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Monetary policy rules in emerging market economies: issues and evidence

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Abstract

The paper reviews the recent conduct of monetary policy and central banks' interest rate setting behaviour in emerging market economies. Using a standard open economy reaction function, we test whether central banks in emerging economies react to changes in inflation, output gaps and the exchange rate in a consistent and predictable manner. In most emerging economies the interest rate responds strongly to the exchange rate; in some, the response is higher than that to changes in the inflation rate or the output gap. The result is robust to alternative specification and estimation methods. This highlights the importance of the exchange rate as a source of shock and supports the "fear of floating" hypothesis. Evidence also suggests that in some countries the central bank's response to a negative inflation shock might be weaker than to a positive shock.

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Introduction[1]

In recent years, it has become common to compare ex post the actual setting of policy rates by central banks with what would have been predicted by the Taylor rule first proposed in 1993. The rule suggested that interest rates would be changed according to the deviation of inflation from a target and an output gap.[2] The empirical literature in the industrial country context has grown significantly during the past decade, providing evidence on the relevance of an interest rate rule as a tool for the analysis of the conduct of monetary policy.

Compared to industrial countries, research on the monetary authorities' reaction function in the context of emerging market economies is of recent origin and largely coincides with the movement towards more independent central banks.[3] Nevertheless, several recent studies contain important findings. For example, by examining the behaviour of Latin American central banks, Corbo (2002) finds that, in setting their interest rates, they tend to look beyond inflation and focus on other objectives as well. A study conducted by the Monetary Authority of Singapore (2000) focused on the changes in central bank behaviour in East Asia after the 1997-98 financial crises. The paper points out that the introduction of inflation targeting has enhanced monetary policy credibility as countries now place greater weight on inflation control and are more willing to vary interest rates according to inflation expectations. Filosa (2001) examined the interest rate setting behaviour of monetary authorities in a cross section of maturing emerging market economies. An important finding of this paper is that most central banks react strongly to the exchange rate, although changes in the monetary policy regime make it difficult to assess the relative importance placed by countries on inflation control and external equilibrium.

A particular gap in the existing literature is, however, that most researchers have concentrated on either individual country or regional experiences. Very little attention has been paid to the comparability of countries' experience across regions, and whether consistency in interest rate setting behaviour is a unique experience of some countries or a common feature of the conduct of monetary policy in emerging market economies. Moreover, it is often argued that the exchange rate is particularly important for emerging economies' central banks for several reasons: a high degree of pass-through of the exchange rate into inflation, ensuring competitiveness of the tradable sector and maintaining financial stability. But empirical evidence is scant about the relative significance of the exchange rate for interest rate decisions. Which other variables might a typical central bank reaction function in emerging economies include?

The purpose of this paper is threefold. First, to obtain some preliminary evidence about interest rate setting behaviour in emerging market economies, we briefly review the recent conduct of monetary policy and the potential variables in a typical central bank reaction function. Second, to provide empirical evidence on interest rate setting behaviour, we estimate an open economy Taylor rule for each of the countries[4] in our sample using more recent data. The emphasis is thus on positive or descriptive rather than normative aspects of policy analysis. Third, using the estimated reaction functions we try to answer a few policy questions.

A review of the evidence reveals that most central banks in emerging market economies focus their primary attention on maintaining price stability. In some countries other objectives might also play a role. One general finding is that most central banks change interest rates systematically in response to inflation and exchange rate shocks. The reaction to the exchange rate is typically strong in all countries in the sample; in some, the response is even found to be stronger than that to the inflation rate or the output gap. This highlights the importance of exchange rate movements as a source of

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2 For recent reviews, see Taylor (1999), Svensson (1999, 2002) and Clarida et al (1999, 2000).

3 For a recent review, see Loayza and Schmidt-Hebbel (2002).

4 The countries are: India, Korea, the Philippines, Taiwan (China) and Thailand from Asia; Brazil, Chile, Mexico and Peru from Latin America; the Czech Republic, Hungary and Poland from central Europe; and South Africa.

shock and supports the "fear of floating" hypothesis. Evidence also suggests that central banks' response may vary depending on whether inflation is above or below the long-term average; in particular, the response to a negative inflation shock appears to be weaker than to a positive shock. But there is no strong evidence to suggest that the interest rate response changes according to the size of the inflation and output deviations - large and small shocks seem to have similar importance for policy.

In passing, we would, however, note two limitations of our study. Our analysis focuses on the historical response of emerging economies' central banks to a common set of variables. Hence it does not provide evidence on the optimal monetary policy setting. This is a fertile area for research and goes beyond the scope of this paper. Second, monetary policy regimes in many countries have undergone significant changes during the past few years. Although our estimated reaction functions appear robust against alternative specifications and estimation techniques and across a broad set of countries, we do not provide specific evidence on whether central banks' reaction has changed in more recent years.

The rest of the paper is organised as follows. Section 1 starts with a brief review of the usefulness of rules for the conduct of monetary policy in emerging market economies, and then discusses the candidate variables for the reaction function. Section 2 presents estimated reaction functions for 13 emerging economies, while Section 3 provides a battery of robustness checks. Section 4 tests the existence of asymmetric monetary policy responses, and Section 5 concludes.

1. A brief review of the evidence

The role of monetary policy rules

The time inconsistency literature argues that a purely discretionary policy setting leads to higher long-run inflation; see Kydland and Prescott (1977) and Barro and Gordon (1983).[5] In such circumstances, a credible commitment by the central bank to maintain price stability can reduce the inflation bias from monetary policy. In the past, such a commitment was often imposed externally by a fixed exchange rate, or internally by a monetary growth target. However, in the meantime, both approaches have lost their importance: the former has proved to be unsustainable in the face of growing capital flows and financial markets' imperfections, and the latter has failed because of large-scale shocks to money demand functions.

Against this backdrop, a recent and growing body of literature has argued that inflation targeting provides a convenient mechanism for central banks to combine rules and discretion in conducting monetary policy. For example, Svensson (1999) describes inflation targeting as "decision making under discretion" where central banks follow what he calls a "targeting rule" by which they set interest rates to reduce the deviation between the conditional inflation forecast (the "intermediate target" of policy) and the inflation target to zero over the target horizon.[6] In this setting, the central bank is not committed to any particular instrument arrangement and therefore gains considerable flexibility in setting its interest rate. The typical process involves the central bank revising its inflation and output forecast in each period (corresponding to the frequency of the monetary policy committee meetings) based on the information available to it at that time. If the conditional inflation forecast is higher than the target, the central bank will increase the interest rate to minimise such deviations by the end of the targeting horizon, and vice versa. The private sector then decides its consumption and investment

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5 The reason is that while the central bank is tempted to generate surprise inflation to temporarily promote output, people see such behaviour as inconsistent with its objective of price stability.

6 Similarly, Bernanke and Mishkin (1997) characterise inflation targeting as a framework under which policymakers exercise "constrained discretion". According to White (2002), an important practical benefit of rules in monetary policy is that they can constrain the behaviour of central banks and promote transparency.

plans based on the central bank's reaction. Blinder (1998) calls this "enlightened discretion" and argues that it is close to what many policymakers try to do in practice.[7]

The emerging economy context

The need for greater monetary discipline in emerging market economies has been generally stressed against the backdrop of their relatively high inflation and low policy credibility. In a recent paper Calvo and Mishkin (2003) discuss why emerging market economies are vulnerable to "sudden stops" of capital inflows and repeated exchange rate collapses. Attributing financial crises in emerging market economies to their weak institutional credibility, they suggest that central banks in these economies should be subject to "constrained discretion" through inflation targeting, making it harder for them to follow an "overly expansionary monetary policy". To the extent that this leads to a more transparent and accountable instrument setting behaviour by the central bank, it can pin down investors' confidence and reduce vulnerability to crisis.

Taylor (2002) provides another reason for adopting a rule-based monetary policy in emerging economies. He argues that anticipation effects of monetary policy are higher when the central bank follows a systematic approach in setting interest rates. Given their less developed financial markets, such effects are likely to be lower in emerging economies. Yet monetary policy could still have significant impacts through movements of wages and property prices. More predictable central bank behaviour is therefore expected to improve the transmission and effectiveness of monetary policy.

Indeed, over the last decade, the conduct of monetary policy in emerging market economies has increasingly moved in this direction. For example, out of the 13 countries in our study, all but two (India and Taiwan) have now introduced inflation targeting - from Chile in 1990 to Peru in 2002. Amato and Gerlach (2002) note that an important distinguishing feature of inflation targeting is that it leads to a more systematic interest rate response by the central bank to inflation. The necessary conditions for such a change are provided by the accompanying institutional reforms such as greater instrument independence, a greater reliance on econometric models in the conduct of monetary policy, and better communication of central bank policy and its outcomes to the public: see Bernanke and Mishkin (1997).

Table 1 in the annex shows objectives and instrument setting of central banks in a number of emerging market economies. The table draws on the announcements made by central banks from time to time and hence may vary from the objectives enshrined in the relevant central bank laws. As can be seen from the table, most central banks focus their primary attention on maintaining price stability by formally committing to an explicit inflation target. Another notable feature of Table 1 is the announcement by some central banks of "guidelines" for setting interest rates. These guidelines generally include how the central bank will react to a particular shock and under what circumstances it might choose to accommodate some of the shocks. For example, the Central Bank of Chile (2000) provides a clear statement of action in the event of a price shock: only shocks that affect trend inflation are neutralised by interest rate changes, and the response is symmetric to positive and negative deviations. In Hungary, the central bank's preferred strategy has been to change interest rates only in response to demand-led, long-term deviation of inflation from the target: see National Bank of Hungary (2002). This is expected to reduce excessive volatility in short-term interest rates and avoid unintended output fluctuations. In Mexico, the central bank adjusts the corto (the central bank's operating instrument) when inflation expectations deviate considerably from the target and neutralises the second-round effects of an exogenous price shock (Martínez et al (2001)).

Korea provides a typical example of how an inflation targeting central bank may set its interest rate in response to price shocks. The Bank of Korea changes its repurchase rate when price pressures become persistent in the monthly forecast of inflation and the forecast deviates substantially from the inflation target (Bank of Korea (2003)). The bank follows a "look-at-everything approach" in its

[7] This is also clear from Taylor (1993, 2002), who defines rules as the systematic response of the central bank to inflation and output deviations and not a fixed setting for monetary policy.

assessment of price pressures and not just model-generated projections.[8] In situations of conflict of objectives - for instance, an economic slowdown or financial market uncertainty coinciding with overshooting of inflation from the target - it follows an eclectic approach and relies heavily on judgment in setting the policy stance. Moreover, save in exceptional situations, the Bank adjusts its policy rate in small steps, usually a quarter percentage point, each time it considers a rate change.[9]

These changes in the conduct of monetary policy have been associated with a significant reduction of inflation rates and their volatility in most countries. Table 2 in the annex shows the inflation performance of countries in the past two decades. In many countries, inflation fell sharply in the 1990s compared to the previous decade. Inflation performance during the past three years has been particularly striking. Not only has inflation declined further, but the volatility of inflation has been much lower and is comparable to that of industrial economies. The most dramatic fall of inflation has been in Latin America, where the earlier high- to hyperinflation conditions seem to have disappeared.

A closer examination of Table 1 also reveals that central banks in emerging economies focus on several other objectives. Next to inflation, output stabilisation constitutes an important objective of monetary policy, although noticeable differences remain about how this objective is defined. For example, in the Philippines the output stabilisation objective is defined as keeping output on the "desired" path, in India as "facilitating" growth, and in Korea as "assisting" economic recovery. By contrast, in Chile and Hungary the emphasis seems to be on smoothing output volatility in the context of achieving the inflation target. What is important to note is that irrespective of the monetary policy regime, stability of the exchange rate appears to be a key concern in many countries. Chile is perhaps one exception as the announced policy is to allow the exchange rate to move freely. In Korea there is some preference to monitor asset prices for monetary policy, while in India the central bank attempts to reduce volatility in interest rates. Although not announced explicitly, central banks in Latin America show a greater preference to stabilise current account deficits in the balance of payments (Corbo (2002)).

Variables in the reaction function

Given the above discussion, there are reasons to believe that central banks' reaction function in emerging market economies needs to consider their multiple objective setting. In a closed economy context, following Taylor (1999), equations (1) to (3) summarise the standard aggregate model where the central bank sets the interest rate according to inflation and the output gap:

$$y_t = -\beta(i_t - \pi_t - r) + u_t \text{..........(1)}$$
$$\pi_t = \pi_{t-1} + \alpha y_{t-1} + e_t \text{...............(2)}$$
$$i_t = g_0 + g_1\pi_t + g_2 y_t \text{...............(3)}$$

where y, i, π and r are the output gap, the central bank's policy rate, the inflation rate and the long-run equilibrium real interest rate, respectively. Equations (1) and (2) are the closed economy aggregate demand and supply equations (traditional backward-looking Phillips curve), β and α are the respective slope parameters, and u and e stochastic disturbance terms. Equation (3) defines the policy rule whereby the central bank changes its policy rate according to the current period inflation rate and the output gap, given the policy parameters g_0, g_1 and g_2.[10] A crucial condition for the stability of this

8 See Bank of Korea (2003). The "look-at-everything approach" is defined by the Bank to mean that it considers all possible indicators to measure inflationary pressures, including econometric models, primary data and other proximate indicators (output gap, NAIRU, liquidity gap, monetary thrust index etc) to set direction for monetary policy.

9 The Bank follows what it calls "Greenspan's baby step" approach, a phrase indicating a quarter percentage point move in the interest rate at each go, when the "adjustment is advisable but not essential and a half percentage point when it is deemed crucial".

10 In the US context, Taylor (1993) formulated a reaction function by which the Fed adjusted the federal funds rate (i) according to the following rule: $i_t = \pi_t + 0.5y_t + 0.5(\pi_t - 2) + 2$. This rule, which assumed a constant real interest rate and long-run inflation target (each at 2%), came to be known as the celebrated "Taylor rule".

model is that the reaction coefficient on inflation (g_1) should be above unity.[11] The aggregate demand function is then negatively sloped with respect to the inflation rate. Faced with a price shock (e) the central bank increases its interest rate by more than the rise in inflation, which raises real interest rates until inflation returns to the target.

Given the underlying Phillips curve relationship in (2), the coefficient on the output gap (g_2) in the reaction function depends on two factors: the slope of the aggregate supply curve and the weight given to the variability of output in the loss function. For instance, a flat supply curve implies that a policy shock to reduce inflation will significantly increase output variability, suggesting, ceteris paribus, a relatively small coefficient.

Moreover, a standard practice followed by many researchers is to include a lagged interest rate term in the reaction function (3), reflecting the desire of central banks to smooth interest rate changes. The economic rationale behind such smoothing has been well documented in the literature.[12] Moving the policy rate by small steps in the same direction increases its impact on the long-term interest rate because market participants expect the change to continue and hence price their expectations into forward rates. Acting gradually also reduces the risk of policy mistakes, when uncertainty about model parameters is high and policymakers have to act on partial information. Another reason is that central banks may care about the implications of their actions for the financial system: if markets have limited capacity to hedge interest rate risk, a sudden and large change in the interest rate could expose market participants to capital losses and might raise systemic financial risks. Other reasons could include avoiding reputation risks to central banks from sudden reversals of interest rate directions.[13]

The exchange rate

One variable that might be important in the context of open economies is the exchange rate. When the pass-through of the exchange rate into prices is high, the exchange rate is likely to assume special importance for monetary policy. However, the monetary policy response to the exchange rate may depend on whether the central bank can use other instruments. These can include not only the conventional types such as foreign exchange intervention but also less conventional ones such as temporary capital controls, debt swaps and exchange rate-linked instruments to stabilise exchange rate expectations.[14] Table A overleaf presents a highly stylised view of policy reactions to the exchange rate.

A familiar argument, pioneered by Taylor (2001), is that if the exchange rate depreciates due to a temporary disturbance, the interest rate should remain unchanged (first row of Table A). This is because such exchange rate movements do not have much effect on expectations of inflation, and a central bank that reacts to inflation will indirectly take into account the consequences of the exchange rate movement for its policy.[15] If the depreciation is due to a decline in the demand for exports, the central bank faces a positive price shock as well as a negative demand shock, making an interest rate increase less necessary. Attempts to reduce exchange rate volatility might also increase output volatility. Ball (1999) shows that, in such circumstances, targeting a long-run inflation rate that

[11] Substituting equation (3) into equation (1) gives the slope of the aggregate demand function as $-\beta(g_1 - 1)/(1+ \beta g_2)$. Hence the stability of the policy rule requires that $g_1 > 1$.

[12] For recent reviews see Lowe and Ellis (1997) and Sack and Wieland (1999).

[13] See Goodhart (1999). He argues that in the presence of multiplicative uncertainty, an optimal reaction may imply more aggressive interest rate moves in both directions. In practice, however, central banks are disinclined to reverse their actions.

[14] Recent experiences reveal a wide scale of such non-conventional instruments; see Ho and McCauley (2003) and Mohanty and Scatigna (2003) for a detailed account. Notable examples include Brazil and Turkey, which have used exchange rate indexed bonds extensively in the past to stabilise exchange rate expectations. Before 1998, Chile used reserve requirements on short-term capital inflows to stem exchange rate speculation. Argentina and Thailand have recently introduced various controls on capital inflows to stem appreciation of their currencies. During 2003, Uruguay offered to swap a large part of its short-term dollar debt into longer-term securities to avoid an imminent default and check further currency depreciation.

[15] Mishkin and Savastano (2001) argue that reacting “too heavily and frequently” to exchange rate movements raises the risk that the exchange rate might become the de facto anchor for monetary policy

excludes exchange rate effects is more helpful. This may increase the short-run inflation volatility, but will greatly reduce output variability.

Table A

A simple matrix of monetary policy reaction to the exchange rate

	Real shock	**Financial shock**
Temporary	no reaction	no reaction
Permanent	fiscal policy	monetary policy

Another case theoretically meriting no monetary response is a depreciation caused by a permanent real shock; for instance, a secular decline in the terms-of-trade or a negative productivity shock. A first best policy may be to adjust other policies, in particular fiscal policy to align the aggregate absorption level in the economy (second row of Table A, left-hand column). On the other hand, Ball (2002) points out that if the adverse exchange rate shock is from the financial side (for example, a sudden withdrawal of foreign investors from the country), an increase in the interest rate may be an appropriate response to stabilise both inflation and output (second row of Table A, right-hand column). While currency depreciation will increase external demand and prices, a higher interest rate will reduce domestic demand and stabilise inflation.[16]

Nevertheless, in practice, many emerging market economies intervene to stabilise the exchange rate by changing interest rates, and the scale of such intervention also tends to be large. This raises the question of the factors that may account for this behaviour. One reason, consistent with theory, is that major currency depreciations in emerging market economies have, in fact, been due to financial shocks, often resulting in high inflation. Second, exchange rate shocks tend to be large and persistent in emerging economies, which can create a dilemma for the central bank. If it chooses to absorb the exchange rate depreciation it might risk overshooting the inflation target and lose credibility. At the same time, defending the currency might require raising the interest rate to a very high level, which can cause large output losses. In a recent study, Ho and McCauley (2003) show that emerging economies that miss their inflation targets are generally the ones experiencing sharp exchange rate volatility. This suggests that central banks may be ready to raise rates when faced with large currency depreciations. But they may, at the same time, prevent sharp contraction of the economy even at the cost of missing the inflation target.

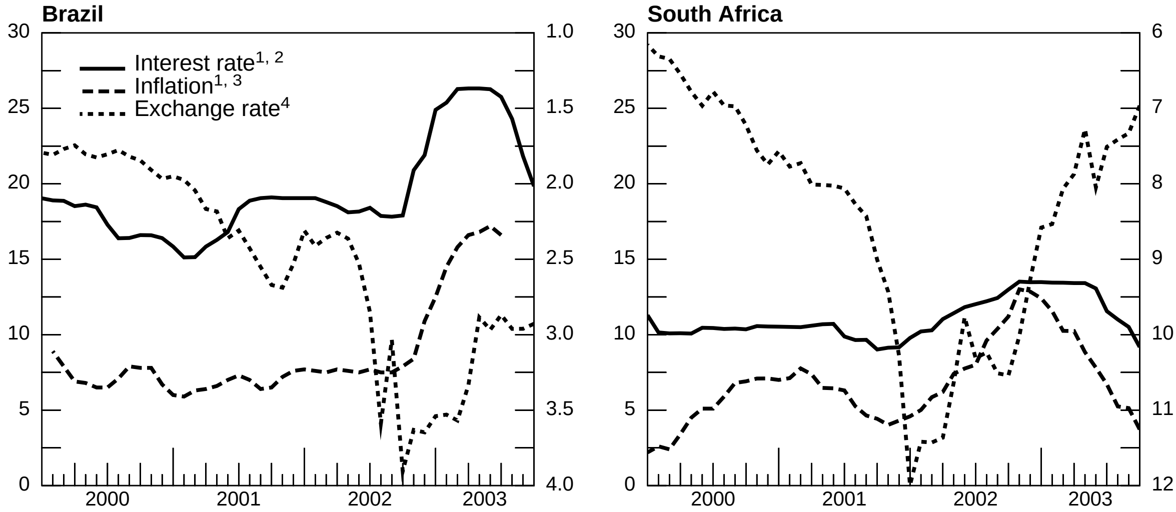
The recent experiences of South Africa and Brazil illustrate this point quite well. Graph 1 shows how closely exchange rates, inflation and interest rates moved in the two countries during the recent currency crises. Led by speculative currency pressure, increased risk aversion and regional political uncertainties, the South African rand came under sharp depreciation pressure in 2001, falling by over 20% in the last two months of the year. The central bank did not intervene at that time and only raised the interest rate in January 2002 when currency depreciation led to strong inflationary pressures.[17] Eventually, the currency recovered, and the central bank missed its inflation target. In Brazil, the real fell by over 40% in the second half of 2002, while the central bank only raised interest rates when the currency depreciation threatened its inflation target. Explaining the overshooting of inflation, the central bank has argued that it raised the interest rate primarily to prevent the second-round impact of currency depreciation on inflation while allowing the first-round effect to be absorbed in prices.[18] The central bank also raised its inflation target for 2003 from 4% to 8.5%.

16 Ball (2002) argues that the most appropriate policy instrument in this case is a combination of the exchange rate and the interest rate (a monetary conditions index (MCI)) rather than the interest rate alone. Using the recent experience of Australia and New Zealand, he demonstrates that a response based on the MCI reduces output volatility compared to a response based on the interest rate when the source of the shock is a financial disturbance. Wollmershäuser (2003) reaches a similar conclusion by showing that central banks can reduce uncertainty about output and inflation by reacting to exchange rate shocks stemming from financial disturbances. A problem with this view, however, is that the MCI is not an instrument and that it is difficult to separate financial from real shocks.

17 See South African Reserve Bank (2002).

18 See the open letter of the Governor to the Minister of Finance (Banco Central Do Brasil (2003)).

Graph 1 **Interest rates, exchange rates and inflation**



[1] Left-hand scale. [2] In percentages; short-term rate. [3] Annual percentage changes. [4] Right-hand inverted scale; local currency per US dollar; an increase indicates an appreciation.

Sources: Bloomberg; Consensus Economics; IMF; national data.

Central banks in emerging market economies may also assign a relatively higher weight to the exchange rate for reasons other than price stability - most importantly, maintaining financial stability. Calvo and Reinhart (2002) attribute such "fear of floating" behaviour on the part of emerging economies to the high risk premium they have to pay because of their low institutional and policy credibility.[19] Such resistance to floating may be particularly high in countries with thin exchange markets, which are vulnerable to one-way expectations and herd behaviour. A disorderly depreciation can encourage speculation through leads and lags in trade transactions and short-term capital flows, giving the exchange rate its own momentum. Many recent experiences of exchange market intervention go to support this concern. Partly because its exchange market is thin, India has tried to avoid excessive exchange rate volatility through forex and interest rate interventions. When the Philippine peso came under strong depreciation pressure in the middle of 2001 and again in early 2003, the central bank raised reserve requirements to limit currency speculation.

In some cases, financial imperfections such as a large amount of external debt or debt indexed to the exchange rate may have made the case for monetary policy intervention even stronger. Eichengreen (2002) and Goldstein and Turner (2004) have recently highlighted the adverse consequences of exchange rate depreciations in countries with a high degree of dollarisation. Sharp currency depreciations in such circumstances, it is argued, can cause widespread bankruptcies and even change the sign of the exchange rate in the aggregate demand function from positive to negative. This rather unconventional contractionary impact of the exchange rate makes it necessary for the central bank to raise rates defensively against major exchange rate shocks.[20]

Other asset prices

Empirical testing of the role of other asset prices (mainly equities and housing) in central bank interest rate decisions is beyond the scope of this study. Nonetheless, we briefly review the relevant issues and the recent experience with regard to emerging market economies. Many have argued that since asset price cycles generally peak during an economic upturn, they foreshadow future inflation,

19 In a recent paper, Alesina and Wagner (2003) argue that the "fear of floating" critically depends on the state of political institutions. Countries with poor political institutions end up with more volatile exchange rates than countries with sound political institutions.

20 See also Kamin and Klau (1997) on the contractionary effects of the exchange rate on output.

requiring preventive action.[21] Moreover, asset prices may include a "bubble" element that is subject to reversal at a later date with potentially destabilising implications for the financial system.[22]

Nevertheless, views differ about whether central banks should respond to asset price movements, partly reflecting different assumptions about transmission mechanisms. For instance, Bernanke and Gertler (2001) model asset prices primarily from their impact on aggregate demand - through both the conventional wealth channel and the balance sheet route - and show that a central bank that reacts aggressively to expected inflation can effectively stabilise the economy against asset price volatility. On the other hand, Bordo and Jeanne (2002) model risks of financial instability arising from asset price misalignment as an endogenous process, partly dependent on the nature of monetary policy reactions. Two variables that monetary policy can control in their model are the extent of debt accumulation and the price of assets.[23] This leads them to argue that central banks need to react proactively to asset prices. For the same reason, Borio and Lowe (2002) argue that the failure of monetary authorities to address asset price imbalances built up during periods of low inflation "can unwittingly accommodate an unsustainable and disruptive boom in the real economy".

A second difference arises from practical considerations: it is difficult for the central bank to know precisely what causes asset price cycles and to differentiate fundamentals from bubbles.[24] When central banks are uncertain about the implications of asset prices for inflation and output, the costs of intervening may also be high if this makes interest rates more volatile. It could also render them politically unpopular if they prematurely end an asset price boom. In such circumstances, Filardo (2001) shows that the monetary authority's response is likely to depend on the net benefits from stabilising asset prices and the probability it attaches to asset prices having significant implications for inflation and output developments.[25]

In emerging economies, households' portfolios are generally less diversified. With equities constituting a much smaller share of their overall portfolio than in industrial economies, the wealth effects are correspondingly lower. Moreover, equity prices are significantly more volatile in emerging economies, which could imply a much higher interest rate volatility should monetary policy attempt to stabilise asset prices. The net benefits for monetary policy from reacting to equity price imbalances are thus likely to be low.

On the other hand, the role of property prices in inflation and output developments has been significant in several countries. For example, overshooting of property prices, led by imprudent bank lending, played an important role in the 1997-98 Asian financial crisis, as did their subsequent collapse ending in deflation in Hong Kong and, more recently, in Singapore. The recent experience of Korea provides another important example. In 2002, sharp growth in housing and mortgage credit raised household debt to unsustainable levels. The central bank tightened prudential requirements on banks and also announced its intention to closely monitor asset prices for its interest rate decisions. Several other Asian countries have faced similar run away increases in housing credit and strong growth in property prices in the past two years.

Another asset price that seems important in some countries is the long-term bond rate. Many central banks in emerging economies directly intervene in the bond market to influence long-term interest

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21 An important pioneer of this view is Goodhart (1995).

22 Cecchetti et al (2000), for instance, show that inflation and output performance improve significantly for any combination of weights when central banks take asset price misalignments (stock prices and the exchange rate) into account in setting interest rates.

23 An important conclusion by Bordo and Jeanne (2002) is that a simple linear extension of the Taylor rule to account for asset price misalignments is not a sufficient safeguard against financial instability. Given the complex and non-linear interaction between central bank actions and private sector expectations, an optimal monetary policy also involves judgment.

24 Bernanke and Gertler (2001) argue that it is far more difficult for central banks to know the fundamental component of asset prices than potential output. However, Borio and Lowe (2002) point out that this is not a problem insofar as the central bank reacts to the *conditions* (most importantly, excessive growth in bank credit during a period of low inflation) that lead to the build-up of financial imbalances.

25 Benefits from stabilising asset prices mainly arise from the reduction of inflation volatility and the costs from higher interest rate volatility. In the US context, Filardo (2001) shows that when the Fed is 60% sure that asset prices matter for the economy the net benefit of reaction to asset prices turns positive.

rates, although such intervention may not always be guided by inflation and output considerations.[26] For instance, the stability of long-term interest rates has been an explicit objective of monetary policy in India (Table 1). In pursuing this objective, the Reserve Bank has, from time to time, intervened to stabilise long-term bond yields, especially when the risk premium rose and the government had to issue large amounts of bonds to finance its fiscal deficit.[27]

One apparent reason for such bond market intervention is that the term structure of interest rates may not be well behaved, especially if the degree of financial uncertainty is high and the bond market is illiquid. In such circumstances, financial markets are likely to exhibit high and variable risk premia, reducing the importance of the expectations mechanism in the determination of interest rates. Other reasons for stabilising long-term rates might include financial imperfections, such as a low pass-through of policy rates to lending rates, and a high degree of exposure of banks to interest rate risks in the absence of inadequate risk transfer mechanisms.

2. Estimates of the reaction function

In this section, we try to find empirical answers to some of the hypotheses laid out in the previous section. As a preliminary check, Tables 3 and 4 in the annex summarise the main statistical properties of short-term interest rates, inflation rates, the output gap and exchange rates for the 13 countries in our sample. In most countries the short-term interest rate is strongly and positively correlated with the inflation rate (Table 3). The exceptions are India, the Philippines and South Africa, where the degree of association between these two variables is relatively weak. With the exception of Chile, the interest rate appears to be negatively correlated with the exchange rate - a currency depreciation is associated with an increase in the interest rate and vice versa. This contrasts with a rather weak and, in some cases, theoretically surprising relationship between the short-term interest rate and the output gap. For example, in Hungary, Mexico and South Africa the short-term interest rate is negatively correlated with the output gap, giving the impression of a procyclical monetary policy.

Volatility indicators, as represented by the standard deviation of variables, are shown in Table 4. Short-term interest rates are more volatile in countries which have witnessed more variable inflation rates and exchange rates than those with relatively stable financial environments. In particular, mirroring frequent devaluations and high inflation until recently, short-term interest rates in Latin America are more volatile than those in Asia and central Europe. What is also striking is that, excepting India, output gaps are relatively more stable than other variables. In summary, the preliminary investigation leads to the prior that interest rates tend to vary closely with the inflation rate and the exchange rate, while the covariance with the output gap is ambiguous.

Open economy Taylor rule

Following Taylor (2001), we focus on an open economy interest rate reaction function, where the central bank reacts to the actual inflation rate, the output gap and changes in the exchange rate in the following way:

$$i_t = \delta_0 + \delta_1 \pi_t + \delta_2 y_t + \delta_3 \Delta xr_t + \delta_4 \Delta xr_{t-1} + \delta_5 i_{t-1} \quad \text{........(4)}$$

where i is the short-term nominal interest rate or policy rate of the central bank, π is the annual rate of inflation, y is the deviation of actual from potential output, xr is the log level of the real effective exchange rate (an increase means an appreciation and vice versa), and Δ is the first difference operator. All variables are measured at the end of a quarter, starting in most countries in the first half of the 1990s and ending with 2002. The theoretical signs of the parameters in equation (4) are δ_0 ,

26 See, for example, Mohanty (2002).

27 See Reddy (2002) for a discussion on the challenges posed to the monetary authority by the high fiscal deficit.

δ_2 , δ_5 >0; $\delta_1 /(1-\delta_5) > 1$, δ_3 <0; and δ_4 <> 0. We call (4) the baseline model, and to check robustness properties of the results we estimate an alternate version where actual inflation and the exchange rate are replaced by their deviations from trend values (the gap model).[28]

According to Taylor (2001), the exchange rate is likely to have only marginal significance in (4), with δ_4 approximately equal to - δ_3 .[29] As in Table A, the implicit assumption is that shocks to the exchange rate represent temporary deviations from its long-run value. The central bank might raise interest rates in response to currency depreciations in the current period. But because the exchange rate is assumed to be mean reverting and thus does not have any significant impact on the central bank's inflation forecast, it would lower rates in the next period. However, if shocks to the exchange rate are large and persistent and the central bank places a higher weight on exchange rate stability we would expect significant negative coefficients on both the current and lagged values of the exchange rate in (4).

Results of the baseline model

Table 5 in the annex presents results of the baseline model for the 13 countries. The output gap was derived using an HP filter for measuring trend output. In some cases we control for known episodes of crises by using suitable dummy variables. We use the short-term interest rate – the daily interbank rate in most cases - as the relevant left-hand variable of the reaction function. This choice is guided by the fact that many central banks until recently did not have an official policy rate. Furthermore, to the extent that monetary operating regimes varied considerably during the sample period, a short-term market rate is thought to be more appropriate in capturing the variety of operating procedure than the actual policy rate. In any case, the correlation between the policy rate and the short-term rate is uniformly high in all countries. An exception is India, which follows a multiple instrument approach to influence the call money rate (Table 6).

The results suggest that simple rules explain the interest rate setting behaviour of emerging economies reasonably well. For most countries equation (4) explained between 70 and 90% of the actual movement of short-term interest rates. The estimates are free from problems of autocorrelation, and all coefficients have the expected signs, although some are only weakly significant. As Graph A1 in the annex shows, the model closely tracks the historical policy path and captures most of the turning points since the mid-1990s. The errors seem to be somewhat higher for Brazil and South Africa: in the former case the estimated rule mostly overpredicts the short-term rate since the devaluation of the real in 1999. For South Africa, the model underpredicts the policy rate for much of the period between 1998 and 2001. Overprediction bias appears to be a common phenomenon since the beginning of the current cycle, especially in Asia, where monetary policy was sharply eased.

Table B presents the relevant short and long-run coefficients.[30] One general finding is that emerging economies' central banks seem to adjust interest rates by small steps. The coefficients on the lagged interest rate average 0.6, implying that the initial adjustment in interest rates is only 40%. The degree of interest rate smoothing is particularly high in Hungary, Peru, Poland, South Africa and Taiwan, but small in Chile and the Philippines.

Another important finding is that the monetary policy response to inflation seems to be higher in Asia and Latin America than in central Europe, and particularly strong in South Africa. In about half the countries, the long-run coefficient on inflation exceeds one, indicating that central banks do not accommodate inflationary pressures. Within Asia, the estimated long-run inflation coefficients are low in India and the Philippines, perhaps explaining their relatively high inflation rates. In Latin America, the reaction coefficients point to a non-accommodating monetary policy stance in Chile, Mexico and

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28 In symbols, this is given by $i_t = \theta_0 + \theta_1(\pi_t - \dot{\pi}) + \theta_2 y_t + \theta_3(xr_t - x\dot{r}) + \theta_4(xr_{t-1} - x\dot{r}) + \theta_5 i_{t-1}$.

29 Our model differs from Taylor's to the extent that we assume that central banks respond to the changes rather than levels of the real exchange rate.

30 Ideally the long-run elasticities should also include indirect feedback effects on the short-term interest rates, which are likely to be large in relatively open economies, particularly through the exchange rate. However, this would require estimating full macroeconomic models, which is beyond the scope of this paper.

Peru, whereas the response appears to be weaker in Brazil. The relatively weak monetary policy response in central Europe needs to be interpreted with some caution. During the 1990s, inflation rates were significantly influenced by large relative price movements brought about by the gradual removal of price controls. The results confirm the findings of other studies that central banks in transition economies may have accommodated some of the non-monetary price pressures in order to reduce the output costs.[31]

The evidence on output stabilisation is mixed. The output gap is a statistically significant determinant of short-term interest rates in the Czech Republic, India, Korea, Mexico, Poland, Taiwan and Thailand. In other cases, it is either weakly significant or not significant. However, the coefficients may be downward-biased since our estimates of the output gap may not adequately measure demand gaps. Estimating potential output is more difficult for emerging economies than for industrial economies, given the relatively greater importance of supply shocks in the former.

The implied long-term elasticities suggest that the monetary policy response to output is stronger in Latin America and central Europe than in Asia. With the exception of Chile, the long-term response of monetary policy to the output gap exceeds one for all countries in the first two regions. This result might be related to the role of other polices in output stabilisation. For instance, fiscal policy has played an important role in Asia since the 1997-98 financial crises, perhaps reducing the need for a more aggressive response of monetary policy. In contrast, many recent studies suggest that the fiscal policy response to output in Latin America has been extremely weak or procyclical.[32] As a result, central banks may have played a more active role in output stabilisation. To cite an example, Sidaoui (2003) argues that because fiscal policy in Mexico tended to accentuate rather than attenuate demand shocks, the central bank had to respond more aggressively to demand fluctuations.

Table B

Responses from a simple reaction function[1]

	Inflation		Output		Exchange rate	
	Short-term	**Long-term**	**Short-term**	**Long-term**	**Short-term**	**Long-term**
India	0.13	0.43	0.13	0.43	–0.18	–0.60
Korea	0.66	1.53	0.29	0.67	–0.29	–0.67
Philippines	0.51	0.71	0.35	0.49	–0.09	–0.13
Taiwan	0.23	1.35	0.13	0.76	–0.03	–0.18
Thailand	0.56	1.33	0.37	0.88	–0.31	–0.74
Brazil	0.08	0.29	0.98	3.50	–0.10	–0.36
Chile	0.97	1.43	0.32	0.47	0.00	0.00
Mexico	0.55	1.10	0.74	1.48	–0.79	–1.58
Peru	0.19	1.36	0.15	1.07	–0.38	–2.71
Czech Republic	0.12	0.75	0.32	2.00	0.03	0.19
Hungary	0.20	0.80	0.35	1.40	–0.15	–0.60
Poland	0.17	0.68	0.66	2.64	–0.05	–0.20
South Africa	0.08	4.00	0.04	2.00	–0.12	–6.00

[1] Based on the Taylor rule specification of Table 5 in the annex.

The results strongly reject the hypothesis that central banks do not react to exchange rate volatility. In all countries except for Chile, current period real exchange rate changes have uniformly negative signs in the reaction function, suggesting that central banks "lean against the wind" by raising rates when

[31] See, for example, Coorey et al (1998) and Pujal and Griffiths (1998).

[32] See, for example, Gavin and Perotti (1997) and IMF (2001).

the exchange rate depreciates. This relationship is statistically significant in all countries excepting the Czech Republic, Poland and Taiwan.

As noted earlier, a significant and positive coefficient on the lagged exchange rate change would indicate mean reverting exchange rate movements, and imply that central banks reverse their interest rate actions. However, as may be seen from Table 5, when the coefficient on the lagged exchange rate is positive, it is never statistically significant. By contrast, whenever it is negative it is also statistically significant, indicating a high degree of persistence of exchange rate shocks in Korea, India, Mexico, Peru, Thailand and South Africa. In Chile, the coefficients on the current and lagged exchange rates have "wrong" signs. However, they offset each other, suggesting exchange rate movements do not affect monetary policy.

Taken together, the results suggest a high degree of interest rate response to the exchange rate and a large contribution of the latter to the mean and standard deviation of interest rate movements (Table C). The β-coefficients in Table C measure the contribution when all variables are normalised by their standard deviation. In a similar way, the ε-coefficient evaluates the contribution to the mean. As the table shows, in all countries exchange rate volatility is by far the largest contributor to interest rate volatility. The contributions of inflation and output gap are comparatively smaller. This is also true for contributions to the mean interest rate during the sample period.

Table C

Contribution to interest rate volatility

	Inflation		**Output**		**Exchange rate**	
	β	**ε**	**β**	**ε**	**β**	**ε**
India	0.16	0.08	0.22	0.10	11.68	–0.40
Korea	0.22	0.27	0.15	0.24	19.47	0.31
Philippines	0.40	0.29	0.13	–0.08	7.57	0.34
Taiwan	0.23	0.07	0.10	–0.10	1.63	0.10
Thailand	0.22	0.22	0.22	0.68	14.36	0.96
Brazil	0.28	0.05	0.10	–0.00	3.61	0.40
Chile	0.54	0.49	0.10	–0.00	0.00	–0.00
Mexico	0.76	0.46	0.24	–0.09	42.44	–0.25
Peru	0.15	0.04	0.05	–0.00	13.28	0.02
Czech Republic	0.17	–0.26	0.10	0.01	0.84	–1.04
Hungary	0.19	0.16	0.05	–0.01	3.05	–0.30
Poland	0.27	0.12	0.15	–0.08	2.23	–0.14
South Africa	0.23	0.09	0.28	0.80	15.71	3.89

Note: Derived from the baseline estimates in Table 5 in the annex.

3. Robustness checks

In this section we conduct several robustness checks on our baseline results to see whether they stand up to alternate specifications and whether the estimated relationship has undergone significant changes. There are several potential sources of instability to the estimates. First, our baseline estimates were based on absolute inflation rate and exchange rate changes rather than their deviations from a target or trend. Second, there are known sources of instability, given that a number of countries moved to inflation targeting or significantly changed the weights assigned to different objectives during the past three to four years. It is, however, hard to come to any specific conclusion on the latter aspect given the very short experience with inflation targeting. Third, the baseline estimates were obtained in the context of a reactive interest rate rule whereby central banks respond to observed rather than expected variables and might not be valid with a forward-looking policy setting.

Sensitiveness to alternate specifications

As a first test we estimated the baseline model by replacing the absolute values of inflation and exchange rate changes by their respective deviations from a trend. We used an HP measure of trend inflation, rather than announced targets. But the two are naturally closely related because the filtering allows a trend drift in long-run inflation, which the actual inflation targets seem to follow.

The results given in Table 7 show that there are few major changes to the signs and magnitude of the parameters, although the explanatory power of the model and the statistical significance of individual parameters declined in some countries. With the notable exception of Mexico and South Africa, the interest rate responses to inflation and output declined in the gap model compared to the baseline model. Nonetheless, the results validated the finding of the baseline model with respect to the exchange rate. The coefficient on the current period exchange rate is negative in all countries except for Chile, and significant in a majority of them. As in the baseline model, the results confirm importance of exchange rate shocks and central banks' response to them.

Stability of estimates

As a first step, we conduct Chow breakpoint tests for each country, assuming that the date of a potential break in the relationship is the start of a new monetary era in 1999 after the outbreak of the Asian crises. Although such a breakpoint might look arbitrary for all countries, especially those in Latin America and central Europe, there appears to be a general consensus that the emphasis on inflation control increased significantly around this time. There is evidence of shifts in the estimated equations (Table D) in most Asian countries, Brazil, Mexico and Poland, ie these are countries which have undergone major monetary regime changes.

Table D

In-sample Chow breakpoint stability test

	India	Korea	Philippines	Taiwan	Thailand	South Africa
F-statistic	0.53	2.69*	2.99*	1.91	2.19*	1.62

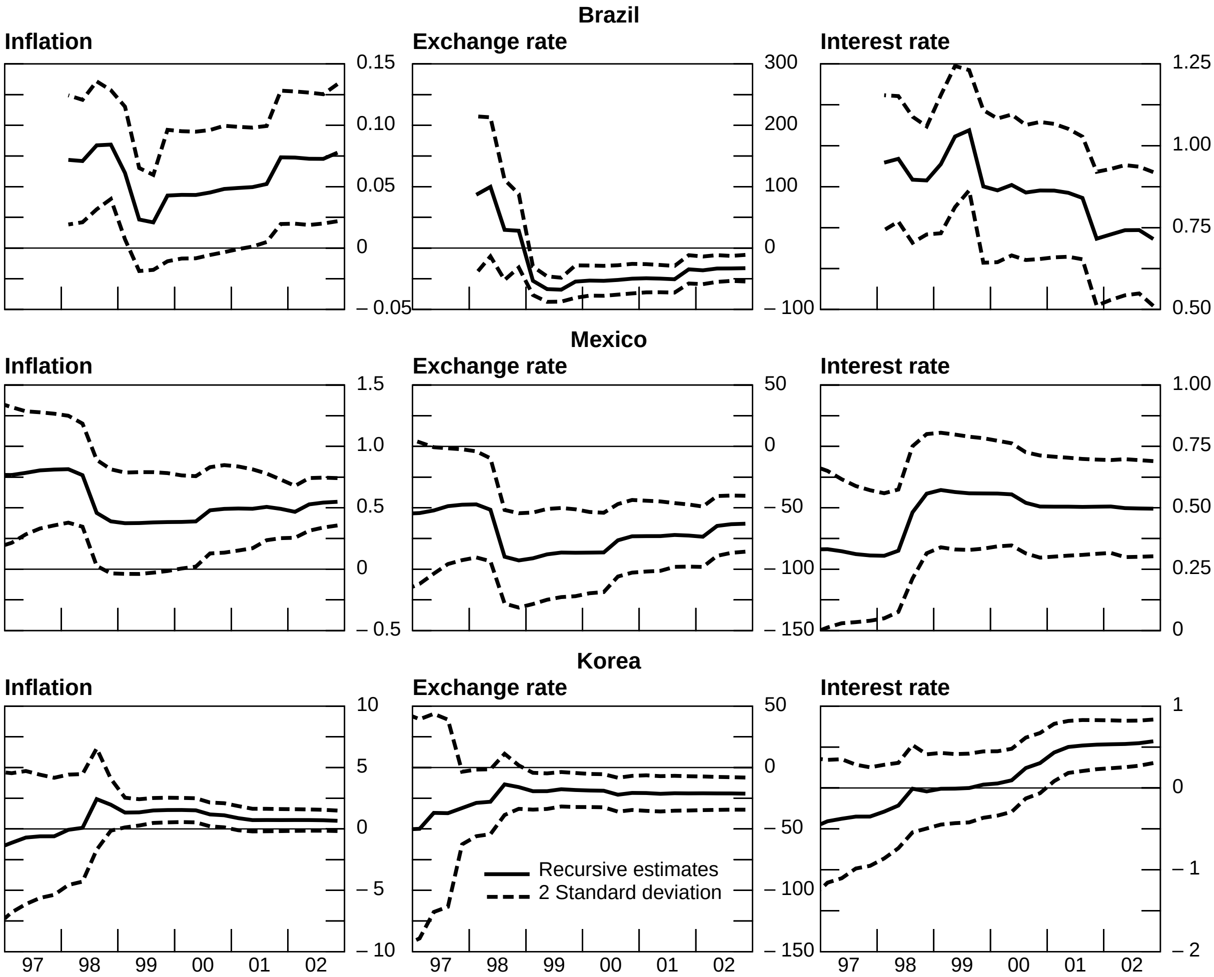
	Brazil	Chile	Mexico	Peru	Czech Republic	Hungary	Poland
F-statistic	18.48*	0.56	5.05*	1.07	1.12	1.39	3.95*

Note: The Chow breakpoint tests have been done for 1999 Q1 (except for Mexico 1998 Q1, Poland 1998 Q1 and Thailand 1997 Q3).

* indicates that the null hypothesis of no structural break has been rejected.

Since the Chow breakpoint test assumes that the estimated relationships are stable before and after a specific last unknown point, a more appropriate technique is to re-estimate the coefficients of each parameter specified in (4) recursively. The plots of the coefficients in Graph 2 do not reveal obvious in-sample parameter instability except for Brazil, Mexico and Korea, where there is some instability towards the end of the 1990s. These results should be interpreted with caution as the time frame is quite short. Using recursive residuals as a third stability test, with the exception of Brazil and Mexico, none of the residuals went outside the standard error bands (see annex Graph A2).

Graph 2 **Recursive estimates for selected countries and coefficients**[1]



[1] Based on the specification of Table 5.

Sensitiveness to alternate estimation methods

As a final test, we estimated the reaction function with expected variables, assuming that monetary policy is pre-emptive rather than reactive. We use monthly data starting from 1998 for the 13 countries. Shortening the sample to the most recent period provides a further test on structural changes and thus supplements the stability tests above. Wherever applicable the shorter sample will also allow us to use the actual inflation target announced by the central banks.

The model is estimated through the generalised method of moments, using the lagged short-term interest rates and current and lagged values of money supply growth, export growth, the exchange rate and the output gap as instruments.[33] The lag length varies across countries, depending on the underlying dynamics. We chose a weighting matrix that would satisfy the orthogonality condition of zero correlation between parameter estimates and instruments[34] and is also robust to heteroskedasticity and autocorrelation of unknown form. To check overidentification conditions Table 8 in the annex presents the relevant p-values of J-statistics. As can be seen from the table, for most countries the null of overidentification is rejected at over 90% confidence level.

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[33] The effective targeting horizon in this model is one month.

[34] The model is first estimated by two-stage least squares to generate the initial covariance matrix for subsequent iterations to find the optimal weighting matrix.

The results of the GMM estimates are reported in Table 9 in the annex. Again, it is important to note that the forward-looking reaction function confirms most findings of the simple function, indicating the robustness of the model for emerging market economies. There are few sign reversals when we used expected rather than actual variables. The size of reaction coefficients, however, underwent some change: the estimated interest rate response to inflation and output declined significantly in Asia and central Europe (excepting Poland with respect to inflation) when using expected variables. By contrast, the reactions in Latin America to inflation generally increased. This, however, is not true for the exchange rate response, which is substantially higher in the Philippines, Taiwan, Brazil, Peru and the Czech Republic.

4. Testing for non-linear and asymmetric reactions

The estimated reaction functions presented in Table 5 assumed a linear and symmetric response by central banks to inflation and output shocks. Specifically, the estimated reaction coefficients imply that central banks give similar weights to positive and negative price pressures as well as the economic upswings and downswings and that their reaction coefficients do not vary with the size of the shocks. However, if these assumptions do not hold the reaction function is mis-specified.

In this section we therefore test whether central banks' response depends on the size and sign of inflation and output deviations. Do central banks respond differently to a negative as against a positive deviation of inflation and output from the target values? Do larger shocks imply a stronger response than smaller shocks?

The literature has identified two potential sources of asymmetric and non-linear monetary policy responses. First, asymmetry may be induced by a non-linear relationship between inflation and output in the presence of significant price and wage rigidities. For example, nominal wages may be sticky downwards but flexible upwards, producing a non-linear Phillips curve.[35] While a positive inflation deviation leads to a faster rate of increase in prices in the subsequent periods because of upward wage flexibility, the effects of a negative inflation deviation will be dampened by the downward rigidities of wages. In such circumstances, Dolado et al (2002) show that an optimal policy involves some degree of asymmetric reaction to offset the non-linear Phillips curve. As a result, the central bank may penalise positive deviations of inflation more severely than negative deviations, and the response may also depend on the size of the shocks.[36]

A second source of asymmetric monetary responses may arise when central banks' loss function is non-linear with respect to the size of inflation and output deviations. Some have argued that, to protect their credibility, independent central banks are likely to be biased towards undershooting rather than overshooting their inflation targets, giving rise to a deflationary bias in monetary policy. Goodhart (1999) cites two, possibly offsetting, asymmetries in central bank policy. While central banks have a bias towards tightening, they tend to delay tightening decisions longer than easing decisions. Others argue that political accountability and uncertainty about future economic developments might encourage central banks to adopt a policy of greater aversion to recession than expansion: see Blinder (1998) and Cukierman (1999).[37]

To test whether interest rate responses change with the sign of inflation and output deviations, we included two slope dummies in equation (4), with the dummy taking a value of 1 in quarters when inflation and output were below their respective trend values. For these quarters central banks' reaction to inflation and output is given by the combined effect of the usual coefficients and the slope

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35 Akerlof et al (1996) point out that this is likely when inflation is low and workers resist nominal wage cuts in response to higher unemployment.

36 Gerlach (2000) provides evidence of asymmetric monetary policy response for industrial countries. Dolado et al (2002) confirm this result for Europe and find both a sign and size asymmetry in central banks' reaction to inflation and output shocks.

37 Cukierman's (1999) model generates an inflation bias in monetary policy similar to that of the Barro-Gordon type without the condition that central bank aims to achieve an output level in excess of the economy's potential.

dummy coefficients. Negative and significant dummy coefficients imply a relatively weak response to negative inflation and output deviations, while positive coefficients indicate the opposite.

The results are reported in Table 10 in the annex. The inflation dummy is strongly or weakly significant in the Czech Republic, Hungary, Korea, Poland and Thailand. Of these, Poland, with a positive coefficient, appears to be an outlier, indicating a stronger response to a negative inflation shock than to a positive shock. In others, the dummy coefficient is negative, exceeding the inflation coefficient in Korea and Thailand, and quite large relative to the inflation coefficients in the other two countries. This provides some evidence of a weaker response of interest rates to a negative inflation shock. On the other hand, given the statistically insignificant coefficient on the dummy for the output gap in all countries, there is little evidence to suggest that central banks' response to output varies depending on whether actual output was below or above trend.

To test for size asymmetry, or non-linearity, equation (4) was augmented by the squared deviations of inflation and the output gap.[38]

$$i_t = \delta_0 + \delta_1 \pi_t + \delta_2 y_t + \delta_3 \Delta xr_t + \delta_4 \Delta xr_{t-1} + \delta_5 i_{t-1} + \delta_6 (\pi_t)^2 + \delta_7 (y_t)^2 \text{.......}(5)$$

Testing for symmetry implies testing the parameter constraints $\delta_6 = \delta_7 = 0$. Acceptance of the constraint implies accepting the hypothesis that central banks do not view a larger shock differently from a smaller shock when changing their interest rates. The results given in Table 11 show that except for the Czech Republic, Brazil, Peru and Thailand, the *p* values of the Wald test failed to reject the constraints of zero coefficients on the squared inflation and output gaps, suggesting no significant difference in response to the size of shocks. Even for these four countries the coefficients on the squared inflation and output term are mostly negative, and therefore economically not meaningful. Including the squared inflation and output terms also led to some odd sign changes of other parameters in India, Taiwan and South Africa.

5. Summary and conclusions

The paper has highlighted several issues in the context of emerging economies. Against the backdrop of a series of financial crises, the recent debate in these countries has increasingly focused on building monetary policy credibility. In this context, suggestions such as subjecting central banks to "constrained discretion" and increasing the predictability of their policy actions have assumed importance. Indeed, monetary reforms in emerging economies in recent years appear to have moved in this direction. As countries have adopted inflation targeting, there have been attempts to improve policy transparency. In some countries, central banks have also announced guidelines for setting interest rates. At the same time, much remains unclear about objectives. While monetary policy has increasingly been focused on price stability, other objectives remain significant as well. One such objective highlighted in the paper is the stabilisation of the exchange rate. Episodes of recent exchange market pressures reviewed in the paper reveal that central banks often intervene to stabilise the exchange rate; in some countries, this may, at times, have dominated interest rate developments.

The empirical evidence presented in the paper confirms the finding of previous studies about the rate setting behaviour of central banks. In many emerging economies the interest rate reaction to inflation exceeds one, suggesting a non-accommodating stance of monetary policy towards price shocks. However, in most countries the estimated relationship also suggests a strong response of the interest rate to movements in the exchange rate, with the latter contributing significantly to the volatility in interest rates. This reflects the joint effects of two factors: first, exchange rate shocks appear to be persistent; and second, central banks' preference for stabilising the exchange rate by the use of monetary policy instruments seems strong. Evidence presented in the paper also suggests that in some countries central banks may respond more aggressively to positive than to negative inflation deviations. There is, however, little evidence that the interest rate response depends on the size of inflation or output shocks.

[38] See Surico (2003) for the formal derivation of the test.

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Table 1

Objectives and instrument setting in emerging economies

	Inflation	Output	Exchange rate	Others
India	To maintain a stable inflation environment	To maintain appropriate liquidity conditions to support growth	To ensure orderly conditions in the exchange market; to avoid excessive volatility in the exchange rate	To maintain a stable interest rate environment
Korea	To reduce inflation to the mid-term inflation target	Assisting economic recovery in the context of price stability		Carefully monitor real and financial asset prices
Philippines	To keep future inflation on the desired target path	To maintain output growth on the desired path	Decisions are influenced by transmission channels (the exchange rate and asset prices) and the health of the banking system	
Chile	To pursue the inflation target; to act preventively to avoid future deviations in trend inflation; not to react to price stocks that do not affect trend inflation; symmetrical reaction to inflation deviations	To take account of the impact of price stability on economic activities and employment in the short and medium run	Preference to allow the exchange rate to move freely	
Mexico	To prevent future inflationary pressures; to neutralise second-round effects and partially prevent the first-round effect of exogenous price stocks		To maintain orderly conditions in the exchange and money markets	
Hungary	To attain the price goal; reduce short-term volatility of the interest rate; respond to long-term inflation deviations	To meet the inflation target at a minimum cost in terms of output volatility	To influence the exchange rate in support of the inflation target	
Poland	To achieve the pre-determined inflation target		Right to intervene for monetary policy reasons	

Sources: Central Bank of Chile (2000), Reserve Bank of India (2002), National Bank of Hungary (2003), Bangko Sentral ng Pilipinas (2002), National Bank of Poland (1998), Bank of Korea (2003); Martinez et al (2001).

Table 2

Inflation rates in emerging economies[1]

	1980s		1990-94		1995-99		2000-02	
	yearly average	**standard deviation**	**yearly average**	**standard deviation**	**yearly average**	**standard deviation**	**yearly average**	**standard deviation**
India	8.1	4.9	10.5	2.4	6.2	2.2	4.3	1.7
Korea	8.1	9.1	7.0	1.9	4.4	2.4	3.0	0.9
Philippines	14.4	13.9	11.6	4.7	7.6	1.8	4.5	1.5
Taiwan	4.4	7.0	3.8	0.6	1.9	1.4	0.4	0.8
Thailand	5.7	5.9	4.8	1.1	5.1	2.9	1.2	0.6
Brazil	229.1	418.9	1397.7	988.7	17.3	26.5	7.4	0.9
Chile	21.2	7.4	17.4	6.2	6.0	1.9	3.3	0.8
Mexico	65.1	38.7	16.1	8.3	24.2	9.5	6.4	1.4
Peru	193.6	1041.2	315.1	3287.6	8.3	3.3	2.0	1.8
Czech Republic	...	...	13.9	21.9	7.8	3.3	3.5	1.5
Hungary	13.7	4.2	25.4	6.1	18.7	7.3	8.0	2.5
Poland	...	...	45.8	244.3	16.2	8.0	5.8	4.1
South Africa	14.6	2.1	12.4	2.9	7.3	1.4	7.0	2.5
Memo:								
United States	*5.5*	*3.6*	*3.6*	*1.2*	*2.4*	*0.5*	*2.6*	*0.9*
Japan	*2.5*	*2.3*	*2.0*	*1.1*	*0.4*	*0.8*	*–0.8*	*0.1*
Germany	*2.9*	*2.2*	*3.8*	*1.1*	*1.3*	*0.5*	*1.6*	*0.3*

[1] Consumer price inflation (for India, wholesale price).

Table 3

Correlation with interest rates[1]

	π	y	Δxr
India	0.38	0.77	–0.17
Korea	0.72	0.04	–0.44
Philippines	0.41	0.26	–0.33
Taiwan	0.55	0.19	–0.11
Thailand	0.86	0.06	–0.21
Brazil	0.61	0.25	–0.08
Chile	0.61	0.12	0.26
Mexico	0.75	–0.28	–0.06
Peru	0.64	0.06	–0.18
Czech Republic	0.84	0.27	–0.03
Hungary	0.96	–0.37	–0.33
Poland	0.88	0.33	–0.21
South Africa	0.10	–0.11	–0.06

Note: π = annual percentage change in consumer prices (for India, wholesale prices); y = output gap; Δxr = quarterly change in the real effective exchange rate (an increase means an appreciation).

[1] Correlation calculated from quarterly data over the period 1995-2002.

Table 4

Standard deviation of variables[1]

	i	π	*y*	Δxr
India	1.9	2.6	4.0	2.4
Korea	5.8	1.9	3.1	7.9
Philippines	3.5	2.7	1.3	5.7
Taiwan	1.9	1.8	1.4	2.9
Thailand	6.8	2.9	4.1	6.3
Brazil	13.0	47.4	1.4	10.0
Chile	6.3	3.2	2.0	4.4
Mexico	8.9	12.3	2.8	9.6
Peru	5.3	4.1	1.8	3.5
Czech Republic	4.2	4.5	2.2	3.1
Hungary	7.7	7.4	1.0	3.0
Poland	6.8	10.9	1.4	5.2
South Africa	1.8	2.5	0.9	7.1

[1] Calculated from quarterly data over the period 1995-2002.

Table 5

Taylor reaction function (baseline model)

	const	π_t	y_t	Δxr_t	Δxr_{t-1}	i_{t-1}	R^2	BG-LM
India	1.11 (1.66)	0.13 (3.10)	0.13[1] (2.70)	–0.09 (–3.44)	–0.09 (–2.00)	0.70 (7.25)	0.88	0.02
Korea	1.15 (1.31)	0.66 (1.54)	0.29 (1.78)	–0.21 (–5.04)	–0.08 (–1.70)	0.57 (3.80)	0.76	1.13
Philippines	4.35 (4.17)	0.51 (3.77)	0.35 (0.78)	–0.15 (–2.25)	0.06 (1.01)	0.28 (2.74)	0.71	0.35
Taiwan	0.49 (1.31)	0.23 (1.85)	0.13 (2.04)	–0.04 (–0.78)	0.01 (0.40)	0.83 (9.10)	0.96	0.30
Thailand	1.19 (1.85)	0.56 (1.86)	0.37 (2.61)	–0.11 (–3.28)	–0.20 (–2.41)	0.58 (3.48)	0.86	0.30
Brazil	4.12 (1.08)	0.08 (3.35)	0.98 (0.93)	–0.33 (–2.20)	0.23 (1.28)	0.72 (5.11)	0.81	2.20
Chile	0.32 (0.25)	0.97 (4.87)	0.32 (1.25)	0.35 (2.78)	–0.35[2] (–2.40)	0.32[2] (4.03)	0.75	0.98
Mexico	1.79 (1.28)	0.55 (4.71)	0.74 (2.09)	–0.63 (–2.93)	–0.16 (–2.03)	0.50 (3.93)	0.86	1.15
Peru	2.57 (1.44)	0.19 (2.37)	0.15 (1.09)	–0.15 (–2.05)	–0.23 (–4.11)	0.86 (12.98)	0.92	0.46
Czech Republic	0.56 (1.36)	0.33 (2.69)	0.20 (2.37)	–0.06 (–1.11)	0.04 (0.49)	0.66 (5.98)	0.96	0.28
Hungary	0.96 (1.03)	0.20 (1.76)	0.35[3] (1.11)	–0.19 (–2.02)	0.04 (0.53)	0.75 (5.69)	0.97	2.11
Poland	2.13 (1.94)	0.17 (3.31)	0.66 (4.89)	–0.07 (–1.16)	0.02 (0.31)	0.75 (8.38)	0.96	0.29
South Africa	–0.59 (–0.42)	0.08 (1.09)	0.04[3] (0.21)	–0.06 (–2.86)	–0.06 (–2.46)	0.98 (11.50)	0.74	0.37

Note: t-statistics in parentheses.

Notation: π = annual percentage change in consumer prices (for India, wholesale prices); y = output gap; Δxr = change in the real effective exchange rate (an increase means an appreciation); i = interest rate (dependant variable); BG-LM = Breusch-Godfrey Serial Correlation LM test (the F-statistics are given).

[1] Industrial production. [2] t-4. [3] t-1.

Table 6

Correlation between policy rates and interbank rates [1]

Brazil	Chile	Mexico	Peru	India	Korea	Philippines
1.00	1.00	0.60	0.86	0.27	0.99	0.79

Taiwan	Thailand	Czech Republic	Hungary	Poland	South Africa
0.92	0.88	0.72	0.99	1.00	0.74

[1] Monthly data; end of period; calculated for different time points over the period 1995-2002.

Sources: Bloomberg; Datastream.

Table 7

Taylor reaction function (gap model)

	const	πgap_t	y_t	$\Delta xrgap_t$	$\Delta xrgap_{t-1}$	i_{t-1}	R^2	BG-LM
India	1.39	0.16	0.16[1]	–0.09	–0.09	0.72	0.88	0.11
	(2.07)	(2.46)	(3.46)	(–3.13)	(–1.93)	(7.13)		
Korea	2.40	0.15	0.19	–0.26	–0.06	0.73	0.80	1.14
	(2.26)	(0.45)	(1.36)	(–5.70)	(–1.44)	(6.27)		
Philippines	6.60	0.53	0.94	–0.30	–0.09	0.43	0.43	0.87
	(3.75)	(2.05)	(2.05)	(–2.94)	(–1.06)	(2.98)		
Taiwan	0.11	0.15	0.11	–0.04	0.06	0.94	0.88	2.42
	(0.42)	(1.08)	(1.89)	(–1.21)	(1.60)	(17.37)		
Thailand	1.12	0.10	0.34	–0.09	–0.10	0.86	0.82	2.00
	(1.27)	(0.31)	(2.11)	(–1.98)	(–1.09)	(7.40)		
Brazil	4.77	0.08	1.04	–0.34	0.24	0.73	0.79	2.08
	(1.31)	(3.27)	(1.00)	(–2.02)	(1.20)	(5.68)		
Chile	3.72	0.93	0.14	0.42	–0.16[2]	0.43[2]	0.62	0.69
	(2.72)	(1.20)	(0.49)	(3.36)	(–0.67)	(3.61)		
Mexico	7.97	1.09	0.40	–0.60	–0.23	0.56	0.82	0.99
	(3.78)	(5.43)	(1.11)	(–4.67)	(–2.04)	(5.92)		
Peru	1.83	0.33	0.17	–0.15	–0.22	0.92	0.95	0.53
	(1.03)	(1.84)	(1.26)	(–1.79)	(–3.94)	(16.38)		
Czech Republic	0.86	0.12	0.32	–0.04	0.07	0.84	0.95	0.57
	(1.79)	(1.27)	(3.42)	(–0.73)	(0.65)	(13.76)		
Hungary	0.40	0.06	0.19	–0.21	0.06	0.93	0.97	2.59
	(0.35)	(0.41)	(0.47)	(–1.95)	(0.76)	(11.86)		
Poland	1.75	0.32	0.46	–0.06	–0.02	0.87	0.95	1.03
	(1.70)	(2.60)	(2.67)	(–1.35)	(–0.52)	(14.92)		
South Africa	1.04	0.31	0.28	–0.08	–0.08	0.93	0.81	0.37
	(0.89)	(3.42)	(1.40)	(–4.61)	(–3.96)	(11.20)		

Note: t-statistics in parentheses.

Notation: πgap = consumer price gap (for India, wholesale prices); *y* = output gap; *Δxrgap* = change in the real effective exchange rate gap (an increase means an appreciation); *i* = interest rate (dependent variable).

[1] Industrial production. [2] t-4.

Table 8

Over-identifying restriction test[1]

	India	Korea	Philippines	Taiwan	Thailand	South Africa
p-value	0.990*	0.892*	0.968*	0.936*	0.992*	0.987*

	Brazil	Chile	Mexico	Peru	Czech Republic	Hungary	Poland
p-value	0.981*	0.865*	0.966*	0.993*	0.943*	0.900*	0.970*

[1] Based on the GMM baseline model (for the Czech Republic and South Africa, the gap model).

* indicates that the null hypothesis of overidentifying restrictions using the J-statistics has been rejected.

Table 9

Reaction functions from GMM estimates

	const	π_t	y_t	Δxr_t	Δxr_{t-1}	i_{t-1}	R^2
India	0.85 (3.73)	0.04 (2.06)	0.05[1, 2] (8.01)	–0.05[2] (–4.02)	–0.06[3] (–4.95)	0.85 (22.39)	0.86
Korea	0.48 (6.14)	0.04 (1.23)	0.03 (3.76)	0.05 (2.69)	–0.10 (–5.15)	0.87 (78.25)	0.91
Philippines	2.23 (6.48)	0.37 (9.24)	0.03 (1.70)	–0.15 (–3.63)	–0.12 (–4.76)	0.53 (10.93)	0.38
Taiwan	0.33 (1.81)	0.10 (2.60)	0.03 (3.40)	–0.06 (–1.86)	–0.05 (–2.33)	0.89 (23.39)	0.92
Thailand	0.60 (10.76)	0.09 (3.67)	0.01 (0.63)	–0.19 (–6.70)	0.09 (4.74)	0.70 (52.41)	0.92
Brazil	1.36 (2.92)	0.16 (19.80)	0.17 (1.84)	–0.10 (–1.34)	–0.12 (–1.86)	0.85 (44.15)	0.91
Chile	2.20 (4.10)	1.15 (4.21)	0.48 (6.89)	0.21 (2.28)	–0.22 (–3.10)	0.75 (10.53)	0.63
Mexico	1.15 (2.90)	0.20 (2.48)	0.42 (4.31)	–0.23 (–2.62)	0.13 (2.42)	0.78 (11.15)	0.92
Peru	0.31 (1.49)	0.22 (6.98)	0.01[2] (1.53)	–0.32[4] (–7.00)	–0.11[5] (–5.48)	0.95 (9.68)	0.97
Czech Republic	0.21 (1.75)	0.11 (5.21)	0.03 (3.07)	–0.15 (–7.95)	0.10 (5.65)	0.92 (50.27)	0.98
Hungary	0.08 (0.92)	0.02 (2.09)	0.01[4] (1.66)	–0.12 (–3.43)	0.02 (1.45)	0.97 (75.11)	0.98
Poland	0.69 (1.96)	0.34 (7.99)	0.07 (3.26)	–0.04 (–1.12)	–0.04 (–2.89)	0.81 (19.35)	0.96
South Africa	0.86 (4.52)	0.04 (7.09)	0.07 (7.52)	–0.04 (–5.84)	0.03 (7.18)	0.88 (76.41)	0.88

Note: t-statistics in parentheses.

Notation: π = annual percentage change in consumer prices (for India, wholesale prices, for the Czech Republic and South Africa the gap model); y = industrial production gap; Δxr = change in the real effective exchange rate (an increase means an appreciation); i = interest rate (dependent variable).

List of instruments: lagged values of annual percentage change in consumer prices; industrial production gap; change in real effective exchange rate; annual percentage change in broad money; annual percentage change in exports.

[1] Industrial production. [2] t-1. [3] t-3. [4] t-2. [5] t-4.

Table 10

Tests for asymmetric response for sign of inflation deviation

	const	π_t	y_t	Δxr_t	Δxr_{t-1}	ir_{t-1}	dum1* π_t	dum2* y_t
India	0.92	0.12	0.14[1]	–0.09	–0.09	0.72	0.02	0.02
	(1.18)	(1.56)	(2.71)	(–2.60)	(–1.69)	(5.77)	(0.22)	(0.41)
Korea	2.73	0.46	0.08	–0.20	–0.13	0.40	–0.66	–0.65
	(2.13)	(1.31)	(0.24)	(–4.62)	(–2.99)	(3.13)	(–1.89)	(–1.13)
Philippines	4.05	0.57	–0.51	–0.13	0.03	0.19	0.07	–1.57
	(2.21)	(3.02)	(–0.98)	(–1.54)	(0.47)	(1.40)	(0.32)	(–1.43)
Taiwan	0.62	0.24	0.22	–0.04	0.02	0.82	–0.12	0.11
	(1.08)	(1.75)	(1.24)	(–0.73)	(0.47)	(8.05)	(–0.55)	(0.43)
Thailand	2.07	0.56	0.54	–0.10	–0.18	0.59	–0.71	0.35
	(2.48)	(2.03)	(1.86)	(–3.19)	(–2.15)	(3.58)	(–1.74)	(0.93)
Brazil	5.96	0.42	0.98	–0.37	0.21	0.49	–0.16	0.71
	(1.36)	(1.12)	(0.54)	(–2.18)	(1.44)	(3.52)	(–0.50)	(0.29)
Chile	1.71	0.61	0.96	0.35	–0.36[2]	0.36[2]	–0.25	1.00
	(0.92)	(1.18)	(1.94)	(2.68)	(–2.05)	(3.41)	(–0.75)	(1.30)
Mexico	1.99	0.77	1.43	–0.58	–0.17	0.43	0.12	1.15
	(0.95)	(4.34)	(2.45)	(–3.05)	(–2.53)	(3.30)	(0.84)	(1.38)
Peru	1.91	0.17	0.02	–0.14	–0.24	0.87	–0.08	–0.33
	(0.89)	(1.49)	(0.08)	(–1.87)	(–4.00)	(10.06)	(–0.34)	(–0.62)
Czech Republic	2.25	0.48	0.14	–0.09	–0.03	0.47	–0.32	0.07
	(1.97)	(3.25)	(0.42)	(–1.47)	(–0.06)	(2.65)	(–1.95)	(0.18)
Hungary	2.13	0.08	0.22[3]	–0.22	–0.04	0.74	–0.07	–0.24
	(1.82)	(0.58)	(0.44)	(–1.98)	(–0.07)	(4.50)	(–1.75)	(–0.33)
Poland	2.28	0.27	0.49	–0.08	0.01	0.63	0.18	0.23
	(2.23)	(5.76)	(1.93)	(–1.58)	(0.23)	(8.39)	(4.11)	(0.47)
South Africa	–0.10	0.05	0.10[3]	–0.07	–0.06	0.96	–0.03	–0.28
	(–0.06)	(0.71)	(0.27)	(–2.62)	(–2.11)	(10.60)	(–0.45)	(–0.59)

Note: t-statistics in parentheses.

Abbreviations: π = annual percentage change in consumer prices (for India, wholesale price); y = output gap; Δxr = change in the real effective exchange rate (an increase means an appreciation); ir = interest rate (dependent variable); dum1 = inflation dummy (= 1 when the gap between the actual and the trend inflation rate is negative). dum2 = output gap dummy (= 1 when output gap is negative).

[1] Industrial production. [2] t-4. [3] t-1.

Table 11

Tests of dependence of response to the size of inflation and output shocks

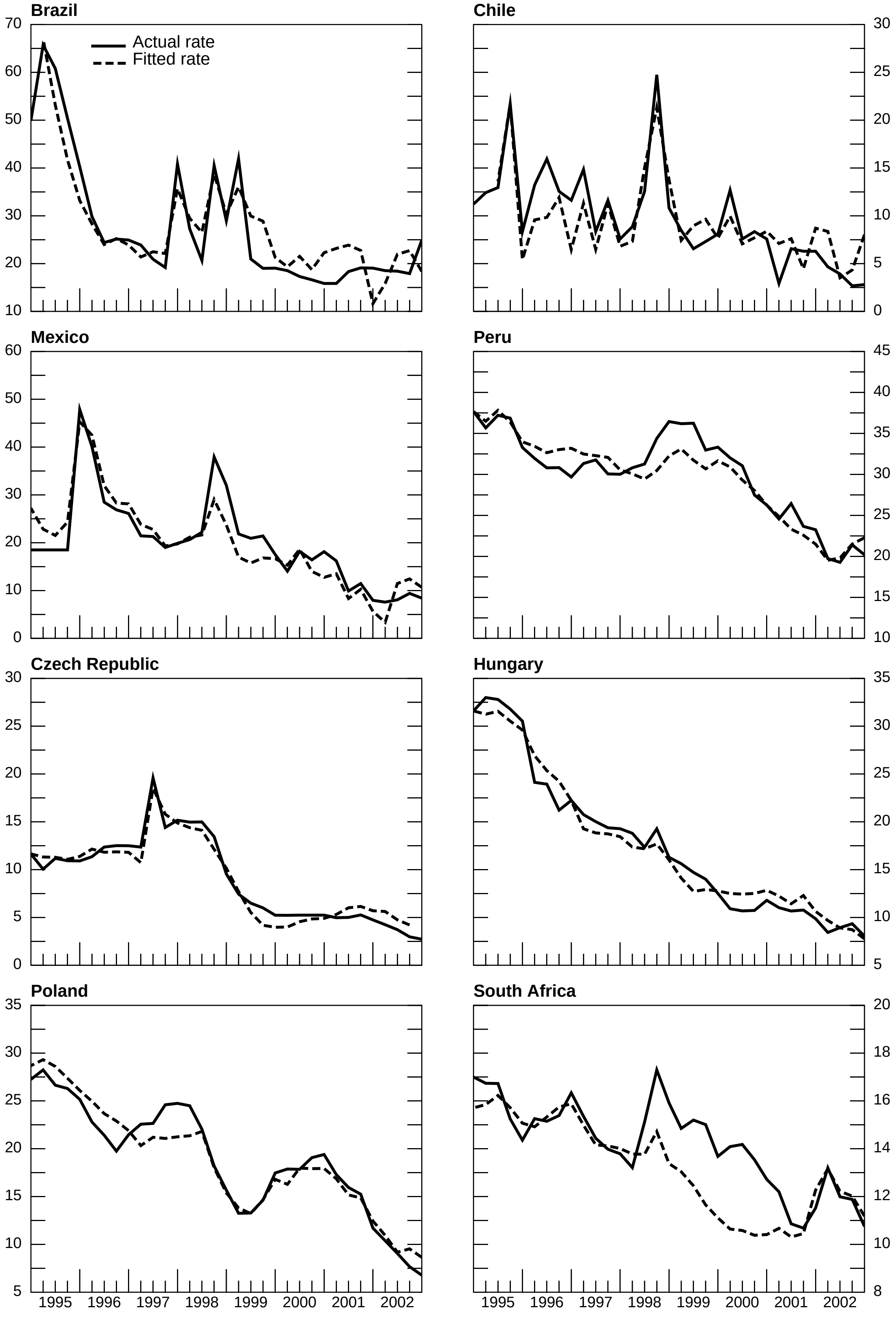
	const	π_t	y_t	Δxr_t	Δxr_{t-1}	i_{t-1}	π^2_t	y^2_t	**Wald test (p value)**
India	1.67 (2.32)	–0.20 (–0.90)	0.10[1] (1.90)	–0.11 (–3.27)	–0.09 (–2.20)	0.76 (7.04)	0.02 (1.48)	–0.02 (–0.44)	0.107*
Korea	0.66 (0.55)	0.75 (1.62)	0.43 (2.25)	–0.20 (–3.93)	–0.12 (–2.00)	0.49 (3.08)	–0.01 (–0.09)	0.03 (0.43)	0.911*
Philippines	3.14 (1.60)	1.05 (1.22)	0.10 (0.38)	–0.13 (–1.79)	0.06 (1.25)	0.21 (1.87)	–0.04 (–0.68)	0.38 (2.17)	0.089*
Taiwan	0.53 (1.23)	–0.13 (–0.94)	0.22 (2.98)	–0.03 (–0.88)	0.03 (1.17)	0.87 (2.78)	0.07 (2.45)	–0.05 (–1.60)	0.636*
Thailand	1.04 (1.06)	0.52 (1.17)	0.39 (2.49)	–0.10 (–2.76)	–0.16 (–1.89)	0.68 (2.93)	–0.01 (–0.14)	–0.03 (–0.92)	0.004
Brazil	3.83 (1.21)	0.64 (3.03)	0.70 (0.74)	–0.39 (–2.19)	0.22 (1.42)	0.54 (4.17)	–0.00 (–2.66)	–0.27 (–0.61)	0.029
Chile	–0.58 (–0.30)	1.42 (2.08)	0.38 (1.44)	0.34 (2.88)	–0.34[2] (–2.43)	0.33[2] (3.73)	–0.03 (–0.63)	–0.15 (–2.29)	0.062*
Mexico	2.84 (1.25)	0.68 (2.63)	0.94 (2.35)	–0.57 (–2.36)	–0.19 (–2.86)	0.38 (2.81)	0.00 (0.02)	–0.12 (–1.36)	0.293*
Peru	3.68 (1.94)	0.85 (3.34)	0.09 (0.75)	–0.17 (–2.24)	–0.21 (–3.90)	0.78 (10.30)	–0.05 (–2.64)	–0.03 (–0.45)	0.025
Czech Republic	1.02 (1.48)	0.15 (0.65)	0.25 (2.38)	–0.09 (–1.22)	0.04 (0.65)	0.67 (7.39)	0.01 (0.82)	–0.01 (–0.53)	0.010
Hungary	1.54 (1.34)	0.21 (1.72)	0.18[3] (0.59)	–0.19 (–1.82)	–0.01 (–0.18)	0.70 (5.27)	0.00 (0.05)	0.04 (0.14)	0.988*
Poland	1.75 (1.76)	0.39 (2.87)	0.54 (3.65)	–0.08 (–1.35)	–0.01 (–0.11)	0.69 (7.51)	–0.00 (–1.75)	0.04 (0.51)	0.109*
South Africa	1.51 (1.04)	0.42 (2.69)	–0.04[3] (–0.14)	–0.07 (–4.74)	–0.06 (–2.87)	0.91 (10.38)	–0.01 (–1.11)	0.06 (0.27)	0.518*

Notes: (1) t-statistics in parentheses; (2) * indicates that the Wald test failed to reject the null hypothesis of parameter of squared inflation = parameter of squared output gap = 0.

Notation: see Table 5.

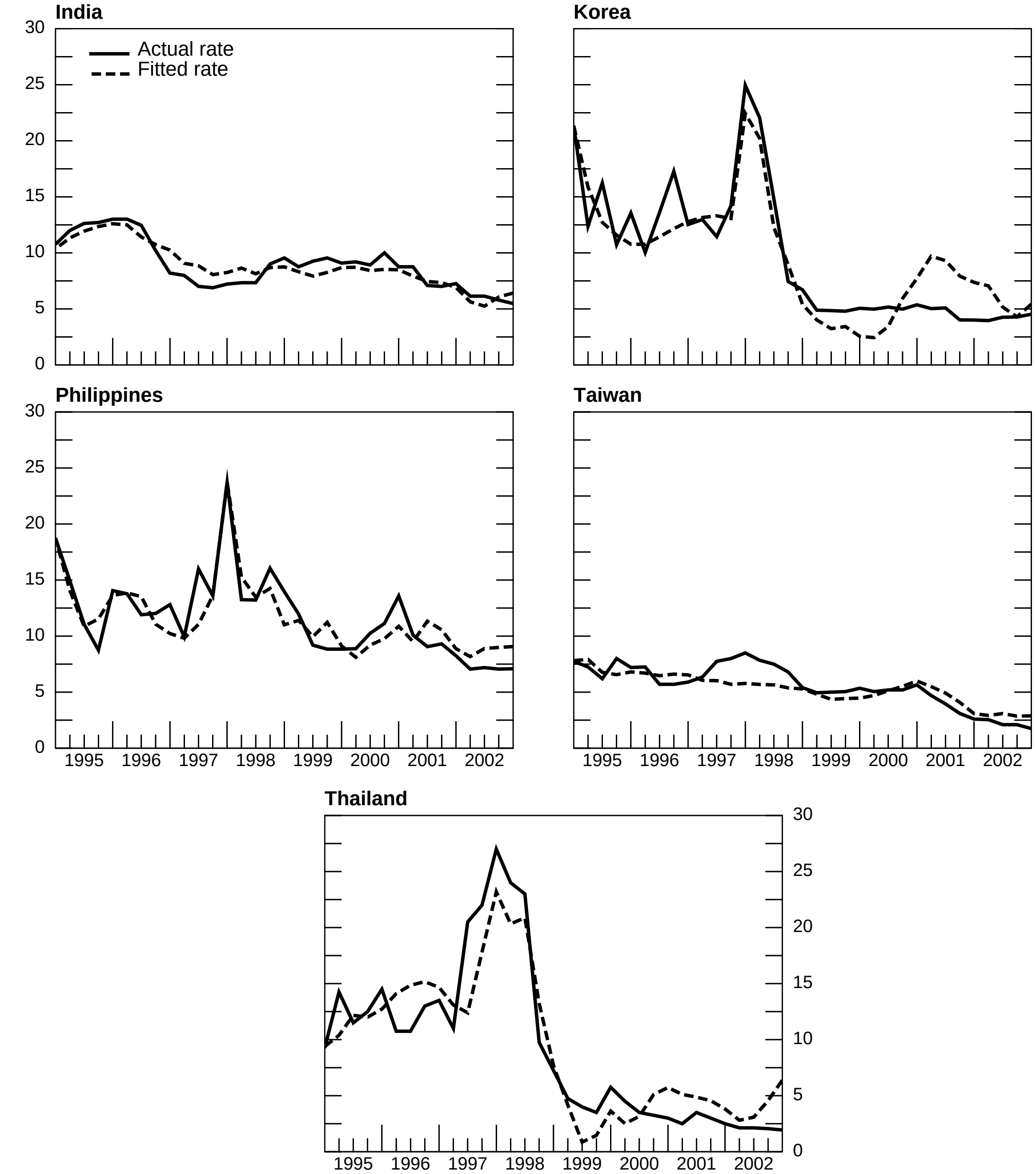
[1] Industrial production. [2] t-4. [3] t-1.

Graph A1 **Actual versus calculated rates (from the simple reaction function specification)**[1]



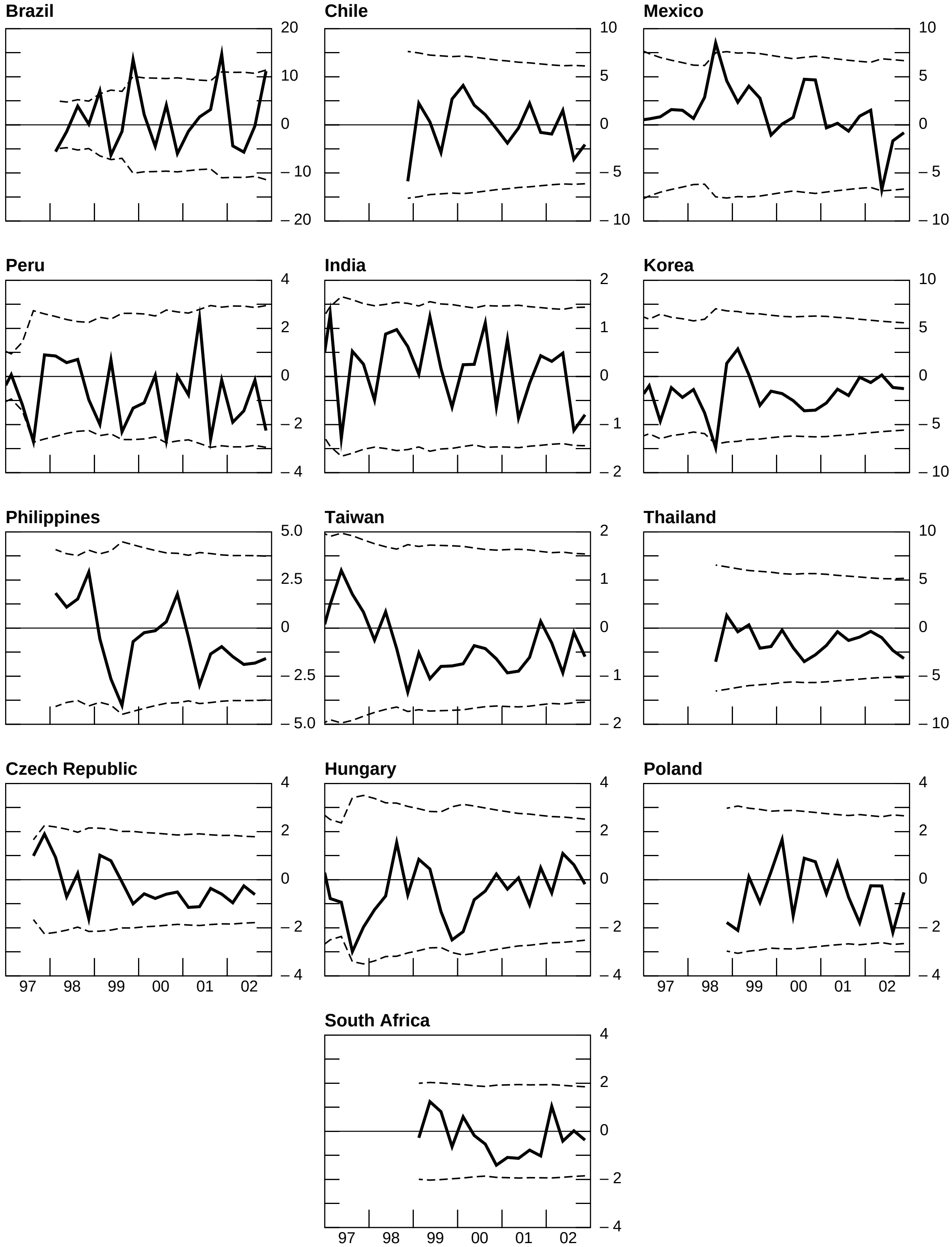
[1] The calculated rates are based on the Taylor rule estimates using the inflation rate.

Graph A1 (cont) **Actual versus calculated rates (from the simple reaction function specification)**[1]



[1] The calculated rates are based on the Taylor rule estimates using the inflation rate.

Graph A2 **Recursive residuals for selected countries**[1]



[1] Based on the specification of Table 5.

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