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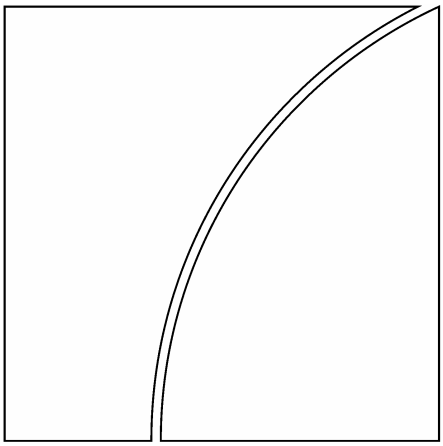

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Research on exchange rates and monetary policy: an overview?

by Jeffery Amato, Andrew Filardo, Gabriele Galati, Goetz von Peter and Feng Zhu

Monetary and Economic Department

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Abstract

This paper reviews research carried out on exchange rates and monetary policy by central banks that participated at the Autumn Meeting of Central Bank Economists on "Exchange rates and monetary policy", which the BIS hosted on 28–29 October 2004. The first part of the paper focuses on the approaches that central banks have found most useful in modelling exchange rate behaviour. We describe efforts to explain exchange rate behaviour ex post and to forecast its future evolution ex ante. We then summarise central banks' recent research on the linkage between exchange rates and inflation, output, profits and the current account. We highlight the main models and methodologies, the main empirical results and the key challenges ahead. The second part of the paper is devoted to research that examines the actual experience that countries have had in incorporating the exchange rate into their monetary policy decisions, and the main lessons learned.

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Introduction[1]

In recent years, our understanding of exchange rates and their impact on variables of policy concern has again been put under test for several reasons. While exchange rates have traditionally proven very difficult to model and, especially, to forecast, this task has recently been complicated by structural changes in financial markets. There is evidence that the relationship between exchange rates, inflation and real activity has changed; in particular, the apparent smaller pass-through of exchange rate changes into prices has attracted much attention. In addition, currency crises and changes in exchange rate regimes in emerging markets have brought to the fore the implications of foreign exchange balance-sheet mismatches for the link between the exchange rate and real economic activity.

In terms of the implications of exchange rates for monetary policy, a number of questions are particularly relevant. What is the appropriate response of monetary policy to exchange rate changes? Should monetary policy respond only to the extent that exchange rate changes affect forecasts of inflation and output? What is the appropriate policy horizon to consider the influence of the exchange rate? If a response is deemed appropriate, what form should the policy response take? And for countries with relatively strong exchange rate commitments, what is the room for manoeuvre to pursue a monetary policy consistent with internal balance?

This paper reviews analytical work carried out on these issues by central banks that participated at the Autumn Meeting of Central Bank Economists on "Exchange rates and monetary policy", which the BIS hosted on 28–29 October 2004. The first part of the paper focuses on the approaches that central banks have found most useful in modelling exchange rate behaviour in the short, medium and long run. In this context, we describe efforts to explain exchange rate behaviour ex post and to forecast its future evolution ex ante. We then summarise central banks' recent research efforts on the linkage between exchange rates and inflation, output, profits and the current account. We highlight the main models and methodologies used in the analyses, the main empirical results and the key challenges ahead. The second part of the paper is devoted to research that examines the actual experience that countries have had in incorporating the exchange rate into their monetary policy decisions, and the main lessons learned.

1. Exchange rates, inflation and the real economy: what do we know?

(a) Determinants of exchange rates

Explaining and forecasting exchange rate behaviour is notoriously difficult. Not surprisingly, central banks have followed a number of different approaches to modelling exchange rate behaviour. Using a broad categorisation, these include models that focus on uncovered interest parity (UIP), long-term models of purchasing power parity (PPP), long-run exchange rate equilibrium concepts that rely on joint internal and external balance, models of short-run exchange rate behaviour, traditional macroeconomic models (eg portfolio balance models and the monetary approach), models that explain the role of commodity prices, general-equilibrium open-economy macroeconomic models and their recent stochastic variant.

A parity condition frequently used is UIP, which is based on the efficient markets hypothesis. As expectations of future variables incorporate all available information at the time the expectations are formed, in an efficient market no expected risk-adjusted arbitrage should be profitable. UIP pins down the expected change in exchange rates but not the level. Andrews et al (Bank of England (2004)) review the theoretical underpinnings of UIP and the empirical evidence. UIP requires that every per cent of interest rate differential be matched by one per cent of expected depreciation. However,

[1] The authors would like to thank Steve Arthur for editorial suggestions, as well as Janet Plancherel and Melanie Sykes for editorial assistance. The views expressed are our own and do not reflect those of the central banks that were represented at the Autumn Meeting of Central Bank Economists on "Exchange rates and monetary policy" or the Bank for International Settlements.

estimated coefficients are typically negative, and often below –3. Andrews et al discuss a large body of literature that has rejected UIP and explained this with the existence of risk premia, peso problems, changes in the long-run equilibrium exchange rate, and irrationality and learning. More recently, these explanations have been challenged, as models incorporating monetary policy reactions, different data sets, and new econometric specifications have been considered. The authors also review the common failure of formal exchange rate forecasting models, including those based on UIP, in outperforming a simple random walk in forecasting exchange rates at most forecast horizons.[2] They argue that in spite of these problems, there are practical advantages that make UIP preferable to a structural model for exchange rate projections. The implications for the way the exchange rate is projected in inflation forecasts at the Bank of England are discussed below.

A recent paper by Verdelhan (Bank of France (2004)) presents an interesting theoretical approach to improving the explanatory power of UIP. He develops a two-country model characterised by fully rational agents with slow-moving external habit preferences as in Campbell and Cochrane (1999). The model is capable of reproducing both sign and magnitude of typical UIP regression coefficients, reconciling the empirical findings and the validity of UIP with a time-varying risk premium.

Bernhardsen and Holmsen (Central Bank of Norway (2005)) discuss whether inflation forecasts should be based on technical exchange rate assumptions like a constant exchange rate (random walk) and uncovered interest rate parity (UIP) or on assumptions reflecting the central bank's best prediction of future exchange rate movements. Because of the strong link between the interest rate and the exchange rate, the exchange rate does not principally differ from other variables that are endogenous in inflation projections. For countries with a reasonable low half life of real exchange rate, deviations from purchasing power parity (PPP) could provide a basis for predicting future exchange rate movements. For Norway, since the beginning of 1999, prediction paths based on deviation from PPP track actual exchange rate movements better than paths implied by random walk and UIP.

UIP is also an ingredient of structural macro-econometric models used by several central banks. At the Central Bank of Brazil, for example, the exchange rate is incorporated into a small structural model that includes an IS equation, a Phillips curve, a Taylor rule and a UIP condition modified to reflect the country's risk premium on external debt (Alves et al, Central Bank of Brazil (2002)). In line with the model, empirical tests show that a monetary tightening results in an appreciation, while a rise in the risk premium results in a depreciation of the real.

A number of central bank research papers follow the literature on models of exchange rate determination in the long-run that build on PPP conditions.[3] Arbitrage in goods markets should lead to the law of one price for each good, which aggregates to PPP for identical baskets of traded goods. Although flatly rejected in earlier research, arguably due to the low power of the tests employed (Edison et al (1997)), recent research is more favourable to PPP tested on long time spans or panels of industrialised countries.[4] The literature has also highlighted that the relevance of PPP is limited to traded goods.[5] Research conducted at the Central Bank of Norway, for example, finds evidence that PPP holds for Norwegian data (Akram (2002)).

One useful application of the PPP framework is the analysis of international competitiveness. In an unpublished paper, Hofmann et al (Deutsche Bundesbank (2004)) review research conducted at their central bank on indicators of international price competitiveness of the German economy. One interesting finding is that, in contrast to widely held beliefs, Germany's price competitiveness was relatively favourable in 1999, partly as a result of the improvement of intra-EMU competitiveness since the mid-1990s.

In recent years a growing body of literature has presented empirical evidence on long-run exchange rate equilibrium concepts.[6] One variant, the behavioural equilibrium exchange rate (BEER) approach,

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2 Meese and Rogoff (1983), and Cheung et al (2002) document this point.

3 Useful surveys are provided by MacDonald and Marsh (1999) and Sarno and Taylor (2003).

4 See, for example, Abauf and Jorion (1990), Froot and Rogoff (1995), Lothian and Taylor (2000), Sarno and Taylor (2002). For a contrary view, see Engel (2000).

5 See, for example, MacDonald and Ricci (2003).

6 Many important contributions were presented at a "Workshop on equilibrium values of the euro" organised by the Deutsche Bundesbank in 2000. For an overview, see European Central Bank (2002) and MacDonald (2000).

focuses on a number of plausible determinants, such as productivity, real interest rate differentials, government expenditure and net foreign assets. Another variant, the fundamental equilibrium exchange rate (FEER) approach developed by Williamson (1983, 1994) and Wren-Lewis (1992), combines low unemployment and low inflation with a sustainable desired net flow of resources.

Equilibrium exchange models appear particularly useful for gauging exchange rate levels in accession countries. Égert and Reininger (Oesterreichische National Bank (OeNB), the Austrian central bank (2004)) survey the literature[7] and argue that the steady appreciation of the real exchange rate of most new EU member states of Central and Eastern Europe can be led back to several factors. To start with, the exchange rate of these countries might have been undervalued at the beginning of the transition process. Hence, the observed appreciation might only reflect adjustment towards equilibrium. However, perhaps more important is the equilibrium appreciation of the currencies. The authors stress that this equilibrium appreciation can be only partly, if at all, explained by the well-known Balassa-Samuelson effect: The reason for this is that the steady appreciation of the real exchange rate of the open sector, driven by dramatic changes in the quality of the goods (and services) produced in the NMS, and, to a lesser extent, by increases of regulated and administered prices, also greatly contributed to the equilibrium appreciation of the real exchange rate. For assessing the appropriate level of the exchange rate, the authors emphasize the need of a systematic assessment involving not only different theoretical approaches (BEER, FEER, NATREX) but also alternative econometric techniques applied to both time series and panels of different size.[8] Szpunar (National Bank of Poland (2004)) presents FEER and BEER estimates for the zloty, along with estimates of PPP and UIP and finds that, at end-2003 levels, the zloty remains undervalued.

At the other extreme, central bank research has also focused on exchange rate behaviour in the very short run. This type of analysis typically looks at the role of "news", which are identified either statistically (as residuals in regressions that relate exchange rates to fundamentals) or survey data on expectations about various macroeconomic announcements. One example is a paper by Jansen and de Haan (Netherlands Bank (2003)) that investigates the reaction of the level and the volatility of the euro/dollar rate to statements of European Central Bank officials during the first years of European Monetary Union (see below).

In a related area, Deutsche Bundesbank (2001) uses option prices to extract the implied risk-neutral density of the expected exchange rate, an approach central banks increasingly use to gauge market expectations of future exchange rates.[9] In an unpublished paper, Hofmann et al (Deutsche Bundesbank (2004)) report that the central bank uses this method for event analyses, eg to gauge the impact of the 11 September terrorist attacks, or to study the effectiveness of concerted intervention in support of the euro in September 2000.

Central banks also use a variety of traditional macroeconomic models. In a recent Netherlands Bank working paper, Vlaar (2002) estimates a portfolio balance model that incorporates an output gap equation, a Phillips curve, a Taylor rule and an equation for the balance of payments. Portfolio balance relates desired to actual net foreign assets, allowing for persistent deviations from UIP; foreign direct investment (FDI) is assumed to increase in trend growth. The idea is that greater profit opportunities of US firms make them attractive to foreign firms' investment. Assuming eventual current account balance, the model is calibrated to the US economy and impulse responses are generated. The real exchange rate response differs according to whether growth reflects a cyclical shock (small depreciation) or higher structural trend growth: a 1% growth shock causes an 18% appreciation after 2½ years. This appreciation is due to additional FDI, consistent with a deteriorating current account. Groen (forthcoming) presents evidence based on a panel of vector error correction models that the monetary exchange rate model holds in the long run for the exchange rates of the Canadian and US dollar and the yen with respect to the Deutsche Mark.

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[7] This survey is partly based on Égert, Halpern and MacDonald (2004).

[8] Given the wide variety of approaches to equilibrium exchange rates, Égert and Halpern (2005) propose a "meta-analysis" to systematically assess how estimates vary along the dimensions of theory, data and econometrics.

[9] For an overview of methods and interpretations, see BIS (1999). A number of recent contributions were presented at the workshop on "The measures and determinants of financial market uncertainty", held at the European Central Bank on 27–28 May 2002.

A special case is that of exchange rates that are thought of as being driven to a large extent by commodity prices, such as the Australian and the New Zealand dollars. Chen and Rogoff (2003) indeed find that commodity prices have a strong and stable influence on these real exchange rates. The close co-movement of the terms of trade and the real exchange rate has been particularly pronounced in the case of Australia. This relationship has formed the basis of econometric models of the Australian exchange rate since the float of the currency in 1983 (Beechey et al (2000)). Accordingly, the Reserve Bank of Australia's small macro-econometric model incorporates an equation that relates the real exchange rate to the interest differential and the terms of trade.

Munro and Spencer (Reserve Bank of New Zealand (2004)) also report that commodity prices affect the trade-weighted exchange rate of the New Zealand dollar. A 10% rise in commodity export prices is estimated to lead to an appreciation of the New Zealand dollar in the short run of 3–5% (Munro (2004)), of 0.7% in the medium term (Huang (2004)) and of 0.6–1.8% in the long term (Wren-Lewis (2004)). Ongoing research at the Reserve Bank of New Zealand suggests that combining UIP with commodity prices generally outperforms a random walk model of the exchange rate.

Since the mid-1990s, research on exchange rate determination has increasingly used micro-founded general-equilibrium open-economy macroeconomic models of the type developed by Obstfeld and Rogoff (1996).[10] These models integrate money and price rigidities with real fundamentals in the spirit of real business cycles, allowing the evaluation of nominal, real and policy shocks within a common framework. At present, however, empirical tests of these models are not very supportive.[11]

One application of this approach is found in Cavelaars (Netherlands Bank (2004)). He uses Obstfeld and Rogoff's dynamic version of a Ricardian model developed by Dornbusch et al (1977) to analyse how the response of the real exchange rate to shocks is affected by accession to the European Union. He extends the model by allowing for asymmetries in country size and the initial level of productivity between regions. In addition, he allows for changes in trade costs. Simulations of the model suggest that EU accession can help reduce the variability of the real exchange rate between the currencies of the new member states and the euro, thereby reducing the variability of inflation in the new member states.

Very recent research uses open-economy Dynamic Stochastic General Equilibrium (DSGE) models, which are derived from first principles. These models allow tracking exchange rate effects and at the same time examining the interactions between different economic sectors, monetary and fiscal policies, and key economic indicators. At the National Bank of Belgium, work in progress by de Walque and Wouters (2004) uses a DSGE model with sticky prices and wages that incorporates US and euro area macroeconomic variables, oil prices and the euro/dollar rate. The model is estimated with Bayesian techniques. They find that a positive productivity level shock causes a real depreciation, as part of the increased supply must be absorbed abroad.[12] De Walque and Wouters also find that both tighter monetary policy and domestic demand shocks cause an appreciation of the domestic currency.[13] Variance decomposition indicates that the bulk of real exchange variability in the short run is explained by non fundamental shocks (so-called UIP shocks) but that fundamentals explain a growing part of exchange rate fluctuations at longer horizons.

In recent years, a new approach to modelling exchange rates which draws particularly from the market microstructure literature has increasingly attracted attention.[14] The approach focuses on information asymmetries and how dispersed information – about macroeconomic variables such as money demand, risk preferences, future inflation – is aggregated. Dispersed information also includes information about the actions of other market participants, ie about different trading responses to

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[10] For a survey, see Sarno and Taylor (2001).

[11] A reasonable in-sample fit and some predictive value for output and the price level are overshadowed by the failure to beat a random walk in predicting movements in the exchange rate and the current account (Bergin (2003)).

[12] In the United States in the late 1990s and early 2000s, a shock to expected productivity *growth* was arguably a key factor behind the appreciation of the dollar.

[13] The nominal exchange rate depends, through UIP, on the interest rate differential, which is determined by inflation and output gaps in the Taylor rules of the respective areas, and on a risk premium, which depends on the net foreign asset position.

[14] Lyons (2001a) provides a comprehensive overview of microstructure models. See also Sarno and Taylor (2001).

commonly observed data. In a series of papers, Richard Lyons and his co-authors have presented empirical evidence suggesting that models that follow this approach fit the data fairly well.[15] This conclusion is supported by several central bank research papers.[16]

(b) The effect of exchange rates on inflation, output and the current account

Methodologies

The empirical studies on the effects of changes in exchange rates on inflation and real activity can be broadly divided into four categories: single-equation econometric methods, vector autoregressive (VAR) models, structural macroeconometric models and DSGE models.[17]

First, most participants use single-equation econometric methods that estimate an exchange rate pass-through equation. The Bank of Israel, for example, estimates an open-economy version of a New Keynesian Phillips curve proposed by Svensson (2000), which relates inflation to expected inflation, the output gap, the exchange rate and import prices (Elkayam, Bank of Israel (2004)).[18] Longworth (2002) summarises research at the Bank of Canada that typically used a Phillips curve to examine the impact of exchange rate movements on consumer prices. While most studies estimate pass-through equations with aggregated data, some recent papers also look at sectoral data, following the recent literature that has highlighted heterogeneous responses to exchange rate shocks across sectors (Goldberg and Knetter (1997), Campa and Goldberg (2002)). At the Bank of Italy, Bugamelli and Tedeschi (2004) estimate panel regressions with sectoral data. Several papers also estimate pass-through for a panel of countries, eg that by Bailliu and Fuji (2004) at the Bank of Canada. This line of research has produced a number of papers on euro-area countries.[19] Some empirical studies have also focused on emerging market countries (Mohanty and Klau (2001)).

Secondly, a number of papers use variants of the VAR models. Hahn (European Central Bank (2003)) estimates a VAR model with quarterly data to analyse the effect of exogenous shocks along the pricing chain. Kapur (Reserve Bank of India (2004)) estimates the impact of exchange rate changes in India using a small VAR with short-run restrictions. Work conducted at the Central Bank of Brazil also uses VAR techniques to trace the dynamic effect of exchange rate changes, taking account of the role of administered prices (Minella et al, Central Bank of Brazil (2003)). Arnoštová and Hurník (2004) use a VAR model as a cross-check of their QPM and estimate the impact of exchange rates on output and prices in the Czech Republic. They follow Mojon and Peersman's (2001) VAR for small open economies with a flexible exchange rate, and use German GDP as an exogenous variable representing foreign demand. The Bank of Korea uses a vector error correction model to analyse the dynamic effects of an exchange rate shock on real GDP in Korea (Kim, Bank of Korea (2004)).

A third approach relies on structural models developed at the central bank. In most cases, these are large-scale simultaneous equations models. At the European Central Bank, the Area Wide Model (Dieppe and Henry (2004)) and the Link-5 Multi-country model are standard structural macroeconomic models. In the quarterly macro model used at the Bank of Spain (MTBE), for example, the pass-through is embedded in the equations for import and export deflators, private consumption deflator and private productive investment deflator (Buisán and L'Hotellerie-Fallois, Bank of Spain (2004)).[20] The Bank of Italy also relies on its quarterly econometric model (QMBI) to estimate the effect of changes in the euro's effective exchange rate (Rinaldi, Bank of Italy (2004)). Holub (2004) discusses the use of a small-scale macroeconometric model, the quarterly prediction model, at the Czech National Bank (QPM, see Beneš et al (2003)). This model forms the main tool in the Czech National

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[15] Lyons (2001b), Evans and Lyons (2001, 2002a, 2002b).

[16] See, for example, Bjønnes et al (2004) and D'Souza (2001).

[17] There is also a rich and growing literature on estimating the impact of currency crises on output behaviour. For an overview, see Tovar (2004a).

[18] See Bank of Israel (1999) and Bufman and Leiderman (2001).

[19] See, for example, Netherlands Bank (2004). For an overview of pass-through in the euro area, see, for example, Campa and Gonzales (2002).

[20] See Estrada et al (2004).

Bank's analysis and forecasting. The QPM embodies New Keynesian features, partly forward-looking agents, and a stylised central bank reaction function. Some central banks, for example the Netherlands Bank, rely on small, micro-founded structural models as the basis for empirical analysis.

Fourthly, several central bank studies investigate exchange rate effects using open-economy DSGE models (see above);[21] examples include de Walque and Wouters (National Bank of Belgium (2004)).

Exchange rates and inflation

Several main common results emerge from research papers on the pass-though of exchange rate changes to prices.

First, there is evidence that the pass-through has been small and declining over the 1990s. Otani et al (Bank of Japan (2003)), for example, document how short-term pass-through in Japan declined by one third in the 1990s, while long-term pass-through is now less than half its level in the 1980s. The decline in pass-through has been associated with greater credibility of monetary policy, and the low and stable inflation environment and lower inflation expectations (eg Heath et al (2004)). As in papers by Rinaldi (Bank of Italy (2004) and Netherlands Bank (2004), financial innovations and hedging against short-term exchange rate risks may also have reduced exchange rate pass-through. The underlying idea is that improved hedging possibilities allow importers and exporters to ignore shocks that may turn out to be only temporary. Buisán and L'Hotellerie−Fallois (Bank of Spain (2004)) note that growing integration of the Spanish economy in the European Union has also played a role. A similar conclusion is reached by Netherlands Bank (2004). In emerging market countries, the trend towards the adoption of more flexible exchange rate regime is also found to be important. As the exchange rate becomes more volatile, importers tend to view a change more often as temporary and therefore tend to change prices less frequently.

Secondly, there are apparent sectoral differences in the magnitude of the pass-through coefficients (Rinaldi, Bank of Italy (2004)). The market structure, and in particular the degree of competitiveness, of different sectors seems to be important to determine the ability of importers to pass through exchange rate movements to retail prices.[22] The pass-through should be larger when the domestic market is relatively easier to access by exporters; this is the case when the entry costs are smaller – as in competitive industries – and the domestic producers are less productive – as in non-industrial countries. Differences in exchange rate pass-through across exporting countries turn out to be robust and independent of (markets and products) composition effects. This is particularly clear in the case of Italy, whose exporting firms tend to raise export prices in the face of a depreciation of their own currency by about 30 percentage points – of the exchange rate variation – more than the other main euro area countries. These differences are a reflection of the existence of a "boundary" effect, for which the location of producers matters. Thus institutional and structural factors in the exporting country should also be considered as determinants of exchange rate pass-through.

Thirdly, changes to the institutional and economic environment also play an important role. As emphasised by work at the Bank of Spain, the creation and expansion of the European Union and the common market has led to more competition and lowered pass-through. However, the Bank of Spain does not find any significant evidence on the possible existence of structural change in the pass-through around the starting of the European Monetary Union[23]. The change in the economic environment is particularly relevant for the accession countries in the European Union. As highlighted by research at the Reserve Bank of India, free trade, lower trade barriers, globalisation and "Walmartisation", driven by fast growth in Asian manufacturing capability, enhances global competition and reduces producers' pricing power, therefore lowering pass-through to inflation.

Fourthly, it is important to understand the transmission mechanisms of exchange rate changes, and in particular the role of the trade and investment channels. Empirical work conducted by the Central Bank of Chile, for instance, distinguishes the direct import price effect, the relative price effect

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[21] For an application of DSGE models to studying output behaviour following a devaluation of the domestic currency, see Tovar (2004b).

[22] It should be noted that the paper does not provide evidence on retail prices.

[23] See Campa and Mínguez (2005).

(expenditure-switching), the intermediate effect (cost of input) and the balance sheet effect (currency mismatch) of exchange rate movements on consumer prices (Caputo and Tokman (2004)).

Exchange rates and output, profits and the current account

A number of studies have investigated the impact of exchange rates movements on the real economy. Buisán and L´Hotellerie-Fallois (2004) and other papers by Bank of Spain staff provide evidence of a declining impact (eg Buisán and Caballero (2003), Buisán et al (2004)). Some papers provide evidence indicating that a depreciating currency did not always bring about an expansion of output. Kim (Bank of Korea (2004)) finds that the effect of changes in the won's exchange rate on output seems to have increased since the mid-1980s, a result that seems to reflect in part the effect of the currency crisis.

Motivated by the growing external imbalance of the United States, several papers have looked at the relationship between exchange rates and the current account. Garcia and Moëc (Banque de France (2004)) perform an econometric analysis using NIGEM, a standard multi-country macroeconomic model, and find that a depreciation of the US dollar against other major currencies alone will do little to correct the US external imbalances. Furthermore, they find that it is the monetary policy reaction to the exchange rate shock, and not the exchange rate shock itself, which may have a (small) impact on the current account. Rather, a combination of (possibly sharp) dollar depreciation, fiscal discipline and monetary tightening in the US is more likely to bring about a correction A similar conclusion is reached by the Bank of Italy's staff using simulations with their quarterly econometric model (QMBI).

Gagnon et al (Federal Reserve Board (2004)) suggest that a substantial change in the value of the dollar is likely to play a key role in a future adjustment of the US external balance. Monetary policy can play an important role in these adjustments. To maintain full employment and price stability, monetary policy would be expected to tighten in economies where a rise in external demand might boost output above potential, and, conversely, to ease in economies where a decline in external demand threatened to leave output below potential. They also argue that a reduction of the trade imbalances will require substantial changes in resource allocation across sectors for tradable and non-tradable goods, as well as shifts in sectoral demands. Bartolini (Federal Reserve Bank of New York (2004)) highlights the role of exchange rate policies followed in Asia. He uses simulations of a stochastic general equilibrium model of the global economy (the IMF's Global Economic Model) to assess the quantitative impact of Asian central banks' effort to stabilise exchange rates on the prospects for a current account reversal in the United States. The main effect of the current monetary stance in Asia is found to be a shift of the main burden of adjustment from exchange rates to aggregate demand in the United States and its main partners.

Debelle and Galati (BIS (2005)) argues that along with changes in output growth, exchange rate changes have historically played a key role in the adjustment of external imbalances in industrial countries. They show that in terms of the process of adjustment, the 1987 reversal of the US current account deficit shared some features with the episodes in other industrial countries, but also highlighted some important differences. Given these, and some additional idiosyncratic features of the present conjuncture, they conclude that it is difficult to use historical patterns of reversals to make inferences about the sustainability of, and possible future reduction in, the US current account deficit.

Open issues

One interesting finding is that most methods deliver broadly similar results, indicating that in general and for a variety of reasons, the degree of exchange rate pass-trough and the impact of exchange rate changes on the real economy has diminished in the last 10–15 years. This result seems to be robust to different underlying models and econometric techniques employed. At the same time, several methodological issues have not yet been fully addressed. Buisán and L'Hotellerie-Fallois (Bank of Spain (2004)), Elkayam (Bank of Israel (2004)) and Nessen (Sveriges Riksbank (2004)) make a clear distinction between short- and long-run pass-through effects, and argue that while the long-run pass-through is almost complete, the extent of short-term pass-through is limited and incomplete. To the extent that the definition of "long run" matters for the empirical results, it is important to improve our ability to distinguish short- and long-run. In one case (Israel), short-term pass-through has actually increased, raising the question of what specific factors there may explain this exception.

Secondly, an issue that has received little attention is the potential asymmetry in exchange rate pass-through effects between appreciations and depreciations. Work at the Bank of Italy points out that the

pass-through appears to be complete following an appreciation but incomplete after depreciation. This issue is likely to receive more attention from both a theoretical and an empirical point of view.

Thirdly, exchange rate movements have effects on inflation but may in turn also be affected by inflation and real variables. Hence, empirical work often relies on the same set of data and variables to test two directions of causality. In the analysis of the degree of exchange rate pass-through to inflation, price inflation is used as the dependent variable and the exchange rate as an explanatory variable. By contrast, in models of exchange rate determination, movements in exchange rate are explained in terms of inflation and other variables. There is an identification issue here, and endogeneity may potentially bias estimates. The issue of reverse causality needs to be handled carefully.[24]

Fourthly, while most papers focus on the average level of exchange rates, exchange rate volatility may have an impact on inflation and inflation volatility. West (2003) analyses this. This issue is sometimes discussed but not fully incorporated in the models, as it is difficult to do this in linear or near-linear models.

2. Exchange rates and monetary policy: how to respond?

In the discussion of the role for monetary policy, it is important to distinguish whether the exchange rate matters to the extent that it is relevant for domestic inflation, or monetary authorities care about the exchange rate for reasons other than inflation. In either case, while always taking it into account in policy decisions, the monetary authorities may or may not decide to influence it depending on the perceived ability to do so systematically.

a) What role in monetary policy?

For most industrial economies the exchange rate does not enter into the decisions of policymakers above and beyond the impact on expected inflation. In emerging market countries, by contrast, the exchange rate can in addition play an important role not only in countries with currency boards or explicit exchange rate objectives but also in those that target inflation. One special case is that of EU accession countries, which are currently facing the prospects of greater constraints on monetary policy from exchange rate developments due to the ERM II criteria.

What determines the weight of the exchange rate in the monetary policy framework? There are several key factors: the impact of exchange rate movements on domestic inflation, the source of shocks, credibility, the volatility of capital flows, and financial and structural reforms.

A primary factor that is common to all frameworks is the impact of exchange rate movements on domestic inflation. Countries that experience high pass-through typically tend to put greater emphasis on the exchange rate in their monetary policy framework. The relevance of pass-through is evident from Munro and Spencer's (Reserve Bank of New Zealand (2004)) overview of changes since the 1980s in that central bank's policy. In New Zealand, the exchange rate played a particularly important role during the disinflation phase in 1988–93, when direct pass-through effects from the exchange rate to inflation were the strongest and best identified channel of monetary policy. Subsequently, a weakening exchange rate pass-through in an environment of low and stable inflation led to a shift of emphasis towards interest rate channels and the influence of the output gap. In the current medium-term orientation of monetary policy, the exchange rate remains an important, though less significant, transmission channel for monetary policy.

Minella et al (Central Bank of Brazil (2003)) highlight the importance of pass-through for the monetary policy framework during a crisis.[25] In the turbulent years of 2001 and 2002, when Brazil was hit by

[24] Nessen (2004) argues that reduced-form measures of pass-through will be contaminated by movements in exchange rates and import prices that are endogenous responses to shocks to other variables than the exchange rate.

[25] See also Minella et al (2002).

domestic and external shocks with considerable impact on the exchange rate, the central bank aimed at minimising the potential inflationary effects of the exchange rate depreciation and increases in administered prices. The main goal of monetary policy was to limit the propagation of the shocks to other prices of the economy.

Caputo and Tokman (Central Bank of Chile (2004)) stress the need of accurately measuring changes in pass-through in emerging market economies. They argue that one reason why Chilean monetary policymakers have responded to exchange rate developments above and beyond what they imply for expected inflation is that they may have misperceived the extent and speed of the decline in pass-through.

A second key factor, which is partly related to the role of pass-through, is the nature of shocks that hit the exchange rate. Munro and Spencer (Reserve Bank of New Zealand (2004)) highlights the relevance of the nature of shocks to the exchange rate in their discussion of the changes in monetary policy framework in 1999. One reason for which the reserve bank abandoned the MCI, followed in the 1990s, is that it was found to be inflexible in the face of external shocks, notably the Asian crisis.

A third key factor is the level of credibility enjoyed by the central bank, and, conversely, the potential impact of any actions on credibility. Some have argued that there is greater room for monetary policy to pay attention to the exchange rate over and above its impact on inflation when its anti-inflation credentials are beyond doubt. For instance, Munro and Spencer (Reserve Bank of New Zealand (2004)) argue that an interest rate target perceived to be inconsistent with the inflation target would be likely to have one of two effects, neither of which allows much room for an independent response to exchange rate movements: either the markets would expect policy to come into line with the inflation objective in the near term, in which case the exchange rate will not change much; or inflation expectations could become unstable, leading to larger swings in exchange rates and other variables.

A fourth key factor is the vulnerability to volatile capital flows. In small open economies, in particular in emerging markets, capital inflows can fuel the expansion of domestic credit. In turn, a tightening of monetary policy might encourage those inflows further. This makes these economies vulnerable to a sudden withdrawal of foreign capital.

Kapur (Reserve Bank of India (2004)) notes how India's recent experience highlighted the increased role of capital flows in determining exchange rates, resulting in higher exchange rate volatility. He argues that in emerging markets, capital flows are often more volatile and driven by sentiment rather than fundamentals. Such volatility imposes substantial risks on market agents, which they may not be able to sustain or manage (Reserve Bank of India (2003)). Against this background, India's exchange rate policy has focused on managing volatility with no fixed rate target while allowing the underlying demand and supply conditions to determine exchange rate movements.[26]

Khor et al (Monetary Authority of Singapore (2004)) emphasise that the choice of the exchange rate as the intermediate target of monetary policy in Singapore is predicated on the small size and high degree of openness of the domestic economy to trade and capital flows. The paper then outlines the key ingredients of the monetary authority's exchange rate policy, which has the primary objective of promoting price stability as a sound basis for sustainable economic growth. First, the Singapore dollar is managed against a basket of currencies of its major trading partners and competitors. The various currencies are assigned different degrees of importance, or weights, depending on the extent of Singapore's trade dependence on that particular country. Secondly, the monetary authority operates a managed float regime, where the trade-weighted exchange rate is allowed to fluctuate within a band, the level and slope of which are announced semi-annually. The band provides a mechanism to accommodate short-term fluctuations in the foreign exchange markets and flexibility in managing the exchange rate. Thirdly, the band is periodically reviewed to ensure that it remains consistent with the underlying fundamentals of the economy. As a result, the monetary authority cedes control over domestic interest rates, which in a context of free movement of capital are determined to a large extent by foreign interest rates and investor exchange rate expectations.

Recent econometric research work at the Monetary Authority of Singapore shows that its exchange rate policy framework may have helped to alleviate the negative spillover effects of heightened volatility in international financial markets (Saktiandi et al (2003). Khor et al (Monetary Authority of

[26] For an overview of the transition in India's policy, see Pattnaik et al (2003) and Reserve Bank of India (2004).

Singapore (2004)) argue that the success of the Singapore exchange rate regime reflects the strong institutional setup, which includes credible price stability, fiscal discipline, strong prudential system based on openness and transparency and well-developed capital markets. As they note, "increasingly, the key issue facing policymakers lies not in the particular choice of the exchange rate system per se, but in the institutions and policies underpinning it".

A sixth, related factor, which is highlighted in Xie (People's Bank of China (2004)), is the role of financial and structural reforms. He argues that prior to the lifting of most capital account restrictions and the opening of the trade and financial services sectors, a stable exchange rate allowed Chinese authorities to pursue four different macroeconomic objectives: economic growth, price stability, employment expansion and balance of payments equilibrium. Between 1994 and 2003, inflation declined from 24% to 1.2% and GDP growth averaged 8% per year. The average current account balance was around 2% of GDP, while employment figures increased markedly.

However, when structural reforms were implemented in recent years, the stability of the renminbi exchange rate appeared increasingly inconsistent with these macroeconomic objectives. The current account balance increased sharply, and monetary pressures escalated as the People's Bank of China stepped up foreign exchange intervention to stabilise the renminbi's exchange rate.

Looking ahead, Xie (2004) discusses four ways to improve the balance between the exchange rate and macroeconomic goals. First, improving the exchange rate formation mechanism by enhancing the market determination of the renminbi is critical. Secondly, financial reforms are needed to strengthen the competitiveness of Chinese financial institutions and their "risk tolerance". Thirdly, monetary, fiscal and investment policies need to be fully coordinated. Finally, it is important to sequence appropriately the reform of the exchange rate mechanism, of the state-owned commercial banking system and capital account convertibility.

Challenges in the transition from one regime to another

What are the challenges in the transition from one regime to another? While inflation targeting has been very successful in many countries in helping to achieve low and stable inflation, many central banks faced difficulties related to the exchange rate in the early days of a disinflationary programme. In countries starting from a hard peg or a relatively high inflation rate, combining a managed peg of the exchange rate with the gradual introduction of an inflation-targeting regime can prove to be an effective option. For example, both the Bank of Israel and the Central Bank of Chile found that a managed peg was helpful in achieving their disinflation objectives during the 1990s. Similarly, Poland maintained crawling bands for the exchange rate when direct inflation targeting was introduced in 1998. Szpunar (National Bank of Poland (2004)) argues that de facto flotation of the currency began in mid-1998, although the bands were officially maintained until 2000, which may have helped to condition expectations. In general, it seems that, as inflation gradually converges to its long-run steady-state level, tensions tend to arise between achieving domestic policy goals and maintaining a system of pegs; decisions on interest rates can increasingly come into conflict with the exchange rate targets.

The literature has highlighted that financial liberalisation in emerging economies has often been accompanied by increased volatility of macroeconomic variables, with the exchange rate regime prevailing at the onset of the liberalisation being an important factor (Rinaldi, Bank of Italy (2004)). Research at the Bank of Italy highlights that liberalisation in emerging economies can lead to higher variability of consumption and output and provoke asset bubbles. Pisani (2004) uses a DSGE model to investigate the link between the degree of financial openness and macroeconomic instability in an emerging economy subject to an international borrowing constraint. He concludes that the flexibility of the exchange rate can reduce macroeconomic and financial volatility.

A number of research papers have highlighted the particular challenges for policy makers involved in the transition towards monetary union. There is general consensus that the ERM II criteria have important implications on the way the monetary authorities will have to respond to exchange rate developments. However, Égert and Reininger ((OeNB) (2004)) argue that both before and within ERM II the economic challenge for new EU member countries exchange rate policy consists in allowing for adjustability of the exchange rate in line with the fundamentals, while at the same time preventing the currency from depreciating or appreciating out of line with the fundamentals to a significant extent. To tackle this challenge, they suggest the active use of interest rate policy as well as exchange rate management (coupled with sterilization operations). As there may emerge trade-offs between the use of interest rate policy for domestic stabilization and its use as a tool for targeting the exchange rate,

active exchange rate management by both off-market and on-market interventions as well as the application of other domestic policy instruments (like fiscal or wage policy) that could partly substitute for the role of the interest rate in counteracting domestically generated inflation are considered of particular importance.

This point is reinforced by Szpunar (National Bank of Poland (2004)) in the case of Poland. The ERM II process puts practical constraints on the ability of the central bank to let the zloty float freely. In terms of nominal anchors, the Polish fundamentals indicate that tensions may arise. The Balassa-Samuelson effect also is a potential source of tension if the inflation rate criteria of ERM II translate into an appreciating currency. To satisfy the ERM II criteria, Poland may need to lower its inflation rate. It has two choices – raise interest rates or appreciate the currency. An appreciation of the currency might lead markets to overreact, and it may be hard to control the appreciation process precisely. Thus, it may lead to overvaluation of the currency. Raising interest rates, however, would likely take longer to affect the economy than an appreciation. In addition, interest rates are likely to face downward pressure during the convergence process. Hence a mixed strategy might be the optimal choice.

Research conducted at the Netherlands Bank discusses possible exchange rate regimes in the new (at the time, future) EU member states in the run-up to the adoption of the euro (Netherlands Bank (2003)). It concludes that it may be desirable for some new member states to wait some time before participating in the ERM-II exchange rate mechanism.

b) The exchange rate and policy implementation

Forecasting and horizons

The role of the exchange rate in the operational framework of monetary policy has received much attention. One key issue is what assumptions on exchange rate determination are useful for forecasting inflation. For example, since 1999 the Bank of England has used an average of constant exchange rate and UIP in its central projection (Andrews et al, Bank of England (2004)).

Another important issue is what horizon policymakers should look at. This is relevant in two respects. First, in those cases in which monetary authorities wish to influence the exchange rate, the horizon over which this is possible is critical. Secondly, if the central bank does not try to influence the exchange rate, it is important to understand over which horizon an exogenous exchange rate process has an impact. In the debate on asset prices, financial imbalances and monetary policy, a number of contributions highlighted the importance of articulating monetary policy decisions over longer horizons.[27]

If the exchange rate is fairly volatile and there is a rapid and economically important degree of pass-through from import prices to consumer prices, then strictly targeting an inflation forecast might result in more volatility in interest rates than would normally be considered desirable. In this case, one policy option is to target non-traded inflation, which may be particularly relevant when traded goods prices are largely determined internationally in competitive markets, while non-traded goods may be produced in sectors that are less competitive and more sensitive to domestic excess demand pressure. However, targeting non-traded inflation might raise some transparency issues. An alternative option is to lengthen the forecast horizon to the medium term. Small, temporary deviations from a narrow target band are then not necessarily seen as being inconsistent with the inflation targeting regime. Hence, problems associated with reacting strictly to the temporary effects of exchange rate fluctuations on retail prices can be avoided. Bharucha and Kent (1998) compare aggregate inflation targeting with non-traded inflation targeting using a model of a small open economy producing traded and non-traded goods. The model is tested with Australian data over the period 1979–97. The authors conclude that, in order to avoid excessive volatility in product and financial markets, it may be preferable to target inflation over a medium-term horizon.

[27] See, for example, Bean (2003), Bäckström (2002), Borio and Lowe (2002), Borio and White (2004), Gjedrem (2003), and King (2002).

In emerging markets, monetary policy might have important short-run effects. Kapur (Reserve Bank of India (2004)) suggests that monetary policy in India can have its greatest impact on exchange rates at fairly short horizons. His paper provides evidence from a VAR showing that interest rate shocks have their maximal effect on exchange rates after just four months.

The impact of monetary policy on the exchange rate

In the case in which monetary policy is trying to influence exchange rate movements, what instrument should the central bank use? How predictable is the effect of changes in the policy interest rate on exchange rates? Are foreign exchange interventions effective? How does reserve accumulation impact on foreign exchange policies? Are capital controls a useful additional tool? These are amongst the questions taken up in this section.

In assessing how predictable the effect of policy rate changes is on exchange rates, it is of course first necessary to determine the link from monetary policy to exchange rates. To the extent that a random walk is about as good a model as any for predicting exchange rate movements at most times, monetary policy typically has no predictable effect on exchange rates. On the other hand, as discussed earlier, many central banks include some version of an UIP equation in their models, which suggests that policy interest rate changes are a driver of movements in exchange rates. Furthermore, most open-economy models in the academic literature contain a UIP equation, with perhaps a risk premium added, such as in the papers by Cuche et al (Swiss National Bank (2004)) and by de Walque and Wouters (National Bank of Belgium (2004)). Kapur (Reserve Bank of India (2004)) argues that a monetary tightening can generate a large appreciation of the exchange rate in the short run, and therefore can be a useful tool in stabilising foreign exchange markets.

Research conducted at the Reserve Bank of New Zealand, and elsewhere, suggests that reducing exchange rate volatility through policy instruments can be very costly in terms of higher variability in inflation, output and interest rates. This is based on simulations from small macro models and the Reserve Bank's large-scale model FPS.[28] The implication is that, at least in some countries, monetary policy has relatively weak control over exchange rates, and that large and disruptive policy changes are typically required to dampen exchange rate volatility. Munro and Spencer (Reserve Bank of New Zealand (2004)) conclude that the response of exchange rates to changing policy rates is a major source of monetary policy uncertainty. This conclusion is found also in work at the Polish and Indian central banks. Szpunar (National Bank of Poland (2004)) investigates how the effect of changes in the Polish interest rate on the zloty differs depending on the horizon. He finds that, in the short term, monetary policy has a weak control over the exchange rate. In the medium term, the influence of monetary policy on the exchange rate seems to be somewhat stronger. This is evident, for example, from one of the econometric models used at the National Bank of Poland, the ECMOD, which seems to beat the random walk approach in the medium term. The pattern of the reactions of the zloty to monetary policy impulses is, however, likely to change substantially with changes in the exchange rate regime, and in particular with the accession to the ERMII system. Kapur (Reserve Bank of India (2004)) uses VAR model estimates to characterise the predictability of exchange rates to interest rates. In general, the estimates are of the right size. He notes, however, that since past interest rate moves usually coincided with interventions and administrative measures, the estimates may be reflecting the joint impact. In sum, the estimates are of the right sign but subject to considerable uncertainty.

Interest rates and/or quantity targets need not be the only tools in the monetary policymaker's toolkit. In terms of trying to control exchange rates, foreign exchange intervention is a possible option, which can allow a policymaker to gain a degree of freedom. A recurrent question concerning intervention is how effective it truly is and how its impact is shaped by circumstances at the time. Caputo and Tokman (Central Bank of Chile (2004)) argue that central banks recognize the potential benefits of intervention to help avoid excessive fluctuations in exchange rates or to halt undesirable short-run trend movements away from fundamentals. For example, in two episodes in 2001 and 2002, the Central Bank of Chile intervened to dampen volatility. Munro and Spencer (Bank of New Zealand (2004)) argue that intervention is not necessarily the extra degree of freedom needed to solve the "impossible trinity". Nonetheless, intervention may help reduce exchange rate volatility in certain

[28] See, eg, West (2003).

circumstances; it is likely to be most effective when the exchange rate is clearly inconsistent with the fundamentals and when intervention does not pose a threat to achieving the inflation target.

The academic literature has identified four main channels through which interventions have the potential to affect exchange rates: the monetary channel, the portfolio channel, signalling effects and market microstructure effects.[29]

The monetary channel operates if the central bank decides not to offset completely the effect of intervention on the level of domestic bank reserves. In this case, intervention will influence the exchange rate through its effect on short-term interest rates. While standard economics textbooks discuss the monetary channel in the context of the dichotomy between sterilised and non-sterilised intervention, in practice the relevant distinction appears to be whether or not intervention is accompanied by a change in domestic policy interest rates (Borio (1997)).

Secondly, in the portfolio channel, changes in the relative supply of assets (eg foreign exchange) can affect the prices of assets (eg the exchange rate) if assets are imperfect substitutes. Evidence on the importance of the portfolio channel for industrial countries is ambiguous. Of course, the quantitative importance of any effects from portfolio re-balancing will depend upon the size of asset holdings. The portfolio channel is arguably more likely to be relevant in emerging market countries, where the intervention activity of central banks can play a major role in domestic foreign exchange markets. Presumably only large interventions are likely to have any effect through this channel, as argued in Caputo and Tokman (Central Bank of Chile (2004)).

Thirdly, in the signalling channel, interventions may contain information about the future stance of policy. Changes in agents' expectations could then have an impact on exchange rates. Of course, the effectiveness of this channel depends upon the public's perceived link of interventions to monetary policy. For the signalling channel to work over time, the central bank needs to back up any interventions with the expected change in policy interest rates. And, of course, interventions must be public knowledge for the signalling channel to be in play. Unfortunately, there is little solid evidence on whether signalling is effective in practice.

Fourthly, more recent studies have focused on the impact of intervention in microstructure models of foreign exchange markets.[30] In these models, intervention influences the exchange rates because of informational asymmetries (Evans and Lyons (2002a or b)). In particular, to the extent that intervention has a significant impact on order flows, the central bank can influence market expectations about the future path of the exchange rate. This will trigger an even greater change in aggregate order flow which, in turn, affects the exchange rate. This channel depends on the structure of the market and the composition of participants (Dominguez (1999)). For example, a higher number of noise traders increases the effect of intervention (Hung (1997)).

Recent empirical work at the Reserve Bank of Australia has attempted to assess the effectiveness of interventions in Australia. Becker and Sinclair (2004) find that interventions have been profitable. This result holds over the entire period since the Australian dollar began to float 20 years ago, and also in several specific episodes.

Capital controls are another set of tools that can be used to supplement standard monetary policy actions to help achieve macroeconomic stabilisation goods, especially during transition periods. For instance, Chile used capital controls along with a managed peg to help disinflate during the early 1990s.

Finally, communication plays an important role in all aspects of policy making. It is well known that there has been a general trend over the past 15 years for central banks to become more transparent about their policy frameworks and the ongoing conduct of monetary policy. However, for various reasons, it seems that central banks have been less communicative about the role of exchange rates in monetary policy. One of the difficulties policymakers face, of course, is that it has proven difficult to forecast exchange rates with much accuracy. Hence, there is much room for making errors in talking about exchange rates. Moreover, it is generally perceived that the markets are very sensitive to official statements on exchange rates. This is shown empirically, for example, in the work by Jansen and de

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[29] See Galati and Melick (2002) and, for emerging market countries Albenoja (2003) and Moreno (2005).

[30] See, for example, D'Souza (2001) and Scalia (2004).

Haan (2003) at the Netherlands Bank (see above). The paper finds that ECB statements have mainly influenced volatility, raising it temporarily, but had little impact on the level of the euro-dollar rate. There is also evidence of asymmetric reactions to news.

Even in regimes with relatively fixed exchange rates, central bank transparency can be important for helping to guide market expectations. For instance, this can help minimise exchange rate volatility within a crawling band regime. Indeed, one of the potential difficulties with "intermediate" exchange rate regimes, relative to the extremes, is a perceived lack of transparency about how policy is conducted. Khor et al (Monetary Authority of Singapore (2004)), for example, discuss how the monetary authority has taken several steps over the last five years in an effort to increase transparency. Beginning in April 1999, it began to release a quarterly economics bulletin, and now releases a monthly inflation report; in February 2001 it started to release a semi-annual monetary policy statement; details of its model of the Singapore economy appear on its web site; and it has published documents on its monetary policy operations, including key aspects of its foreign exchange operations.

Communication is also an important part of interventions. If central banks desire an intervention to serve a signalling role, then clear communication about the scope of the intervention would seem to be necessary. However, most central banks are not very transparent about their intervention activities. The Central Bank of Chile is one of the few exceptions. The aforementioned interventions in 2001–02 were announced before they occurred, and the central bank will continue to announce interventions in advance. In addition, some other central banks have begun to make public announcements on an ex post basis about their intervention activities and, in some cases, also on the size of interventions.[31] One example is the Bank of Canada, which has not intervened since 1998 and has recently described the mechanics for possible future intervention. When an intervention occurs, an announcement indicating the intervention will be made on its web site, while the amount of the intervention undertaken will be publicly available in the government's monthly official press release on international reserves (Bank of Canada (2003)).

[31] In the case of Japan, the Ministry of Finance posts information on the timing and magnitude of its intervention in foreign exchange markets on its website (http://www.mof.go.jp/english/e1c021.htm).

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