Box 3 What determines the exchange rate of currencies?

Exchange rate developments are crucial to the performance of industries and the economy as a whole, especially in small, open economies like Iceland. An understanding of exchange rate developments is obviously an important precondition for forecasting them. However, exchange rate models which are useful for forecasting have proved difficult to design. The strong appreciation of the US dollar against the euro, for example, was contrary to most forecasts. And models which could explain the strengthening of the dollar against the euro ex-post seem inadequate for explaining its developments against the yen at the same time.

The following is a brief outline of the main theories about exchange rate determination and how well they have been able to explain actual exchange rate developments. Since there is no scope here for a detailed analysis of the historical evolution of such theories, this outline is confined to the main concepts which are current today, some of which have a long history. Twentieth-century theorists tried to explain exchange rate developments by referring to developments of relative prices (PPP), price elasticity of imports and exports, the (Keynesian) relationship between expenditure and income in an open economy, relative allocation of domestic and foreign financial assets, proportional developments in money supply, domestic production, real interest rates, expected inflation, etc. Attempts were subsequently made to improve these simple models and explain why they failed to account for actual exchange rate developments. These include models in which price stickiness and expectations played a key role.1

None of the above theories has managed to provide a satisfactory explanation for exchange rate developments or predict them in different periods and regions. There is a growing tendency to regard the development of the exchange rate as a complex interaction of macroeconomic fundamentals and expectations about the course they will take. It is emphasised that the exchange rate is an asset price which, like other assets prices, is largely determined by expectations about the relative return on it and by other factors which are considered to affect this. Consequently, exchange rates are highly sensitive to new information (news) about fundamentals which could reveal information on their future path and thereby the future return on assets tied up in a specific currency.

The problem is to assess which fundamentals prevail at any given time and how markets will interpret new information about their future path. This is no easy matter, since expectations sometimes appear to change quickly without any clear link to corresponding fluctuations in the fundamentals themselves. Some theorists have proposed models based on rational expectations, which in effect preclude systemic deviations between fundamentals and investors' expectations about them. According to such models, two types of fundamentals are most important: those concerning domestic inflation expectations relative to abroad, and those determining the position of the real domestic economy relative to abroad. All things being equal, a poorer inflation outlook at home than abroad, e.g. as a result of a lax monetary stance, ought to lead to a depreciation of the domestic currency, since higher domestic inflation will erode its future purchasing power. Investors will therefore want to divest themselves of that currency to avoid later exchange rate losses, causing it to depreciate immediately. An event which gives market participants grounds for supposing that growth prospects have improved should, all things being equal, lead to a strengthening of the currency, given the likely relationship between economic growth and return on assets denominated in it. Expected return on domestic assets will therefore exceed that on foreign assets with a similar risk. Thus demand for the domestic currency increases and the exchange rate appreciates.

Expectation-based models do not show as obvious a link between domestic interest rates and the exchange rate as earlier exchange rate models. In ear-

A detailed discussion of these theories and many of the topics covered here can be found in M. Obstfeld and K. Rogoff (1996), *Foundations of International Economics*, MIT Press; and S. Lucio and M. P. Taylor (2001), *The Economics of Exchange Rates*, Cambridge University Press.

lier models, a rise in domestic interest rates always caused the currency to appreciate. This does not apply if a proper distinction is made between a nominal interest rates rise which reflects a rise in the expected higher real interest rate and those caused by higher inflation expectations. In the former case, the domestic exchange rate ought to appreciate, while the opposite can be expected in the latter case. In addition, the contemporaneous impact that interest rate changes have on the exchange rate ought to differ from the longer-term impact. In models assuming nominal price stickiness, an unforeseen rise in interest rates causes an initial appreciation of the domestic currency, then a depreciation corresponding to the interest rate differential. This is because market equilibrium requires the expected return on domestic and foreign investments to be equal, and for this to happen, the domestic currency needs to depreciate if domestic interest rates are higher than foreign ones.

Models of this kind have been tested extensively for different currencies, periods and currency regimes. They fitted the development of exchange rates over the period from the end of the Bretton-Woods system to the end of the 1970s fairly well, and also exchange rate developments in countries experiencing hyperinflation. Furthermore, they have been regarded as giving a fairly accurate description of the impact of major shifts in the monetary policy stance. However, they provide a poor description of exchange rate developments since the beginning of the 1980s. For example, the development of real exchange rates has not followed the development of real interest rates as could be expected, except perhaps in the long run. Most models have difficulties in explaining the increased volatility of real exchange rates of major currencies after they were floated. Since the volatility of fundamentals has not increased it seems that fluctuations in exchange rates are broadly speaking unrelated to fluctuations in fundamentals. Only a small part of exchange rate changes can apparently be explained by new information about fundamentals - news concerning the exchange rate itself appears to have more impact. Contrary to what may be deduced from these models, a tighter monetary stance does not seem to be reflected in a strengthening of the exchange rate until after some lag. This also appears to apply to Iceland (see the article by Thórarinn G. Pétursson in this edition of *Monetary Bulletin*).

If simple models of exchange rate developments are inadequate for in-sample description of exchange rate changes, they are even less effective for forecasting out-of-sample. In a famous paper, Meese and Rogoff found that such models do not forecast major exchange rates for up to a year any better than a random walk, which always assumes an unchanged exchange rate.² Many attempts have been made to overturn this refutation of theoretical exchange rate models, but have failed to provide alternatives which are better at forecasting for different periods and currencies. Longer-term forecasting has been more successful. Interesting new research suggests, for example, that theoretical models can provide indications about long-term exchange rate developments. However, the adjustment path to the long-run equilibrium may be non-linear, i.e. the exchange rate may more or less behave like a random walk when deviations from the long-run equilibrium, suggested by fundamentals, are small. Large deviations may, however, lead to a very swift adjustment to the long-term equilibrium.

The conclusion appears to be that theoretical exchange rate models are fairly inadequate for forecasting or explaining short-term exchange rate fluctuations and that there is a weak connection between exchange rate developments and those of economic fundamentals, at least in the shorter term.³ Explanations of short-term exchange rate fluctuations lie rather in psychological and institutional factors in foreign exchange markets. In the long run, however, economic factors apparently have a stronger impact. Theoretical exchange rate models may therefore be useful for long-term forecasting. In the case of a nonlinear adjustment to long-run equilibrium as described above, these type of models should be most useful when the exchange rate deviates substantially from the rate suggested by fundamentals.

R. A. Meese and K. Rogoff (1983), "Empirical exchange rate models of the Seventies: Do they fit out of sample?", *Journal of International Economics*, 14, 3-24.

This finding is not confined to exchange rates. The same problems arise with other asset prices, such as equity prices.

In the short-term, an exchange rate may be determined by self-fulfilling market expectations, which cause it to shift from its long-run equilibrium until the deviation is so great that it returns towards the equilibrium path. This effect is usually termed a bubble. Irrational as such herd behaviour may sometimes appear in the aggregate, such behaviour may be perfectly rational for each investor if they all expect that someone else is prepared to buy the currency at a rate which deviates substantially from the long-run equilibrium rate. Exactly what causes, sustains or bursts such bubbles, however, are difficult questions to answer. In recent years, attention has focused on the impact of the institutional framework of foreign exchange markets on investor behaviour and bubble formation. The assumptions underlying many rational expectations models has also been criticised. Uncertainties about the current situation, e.g. concerning monetary policy, may make investors fail to take advantage of arbitrage opportunities which in retrospect seem obvious. Rational investors may therefore respond to changes in monetary policy more slowly than if their impact were absolutely certain. Obviously investors also have different views and expectations; otherwise it would be difficult to explain the enormous amount of trading that takes place every day.

Research seems to suggest that investors may be broadly classified into two groups: long-term investors who primarily look at fundamentals, and speculators who base their decisions among other things on technical analysis. The latter group often appears to be characterised by herd behaviour which creates instability in currency price formation. A depreciation will prompt them to predict further depreciation, thereby amplifying the impact of the initial change instead of counteracting it by selling a currency when its exchange rate is high and buying when it is low, as long-term investors do. Speculators tend to make short-term investments. Indeed, the bulk of foreign exchange market trading involves opening and closing very short-term positions. The interaction between these two types of investor may render exchange rate determination virtually unforeseeable, and even chaotic. It has even been claimed that investors allow themselves to be swaved by fashion, since they try to identify fundamentals that justify current exchange rate trends. As the data suggest, one result may be that it is primarily news about the exchange rate itself, rather than fundamentals, which cause exchange rates to move. This process may continue until investor confidence is so patently in contradiction to the facts that they change their minds and find new fundamentals to confirm the opposite view.

Foreign exchange trading arrangements may also cause exchange rate fluctuations which swamp the impact of fundamentals in the short term. Systemic fluctuations related to trading volume, e.g. on the opening or closing of markets, may indicate this. Sharp swings in the exchange rates of currencies when domestic markets open on Mondays, even though trading in the same currency has already begun in markets in other time zones, could suggest that currency trade has little to do with the arrival of new information. Attention has also focused on spirals formed in foreign exchange markets when participants roll over their customers' currency orders without any of them being prepared to take an open position. Such transactions can continue, with market participants opening positions at the start of the day's trading and then trying to close them before the market closes, without any new information arriving about fundamentals that could justify these exchange rate changes.