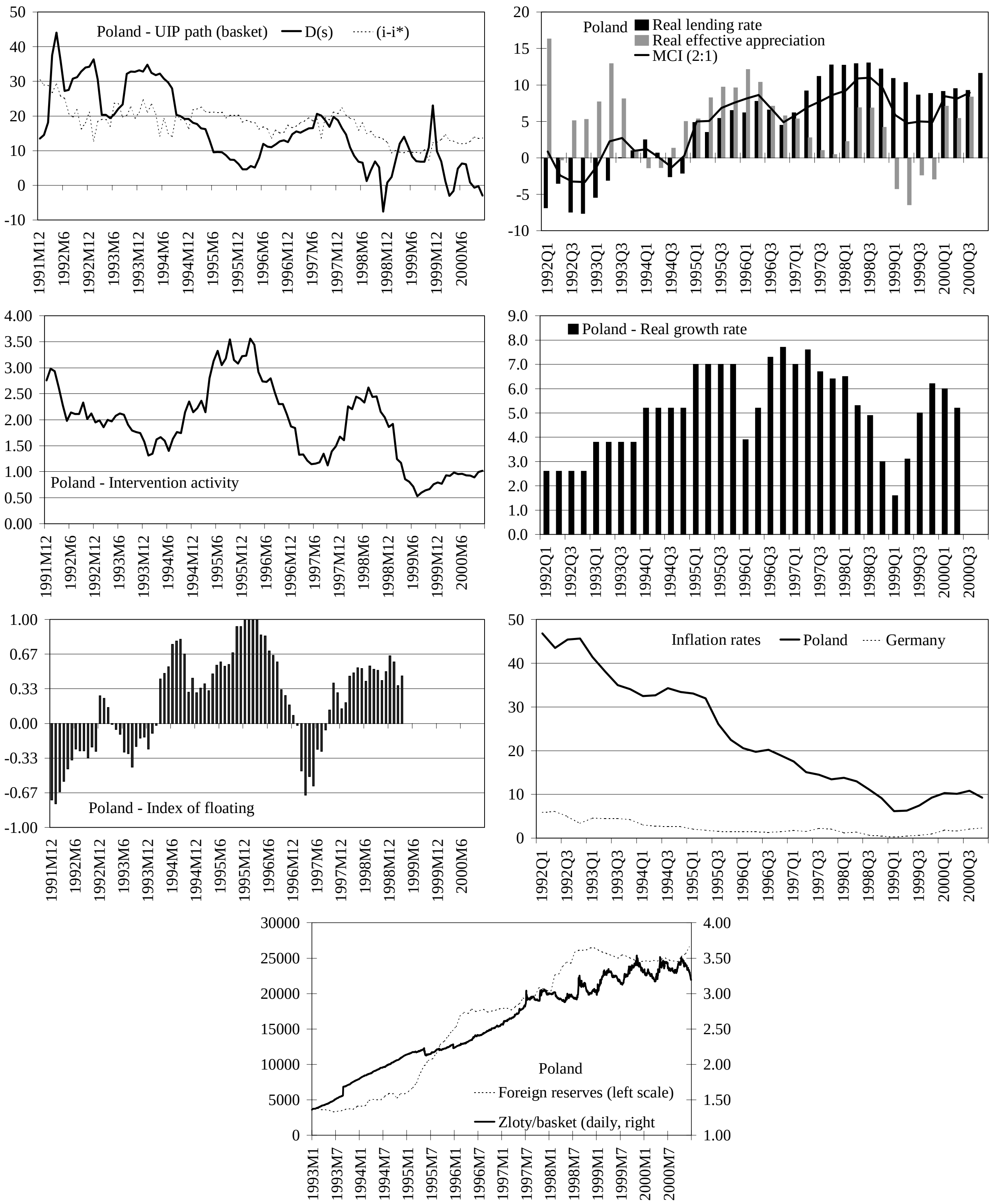
Sources and data description: see note after Figure 14

Figure 12: The case of Peru



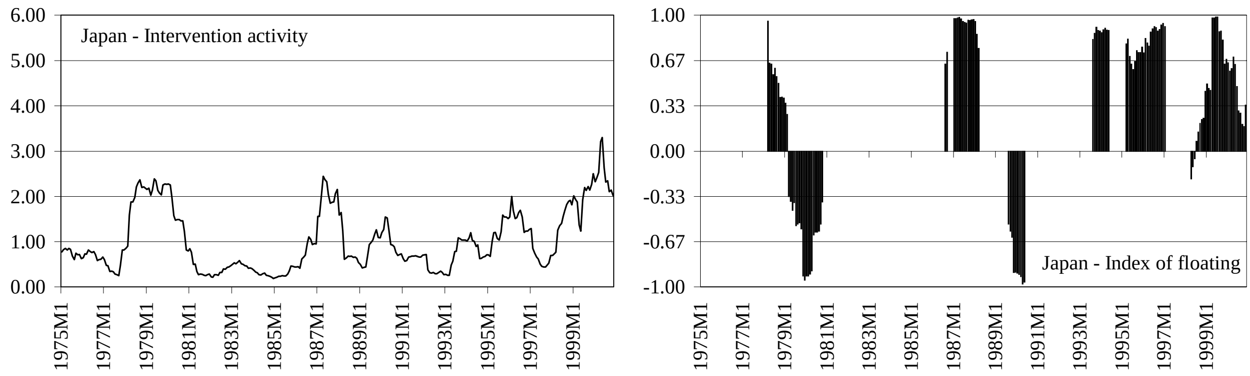
Sources and data description: see note after Figure 14

Figure 13: The case of Poland



Sources and data description: see note after Figure 14

Figure 14: The case of Japan



Sources and data description of Figure 11 to Figure 14:
Most of the data are taken from the IFS. Exceptions from this are:

- Slovenia, Real effective appreciation (Institute of Macroeconomic Analysis and Development, Ljubljana);
- Poland, Real growth rate (Oesterreichische Nationalbank, Vienna, Focus on Transition, various issues); note that the figures from 1992 to 1995 are yearly averages;
- Poland, Daily Zloty/basket exchange rate (National Bank of Poland, Warsaw).

The chart labelled "UIP path" shows the nominal depreciation of the domestic exchange rate in the last 12 months and the difference between the actual domestic money market rate and the actual foreign money market rate. As foreign country we chose Germany for Slovenia, the US for Peru and the basket (45% US, 35% Germany, 10% UK, 5% France and 5% Switzerland until December 1998; 45% US and 55% Euro area since January 1999) for Poland. In the case of Peru, we took the central bank's discount rate instead of the money market rate.

The MCI in the upper right hand chart of Figure 11 to Figure 13 was constructed as follows: In all three cases we weighted the real interest rate relative to the real appreciation according to the degree of openness. As Slovenia is the most open economy (external sector's size relative to GDP in 1998: 49%) the weights are assumed to be the same (1:1). For Poland with a degree of openness of 23% we applied a relative weight of 2:1 (real interest rate to real exchange rate), and for Peru with a degree of openness of only 11% 3:1. In order to calculate the real interest rate we subtracted the actual inflation rate from the nominal lending rate. The lending rate was chosen as it is assumed to be more informative as a measure of the influence of monetary instruments on macroeconomic variables in the transmission process as for example described by the bank lending literature. The real exchange rate lever was calculated as a one year aback change of the real exchange rate. In the cases of Poland and Slovenia we used real effective exchange rates, in the case of Peru the bilateral US-Peruvian real exchange rate. All real exchange rates are CPI based.

Note that in the charts labelled "Index of floating" we only depicted the bars if the overall intervention activity was higher than 1.0. As we defined an activity index of below 1.0 as non-interventionist, a distinction between exchange rate targeting and exchange rate smoothing on the basis of the index of floating appeared to make no sense. This is especially relevant in the case of Japan and Poland.