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Duesternbrooker Weg 120
24105 Kiel (Germany)

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Comparing Monetary Policy Strategies: Towards a Generalized Reaction Function

by

Felix Hammermann

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Abstract

There seems to be no consensus in the literature with respect to monetary policy strategies in combination with flexible exchange rate regimes. Therefore, this paper determines what the alternative strategies inflation targeting, Taylor rule, monetary conditions index, and managed floating have in common. The fact that all strategies build on reaction functions which use the short-term interest rate as an important or even the single monetary policy instrument allows a generalized reaction function for all strategies to be derived. Future research may use such a generalized reaction function for describing and determining monetary policy in emerging market economies with flexible exchange rate regimes.

Keywords: Monetary Policy, Inflation Targeting, Taylor Rule, Monetary Conditions Index, Managed Floating

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Felix Hammermann
Institute for World Economics (IfW)
Duesternbrooker Weg 120
24105 Kiel, Germany
phone: +49 431 8814 210
fax: +49 431 8814 500
e-mail: hammermann@ifw-kiel.de

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Contents

I. Introduction

Monetary policy strategies worldwide, and particularly in emerging market economies, are characterized by a policy of announced flexible exchange rates. The reason for this is that experiences of the 1990s revealed shortcomings in pegged exchange rates, as central banks were unable to hold the pegged rates during financial crises. Moreover, speculative attacks forced the break down of soft pegs. The conclusion from these episodes was that only the "corner solutions" (Fischer 2001) could be sustainable. According to this view either hard pegs or pure floating exchange rate regimes may sustain speculative attacks.

Under a hard peg like currency board, dollarization, and monetary union the national central banks do not execute their own monetary policy. Monetary policy of a national central bank is tied to the central bank of the anchor country or of the common central bank and, as exits are hardly possible, these monetary policy strategies withstand speculative attacks.

The recent crisis in Argentina revealed that fixed exchange rate regimes contain a high risk and demand a high degree of fiscal consolidation (Mussa 2002). As a consequence of the collapse of the Argentine currency board and the fact that dollarization and monetary union are either not desirable or not feasible, hard peg regimes have been discredited for the moment. This leaves only one corner solution: a pure floating regime.

Under a pure floating exchange rate regime there is no nominal anchor and each national central bank is free to conduct its policy on its own. However, in such an environment particularly central banks in emerging market economies need to build up reputation. Here, inflation targeting as the most recent strategy seems to provide an attractive framework for monetary policy, which is supposed to meet financial markets' criteria of prudent monetary policy. But critics call this new monetary policy strategy just "conservative window-dressing" (Romer 2001: 509) or claim that independent of the label attached to monetary policy the importance of the exchange rate for macroeconomic institutions in emerging markets demand for intermediate regimes (Williamson 2000).

Because there seems to be no consensus in the literature with respect to monetary policy strategies in combination with flexible exchange rate regimes, this paper determines what these strategies have in common. In a first step, Section II describes how the reaction function of the central bank is integrated in the alternative strategies. It is shown that all strategies are based on a reaction function which uses the short-term interest rate as the monetary policy instrument. In a second step, Section III compares the reaction functions of the monetary policy strategies inflation targeting, monetary conditions index, and managed floating with the reaction function of the Taylor rule. It can be demonstrated that the individual reaction functions are closely related to each other. This allows, in a final step (Section IV), deriving a generalized reaction function. Section V gives an outlook for future research on the use of such a

generalized reaction function for describing and determining monetary policy in emerging market economies with flexible exchange rate regimes.

II. Alternative Monetary Policy Strategies

1. Inflation Targeting

During the 1990s, inflation targeting became increasingly popular. Quite a few central banks of industrialized as well as emerging market economies announced an inflation target and, thus, claimed to conduct their monetary policy within an inflation targeting framework. The International Monetary Fund classified countries having an inflation targeting regime at the end of 2001 (Table 1). As can be seen, most countries decided to combine inflation targeting with a freely floating exchange rate.

Bofinger (2001: 263) characterizes an inflation targeting regime by the following implicit reaction function of the central bank:

$$(1) \qquad i_t = \bar{i} + \gamma \left(\pi_{t+T|i_t} - \bar{\pi} \right) \quad \text{with} \quad \gamma > 0 .$$

The average short-term interest is given by $\bar{i}$, and the forecast of inflation for period T conditional on the prevailing interest rate, i_t, is given by $\pi_{t+T|i_t}$.[1] The central bank announces an inflation target, $\bar{\pi}$. The parameter γ specifies how strong the central bank responds to the deviation of the forecasted inflation, $\pi_{t+T|i_t}$, from its inflation target, $\bar{\pi}$. Together, this deviation from the inflation

[1] The reaction function is determined implicitly because it depends on forward-looking information. It can be transformed into an explicit reaction function by using adequate inflation forecasts determined by current and past information, i.e., predetermined variables.

target and the average short-term interest, $\bar{i}$, determine the actual interest rate, i_t. The focus on price stability is thought to increase the credibility of monetary policy and of the central bank as the associated institution. Inflation as the single target in the central bank's reaction function should guarantee that conflicts between opposing targets do not emerge.

Table 1 — Inflation Targeting Regimes

Country	Year[a]	Independently floating	Pegged exchange rates within horizontal bands	Exchange rates within crawling bands	Managed floating with no preannounce path for the exchange rate
Australia	1993	✓			
Brazil	1999	✓			
Canada	1991	✓			
Chile	1999[b]	✓			
Colombia	2000	✓			
Czech Republic	1997	✓			
Hungary	2001		✓		
Iceland	2001	✓			
Israel	1991			✓	
Korea	1998	✓			
Mexico	2002[c]	✓			
New Zealand	1989	✓			
Norway	2001	✓			
Poland	1999[d]	✓			
South Africa	2000	✓			
Sweden	1993	✓			
Thailand	2000				✓
United Kingdom	1992	✓			

[a]The year is the starting year of the inflation targeting regime. — [b]Chile announced an inflation target already in October 1989 but had a crawling peg till September 1999. — [c]Mexico followed a gradual approach when introducing inflation targeting. — [d]Poland announced an inflation target already in September 1998.

Source: IFS (January 2003); Schaechter et al. (2000); National authorities.

Besides the focus on price stability, inflation targeting is a monetary policy strategy that emphasizes the institutional framework. The institutional framework builds on independence, transparency, and accountability. The background for such an institutional setting is the problem of dynamic inconsistency and the problem of the inflation bias derived by Kydland and Prescott (1977) and Barro and Gordon (1983), respectively. Both problems

originate from incentives to the central bank to create surprise inflation in order to increase employment. As a consequence of rational agents recognizing these incentives, central banks that conduct monetary policy in a discretionary way end up with suboptimally high inflation rates.

Rogoff (1985) tries to solve these problems by appointing a central banker who is more conservative than the public, i.e., who cares more about keeping inflation low. Unfortunately, this strategy leads to higher volatility in employment. Walsh (1995b) and Svensson (1997) propose contracts between the government and the central bank about the goals of monetary policy, i.e., inflation targets. Walsh's (1995b) proposal asks for some form of punishment in case the central bank fails to fulfill the contract. Such a rule is applied in New Zealand (Sherwin 2000: 24), where the governor of the central bank can be dismissed if the specified inflation target band is missed.[2] In Svensson's (1997) alternative proposal the government assigns an inflation target to the central bank that is already corrected for the inflation bias. In both proposals the central bank does not have "goal independence" but remains to have "instrument independence" (Svensson 1997: 99). The central bank decides on its own what the adequate instrument is and when this instrument is changed.

However, inflation targeting as a monetary policy strategy needs some more specification concerning the time horizon, the precision, and possible escape

[2] A similar proposal has been made by Persson and Tabellini (1993). Walsh (1995a) discusses the approach chosen in New Zealand. Blinder (1998: 45) is skeptical about central bankers' response to this kind of incentives. See also Fischer (1995: 38–39).

clauses. Most specifications face the classical trade-off between credibility and flexibility. A rather short horizon on which the inflation target is supposed to be met increases credibility—it is straightforward to verify whether or not the inflation target is reached—while a longer horizon allows the central bank more flexibility. A point target is easy to communicate and therefore strengthens credibility, while a time frame for reaching the inflation target or a target band, again, increase flexibility. In the same vein, escape clauses can be interpreted as ex ante exculpations for missed inflation targets or as safeguards for more flexibility to react to unforeseen shocks.

In order to gain credibility by a transparent conduct of monetary policy, inflation targeting central banks publish their inflation forecasts.[3] The public gets to know how the central bank sees the economic future. Consumers make their decisions on this background. For instance, a forecasted raise in inflation might lead the central bank to raise interest rates. Consumers will anticipate this interest rate rise due to the information of the inflation forecast. Monetary policy becomes more transparent. Nevertheless there remains a danger of reversed causality if not the private agents follow the forecasts of the central bank but the central bank fulfills agents' expectations. How dangerous such a reversal of causality is

[3] For instance, the Bank of England publishes quarterly inflation reports since 1993.

becomes obvious if the central bank follows a bubble instead of basing its expectations on fundamentals.[4]

2. Taylor Rule

The most common interest rate rule in the academic literature is the so-called Taylor rule. Taylor (1993) links the interest rate to the two targets of monetary policy inflation and output:[5]

$$r_t = \bar{r} + b(\pi_t - \bar{\pi}) + c(y_t - \bar{y}_t). \tag{2}$$

On the left hand side of the reaction function is the short-term real interest rate, r_t, which depends on $\bar{r}$, the equilibrium real interest rate, as well as on deviations of the inflation rate, π_t, and output, y_t, from their target values $\bar{\pi}$ and $\bar{y}_t$, respectively. While $\bar{\pi}$ is determined politically, $\bar{y}_t$ is potential output and, hence, $y_t - \bar{y}_t$ the output gap. A closed output gap underlies the equilibrium real interest rate, $\bar{r}$. The Taylor rule can be expressed in terms of the nominal interest rate as the relevant instrument of monetary policy by using the Fisher equation, $r_t = i_t - \pi_t$:

$$i_t = \bar{i}_t + \gamma(\pi_t - \bar{\pi}) + \lambda(y_t - \bar{y}_t), \tag{3}$$

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4 Blinder (1998: 60) emphasizes this danger: "Central bankers are only human; they want to earn high marks—from whomever is handing out the grades."

5 This "dual mandate" made its way from economic reasoning into US law, namely through the Central Bank Act, the United States Code Title 15 Chapter 58 "Full Employment and Balanced Growth" of the year 1978, also named "Humphrey Hawkins Act," after Sen. Hubert Humphrey and Rep. Augustus Hawkins. However, central banks do not target full employment but real output.

where $\bar{i}_t = \bar{r} + \pi_t$ is the nominal equivalent to an equilibrium real interest rate $\bar{r}$, and the parameters γ and λ determine the relative weights of the central bank's reaction to deviations in inflation and output, respectively.

In the first place, Taylor (2000) tries to answer whether or not actual monetary policy can be described by rules. In case the monetary policy of a central bank can be well described by a specific interest rate rule, the public predicts monetary policy more easily. Taylor (2000: 7) concludes that increased predictability then enhances transparency of monetary policy.

As an example for such a rule-based forecast of monetary policy, Taylor (2000: 7) names the PriceWaterhouseCoopers' analysis of Bank of England's policy in 2001. In this analysis, conditional forecasts based on a Taylor rule predict how the central bank may react to different growth scenarios. Judd and Rudebusch (1998) show how the Taylor rule describes particularly well the monetary policy of the Fed under Greenspan since 1987. Gerlach and Schnabel (2000) report that the Taylor rule also well describes the average interest rates of the European monetary union.[6]

3. Monetary Conditions Index

The monetary conditions index, henceforth MCI, is an indicator for the stance of monetary policy, which does not only consider an output target but also the

[6] See also Peersman and Smets (1999).

influence of the exchange rate on inflation. Freedman (1996a: 75) builds the MCI on the assumption of an aggregate demand relation, where output, *y*, depends on the real interest rate, *r*, the real exchange rate, *q*, and other variables:[7]

(4) $$y_t = \alpha r_t + \beta q_t .$$

Although various measures of the MCI exist, it essentially depends on a weighted combination of real[8] interest rate and real exchange rate[9] deviations from some neutral levels, $\bar{r}$, and, $\bar{q}$. The MCI can then be written as

(5) $$MCI_t = r_t - \bar{r} - \delta \left(q_t - \bar{q}\right).$$

The weight $\delta = \beta / \alpha$ measures the relative demand impact of the interest rate and the exchange rate. The parameters α and β have to be estimated from a macroeconomic model similar to (4).

The MCI takes into account how the stance of monetary policy is influenced not only by the interest rate but also by the exchange rate. Increases in the MCI correspond to a more restrictive monetary policy whereas decreases in the MCI correspond to a less restrictive monetary policy. Central banks calculate the path of an optimal MCI, MCI_t^{opt}, based on forecasts of exogenous variables given no

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7 The adequate lag structure as well as relevant other variables are ignored.

8 The MCI in real terms is the theoretically relevant one (Freedman 1996b: 81). Some central banks use variables in nominal terms, others in real terms (also, e.g., real effective exchange rates). The difference between nominal and real is negligible in the short run due to price rigidities. Otherwise, interest rates can be derived by using the Fisher equation $i_t = r_t + \pi_t$.

9 Here, an increase corresponds to a depreciation of the exchange rate.

other shocks hit the economy and affect the inflation target.[10] Thus, the difference between actual MCI_t and optimal MCI_t^{opt} motivates changes in monetary policy.[11] The nominal interest rate, i_t, is set in order to equalize actual MCI and optimal MCI

$$MCI_t = MCI_t^{opt} . \tag{6}$$

Therefore, when setting the interest rate, the impact of the exchange rate on the stance of monetary policy is taken into account.[12] It is also worth noting that, for instance, a rise in the interest rate does not only lead directly to a more restrictive monetary policy but leads, via the uncovered interest rate parity, to an appreciation of the exchange rate, which also leads to a more restrictive stance of monetary policy. Consequently, both channels increase the actual MCI.

The MCI has been criticized for two reasons (Stevens 1998).[13] First, Stevens (1998: 36) points out that the suggested trade-off between the interest rate and the exchange rate is a crude simplification. The MCI is actually a mixture of an instrument of monetary policy, i.e., the interest rate, and a transmission mechanism of monetary policy, i.e., the exchange rate. If foreign interest rates are given and uncovered interest rate parity holds, any change in the interest rate

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[10] See Freedman (1996b: 82) and also equation (10) for a calculation of the optimal MCI.

[11] Freedman (1996b: 85) gives two reasons for not trying to maintain a precise MCI target on a day-to-day basis. First, the MCI is not a very precise measure. Second, the exchange rate can be quite volatile on a day-to-day basis.

[12] See Gerlach and Smets (2000) for an explicit analysis of the conduct of monetary policy using an MCI.

[13] Further, Eika, Ericsson, and Nymoen (1996) discuss several econometric problems an MCI has to face.

would immediately lead to a change in the exchange rate. Thus, looking at the exchange rate would not be necessary. The exchange rate would be redundant in the MCI.

Second, the MCI recommends an adjustment of monetary policy due to changes in the exchange rate, i.e., a change in prices. This runs against the wisdom that monetary policy should only react to reasons underlying a change in prices and not to the change in prices itself. E.g., a change in foreign interest rates leads to a change in the interest rate spread. The new interest rate spread will be reflected in a new exchange rate and will, thus, lead to a change in the MCI. However, the change in foreign monetary policy, given by the change in foreign interest rates, might not automatically justify a change in domestic monetary policy as it is suggested by the MCI. The domestic central bank has to find out whether or not to draw consequences from the change in the price of the domestic currency.

The first point of the critique does not take into account the role of external stability, i.e., the case when uncovered interest rate parity does not hold and the determination of the exchange rate is therefore not that obvious. Here, the deviation of the exchange rate from its equilibrium might contain important information for the central bank. The second point of the critique might not be such an important problem in practice if the central bank has some experience concerning the exchange rate pass-through on inflation. Then, the central bank knows the impact of the exchange rate on inflation and will react adequately.

Summing up, the MCI captures important information in order to guide monetary policy. However, the indicator contains risks in its simplifications concerning the mixture of instrument and transmission mechanism, and concerning the underlying reasons for changes in the exchange rate.

4. Managed Floating

Unlike an MCI regime, managed floating considers the exchange rate as an instrument of monetary policy. The managed floating strategy proposed by Bofinger (2001) builds on two equilibrium conditions and two instruments. Internal equilibrium is determined by the MCI. External equilibrium is determined by the uncovered interest rate parity. The two monetary policy instruments are the short-term nominal interest rate, i_t, and interventions in the foreign exchange market. These interventions allow the nominal exchange rate, s_t, to be controlled. Therefore, changes in the nominal exchange rate, Δs_t, are treated as an additional instrument of monetary policy. Bofinger (2001: 418) sets up a reaction function for each instrument[14]

$$(7) \qquad i_t = \pi_t + \frac{1}{1-\delta}\left(MCI_t^{opt} - \delta\, r_t^* - \delta\, e_t - \bar{r} + \delta\,(q_{t-1} - \bar{q})\right).$$

$$(8) \qquad \Delta s_t = \pi_t - \pi_t^* + \frac{1}{1-\delta}\left(MCI_t^{opt} - r_t^* - e_t - \bar{r} + \delta\,(q_{t-1} - \bar{q})\right).$$

Together, the reaction functions determine a unique combination of the two instruments. They assure internal as well as external equilibrium. In the reaction

[14] Bofinger and Wollmershäuser (2001) derive the reaction functions from the two equilibrium conditions uncovered interest parity and the MCI.

functions, π_t is the domestic and π_t^* is the foreign inflation rate, r_t^* is the foreign interest rate, e_t is the risk premium on the expected depreciation, $\bar{r}$ is a neutral level of the real interest rate, δ is the relative impact of the interest rate and the exchange rate in the monetary conditions index as in (5), and $(q_{t-1} - \bar{q})$ is the deviation of the lagged real exchange rate from some neutral level.

Managed floating as a monetary policy strategy builds on two necessary conditions. First, sterilized interventions do not induce any costs to the central bank (Bofinger and Wollmershäuser 2001: 27). Managed floating works as long as (i) there is an inflow of capital, and, (ii) interventions are not necessary, or, (iii) there is an outflow of capital but foreign reserves stay above some critical threshold. Managed floating is limited by capital outflow with foreign reserves having fallen below such a threshold. In this situation, the central bank has to adjust its interest rates in order to stop the capital outflow. Managed floating as a strategy for monetary policy does not cover this situation anymore because the country slips towards a foreign exchange crisis (Krugman 1979).

Second, sterilized interventions must be effective. This is still an open question[15] because it is hard to agree on the exchange rate that would have prevailed without intervening and because assessing the effectiveness depends crucially on the examined horizon. Schwartz (2000) reviews the historical record of interventions by monetary authorities in industrialized economies. She finds that

[15] See Breuer (1999), Dominguez and Frankel (1993a, b), and, for a survey, Edison (1993).

U.S. and European monetary authorities stopped to employ interventions in recent years. Only the Bank of Japan has not abandoned interventions. Thus, she concludes that U.S. and European monetary authorities do not believe in the effectiveness of interventions anymore. Meanwhile, Neely (2001) examines the results of a questionnaire on the conduct of interventions send to 44 monetary authorities. He reveals that all of the 22 responding central banks believe that interventions have some effect on exchange rates. However, these results do not answer the question whether or not interventions are a reliable policy instrument.

III. Comparing Monetary Policy Strategies

The four monetary policy strategies inflation targeting, Taylor rule, monetary conditions index, and managed floating use the short-term interest rate as monetary policy instrument. Thus, their reaction functions have similar forms. These similarities will be analyzed by comparing each monetary policy strategy with the Taylor rule.

1. Inflation Targeting versus Taylor Rule

Inflation targeting is connected with the Taylor rule in the following way. The reaction function of an inflation targeting regime

(1) $$i_t = \bar{i} + \gamma \left(\pi_{t+T|i_t} - \bar{\pi} \right) \quad \text{with} \quad \gamma > 0$$

contains no more than the deviation of the inflation rate from its target. It is tempting to assume that inflation targeters are "inflation nutters" (King 1997: 89) who only care about attaining the inflation target. However, Batini and Haldane (1999: 162) demonstrate within a dynamic general equilibrium model how the choice of parameters and forecast horizon in the reaction function (1) allows output to be smoothed without looking at it explicitly. A smaller parameter γ leads to a less strong reaction of the central bank to a deviation from the inflation target. A longer forecast horizon *T* reduces the intensity to which deviations of inflation are adjusted. Both specifications permit to smooth output. Therefore, stabilizing output can be a goal of monetary policy under an inflation targeting regime.

Svensson (1999: 626) suggests to exercise "flexible inflation targeting," which allows accommodating real disturbances. Hence, the reaction function of flexible inflation targeting is extended by a term for the output gap (Svensson 1999: 628):

(9) $$i_t = \bar{i} + \gamma\left(\pi_{t+T|i_t} - \bar{\pi}\right) + \lambda\left(y_{t+T|i_t} - \bar{y}_t\right).$$

Equation (9) looks very similar to the Taylor rule

(3) $$i_t = \bar{i}_t + \gamma\left(\pi_t - \bar{\pi}\right) + \lambda\left(y_t - \bar{y}_t\right).$$

Indeed, the reaction functions (9) and (3) have the same structure.[16] Both reaction functions consider inflation as well as the output gap. The only difference between (9) and (3) is the use of forecasts for inflation $\pi_{t+T|i_t}$ and output gap $y_{t+T|i_t}$ instead of current inflation π_t and current output y_t. Clarida et al. (1998, 2000: 151) label (9) a forward-looking rule of which the Taylor rule (3) is a special case.

2. Monetary Conditions Index versus Taylor Rule

Under a regime that is based on a monetary conditions index, changes in the stance of monetary policy determine changes in the interest rate. In fact, the interest rate is set in order to fulfill the condition

(6) $$MCI_t = MCI_t^{opt}.$$

Bofinger and Wollmershäuser (2001: 26) develop an expression for the optimal MCI, where the reaction function of the optimal MCI is given by[17]

(10) $$MCI_t^{opt} = \gamma\left(\pi_t - \bar{\pi}\right) + \lambda\left(y_t - \bar{y}_t\right).$$

Now, substituting the actual MCI (5) and the optimal MCI (10) into condition (6) leads to

(11) $$r_t - \bar{r} - \delta\left(q_t - \bar{q}\right) = \gamma\left(\pi_t - \bar{\pi}\right) + \lambda\left(y_t - \bar{y}_t\right)$$

and after rearranging

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[16] Output might also be incorporated into inflation targeting in order to transfer the implicit reaction function into an explicit reaction function, i.e., output might help to forecast inflation.

[17] Bofinger and Wollmershäuser (2001: 26) incorporate also a neutral level of the MCI on the right hand side. Here, the neutral level is assumed to be zero.

(12) $$r_t = \bar{r} + \gamma\left(\pi_t - \bar{\pi}\right) + \lambda\left(y_t - \bar{y}_t\right) + \delta\left(q_t - \bar{q}\right).$$

Finally, the reaction function of a monetary conditions index in terms of the nominal interest rate, i_t, is obtained upon using the Fisher equation, $r_t = i_t - \pi_t$:

(13) $$i_t = \bar{i}_t + \gamma\left(\pi_t - \bar{\pi}\right) + \lambda\left(y_t - \bar{y}_t\right) + \delta\left(q_t - \bar{q}\right),$$

where $\bar{i}_t = \bar{r} + \pi_t$ is the nominal equivalent to an equilibrium real interest rate $\bar{r}$. Actually, equation (13) is an extension of the Taylor rule (3).[18] In addition to inflation and output, it takes into account deviations of the exchange rate from its equilibrium value. Thus, the reaction function of the MCI corresponds to a Taylor rule with an exchange rate term (Romer 2001: 503).

Besides the connection between the MCI and the Taylor rule there is also a connection between the MCI and inflation targeting. This connection is a two-way relationship. On the one hand, historically the first MCI was implemented within an inflation targeting regime. The central bank of Canada (Freedman 1996a) applies an MCI as an additional indicator for the stance of monetary policy while focusing on an inflation target.[19]

On the other hand, inflation targeting is part of an MCI based policy. This connection is derived via the Taylor rule. Comparing the reaction function of flexible inflation targeting as in

(9) $$i_t = \bar{i} + \gamma\left(\pi_{t+T|i_t} - \bar{\pi}\right) + \lambda\left(y_{t+T|i_t} - \bar{y}_t\right)$$

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[18] See Clarida et al. (1998: 1041) for Taylor rules extended by the exchange rate.

[19] See Svensson (1999: 628) for inflation targeting extended by foreign variables.

with the reaction function of an MCI as in

(13) $$i_t = \bar{i}_t + \gamma\left(\pi_t - \bar{\pi}\right) + \lambda\left(y_t - \bar{y}_t\right) + \delta\left(q_t - \bar{q}\right)$$

shows that both reaction functions contain an inflation target, $\bar{\pi}$, i.e., the core element of an inflation targeting regime. However, the two reaction functions differ in two respects. First, the inflation target in the reaction function of an MCI is not based on inflation forecasts. Second, the reaction function of an MCI takes explicitly into account exchange rate effects. Hence, an MCI, which would react to differences between a forecasted inflation rate and the inflation target, would contain flexible inflation targeting as a special case.

3. Managed Floating versus Taylor Rule

The relationship between managed floating and the other monetary policy strategies goes only in one direction. Managed floating cannot be expressed in any of the other strategies due to the additional monetary policy instrument, namely sterilized interventions in the foreign exchange market. Both reaction functions of a managed floating regime,

(7) $$i_t = \pi_t + \frac{1}{1-\delta}\left(MCI_t^{opt} - \delta\, r_t^* - \delta\, e_t - \bar{r} + \delta\,(q_{t-1} - \bar{q})\right)$$

and

(8) $$\Delta s_t = \pi_t - \pi_t^* + \frac{1}{1-\delta}\left(MCI_t^{opt} - r_t^* - e_t - \bar{r} + \delta\,(q_{t-1} - \bar{q})\right),$$

contain an optimal MCI. Thus, the connection between managed floating, the MCI, and inflation targeting is already obvious and the MCI and flexible inflation targeting are clearly related as has been discussed in the section before.

The optimal MCI is also the connection between managed floating and an extended Taylor rule as shown in (13). The optimal MCI (10) is substituted into the reaction function for the nominal interest rate (7)

$$(14) \qquad i_t = \pi_t + \frac{1}{1-\delta}\left[\gamma\left(\pi_t - \bar{\pi}\right) + \lambda\left(y_t - \bar{y}\right) - \delta\, r_t^* - \delta\, e_t + \bar{r} + \delta\left(q_{t-1} - \bar{q}\right)\right]$$

and after rearranging

$$(15) \qquad i_t = \pi_t + \frac{1}{1-\delta}\left[\bar{r} + \gamma\left(\pi_t - \bar{\pi}\right) + \lambda\left(y_t - \bar{y}\right)\right] + \frac{\delta}{1-\delta}\left[\left(q_{t-1} - \bar{q}\right) - r_t^* - e_t\right].$$

Some substitutions permit to rearrange this reaction function for easier interpretation. First, the uncovered interest rate parity is given by

$$(16) \qquad \Delta s_t + e_t = i_t - i_t^*,$$

where Δs_t is the targeted depreciation[20] of the nominal exchange rate and e_t is a risk premium on the expected depreciation. The uncovered interest rate parity can also be written in real terms:

$$(17) \qquad \Delta q_t = r_t - r_t^* - e_t.$$

Second, the real exchange rate of the preceding period can be expressed as today's exchange rate minus the depreciation:

$$(18) \qquad q_{t-1} = q_t - \Delta q_t.$$

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[20] As the depreciation is controlled by the central bank, no expectation operator is needed. The remaining risk is covered by the risk premium e_t.

Using these substitutions, the reaction function for the interest rate becomes

$$(19) \qquad i_t = \pi_t + \frac{1}{1-\delta}\left[\bar{r} + \gamma\left(\pi_t - \bar{\pi}\right) + \lambda\left(y_t - \bar{y}\right)\right] - \frac{\delta}{1-\delta}\left[r_t - \left(q_t - \bar{q}\right)\right].$$

The reaction function (19) is simplified for $\delta = 0$. Because $\delta = \beta/\alpha$ the simplification corresponds to $\beta = 0$, i.e., the exchange rate has no impact on relative demand (4),[21] and then the reaction function (19) is equivalent to the Taylor rule (3)

$$(20) \qquad i_t = \pi_t + \bar{r} + \gamma\left(\pi_t - \bar{\pi}\right) + \lambda\left(y_t - \bar{y}\right).$$

This exercise reveals that the Taylor rule is a special case of the reaction function for the interest rate in a managed floating regime. Generally, the exchange rate does have some impact on aggregate demand in an open economy and, therefore, $\delta \neq 0$. Then, the two fractions before each term in brackets add up to unity

$$(21) \qquad \frac{1}{1-\delta} + \left(-\frac{\delta}{1-\delta}\right) = 1.$$

As a result, the reaction function (19) can be interpreted as a weighted mixture of the Taylor rule and some form of a monetary conditions index (5) because the term in the second bracket consists of the interest rate and the exchange rate. These two variables determine the stance of monetary policy. An increase in the weight β of the exchange rate in aggregate demand (4) leads to an increase of the weight of the exchange rate in the reaction function (19). Freedman (1996a: 75) suggests $\delta = 1/3$ for the Canadian MCI. Hence, the first term in the reaction

[21] This assumption could be thought of as the closed economy case.

function (19) has the weight 1.5 and the second term has the weight -0.5. Of course, this connection between managed floating and the Taylor rule holds only for the reaction function of the short-term interest rate (7) and not for the reaction function of the sterilized interventions (8).

IV. Towards a Generalized Reaction Function

The four monetary policy strategies are characterized by differences and similarities. Each monetary policy strategy has its specific approach:

- Inflation targeting concentrates on price stability as a *goal* of monetary policy,
- Taylor rules concentrate on the interest rate as an *instrument* of monetary policy,
- The MCI is an *indicator* for the stance of monetary policy, and
- Managed floating considers the nominal *exchange rate* as an instrument.

Despite these differences, the common basis of the four monetary policy strategies becomes apparent if their reaction functions are compared. The reaction functions of flexible inflation targeting (9), the MCI (13), and managed floating (19) show the same structure as the Taylor rule (3). Hence, the most

generalized version of a reaction function is an extended Taylor rule that allows taking into account inflation, the output gap, and the exchange rate[22]

(13) $$i_t = \bar{i}_t + \gamma\left(\pi_t - \bar{\pi}\right) + \lambda\left(y_t - \bar{y}_t\right) + \delta\left(q_t - \bar{q}\right).$$

Managed floating does not fit as easily into this generalization as inflation targeting and the MCI. However, managed floating remains a close relative.

The extended Taylor rule (13) can be generalized further by starting from the reaction function of forward-looking inflation targeting (1). The forecasted values of inflation, output gap, and exchange rate make the reaction function dependent on forward-looking information

(22) $$i_t = \bar{i}_t + \gamma\left(\pi_{t+T|i_t} - \bar{\pi}\right) + \lambda\left(y_{t+T|i_t} - \bar{y}_{t+T|i_t}\right) + \delta\left(q_{t+T|i_t} - \bar{q}\right).$$

The forecast horizon is period *T*. Each forecast builds on the assumption of the prevailing interest rate i_t. Forward-looking reaction functions like (22) nest the reaction function in contemporary variables (13) as a special case (Clarida et al. 2000: 151). The reaction function (22) is an implicit function because it relies on forecasted variables. For actual application of this reaction function as a rule it would have to be transformed into an explicit reaction function. Otherwise, monetary authorities still maintain discretionary power.

The difference between the generalized reaction function (22) derived from the analysis of monetary policy strategies in this paper and other generalized reaction functions like those discussed in Clarida et al. (2000) and Bryant et al.

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[22] The reaction function may also contain lags of the interest rate as central banks choose to smooth interest rates (Goodfriend 1991).

(1993) is the incorporation of the exchange rate. Clarida et al. (2000: 150) investigate a forward-looking Taylor rule like (9) that consists of forecasts of inflation and output gap. Bryant et al. (1993: 225–229) examine four reaction functions of monetary policy strategies. The first strategy targets a monetary aggregate, the second strategy targets the level of nominal GDP, the third strategy targets the sum of real GNP plus the inflation rate, and the fourth strategy targets a bilateral nominal exchange rate. Thus, Bryant et al. (1993) distinguish between their third strategy, which is a Taylor rule, and their fourth strategy, which is some form of a pegged exchange rate regime. In their classification, the generalized reaction function (22) would be a combination of the third and the fourth strategy, as it consists of inflation, output, and an exchange rate term.

V. Outlook

The role of the exchange rate in monetary policy reaction functions has to be examined in more detail in future research. From a normative perspective, the question to be answered is whether or not the exchange rate should be explicitly included in the formulation of a monetary strategy. It can be expected that the answer to this question differs for industrialized and emerging market economies. Goals of monetary policy in industrialized countries are well described by domestic price and output stability. However, the internal monetary stability in emerging market economies depends largely on the prevailing global

situation, which goes beyond domestic conditions and can hardly be influenced by them. Therefore, central banks in emerging market economies have to take into account foreign variables in order to sustain macroeconomic stability.

From a positive perspective the question is whether or not the exchange rate actually plays a different role in the formulation and the implementation of monetary policy strategies in the two groups of countries. Empirical research on the parameters of the generalized reaction function should allow for the identification of strategies: a large weight of the deviation of inflation from its target would suggest an inflation targeting regime, a large weight of the output gap would suggest a Taylor rule, and, finally, a large weight of the exchange rate would suggest a monetary conditions index or managed floating. The inclusion of all potential determinants of the short-term interest rate in the reaction functions of central banks should allow analyzing more systematically the differences in the importance of the exchange rate for monetary policy in industrialized and emerging market economies. With the respect to emerging market economies it is of special interest to test the role of the exchange rate when central banks claim to do inflation targeting. If the exchange rate actually plays a role this would imply that exchange rate targeting and, hence, intermediate exchange rate regimes are still more widespread than one would assume on the basis of the increasing lip service paid to independent floating and the increasing academic support for this corner solution after the recent crises.

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