

Drawing further on information in the *Survey on Foreign Exchange Market Organization*, this chapter examines factors affecting exchange rate volatility. In addition to indicators of macroeconomic performance and the choice of exchange rate regime, these include in particular various (micro) structural features of the foreign exchange market. The results presented in this chapter offer a number of new insights into the role that structural factors may play in the choice and implementation of exchange rate policy.¹

The determinants of exchange rate volatility are of interest because of its linkages to other economic variables. A common supposition is that volatile exchange rates depress international trade. The empirical evidence on this issue is mixed, but several more recent studies have found significant adverse effects on trade.² Some studies have also found a relationship between exchange rate volatility and real output growth. One major study found that exchange rate flexibility has tended to be associated with lower output volatility (see Ghosh and others, 1995). Reinhart and Rogoff (2002) note in addition that in countries with extremely high rates of depreciation, growth was negative on average. By contrast, countries with floating exchange rate regimes and low inflation have exhibited higher GDP growth than other country groups. Other studies, however, have found that investment and profitability have been adversely affected by exchange rate volatility, at

least in some developing countries (Bleaney and Greenaway, 2001).

The results obtained in the present study may help guide the design of technical assistance on foreign exchange issues by focusing attention on factors that may be more likely than others to affect exchange rate volatility. For example, a key finding is that decentralized dealer markets are associated with lower volatility. Another finding is that regulations on the use of domestic currency by nonresidents may reduce exchange rate volatility.

Earlier Work on the Determinants of Exchange Rate Volatility

There is no consensus in the economic literature on the factors affecting exchange rates and their volatility. This absence of agreement reflects basic difficulties in modeling and predicting exchange rates. Much of the existing work focuses on the levels of exchange rates (in statistical terms, the mean or first moment), but also has implications for exchange rate volatility (the standard deviation or second moment). In the literature, three principal views have emerged:

- The first view is that, at least over short time horizons and for countries without high inflation, exchange rate models that include macroeconomic fundamentals do not perform better than a random walk in

¹For a more detailed discussion of the issues raised in this chapter, see Canales-Kriljenko and Habermeier (forthcoming), which also provides a full treatment of the statistical issues.

²Much of the earlier literature, summarized for example in IMF (1984), focused on individual countries or small groups of mainly advanced countries. More recent studies, which have either included a wider range of both advanced and developing countries or have approached the issue with greater statistical sophistication, have tended to find adverse effects of exchange rate volatility on trade, mainly in developing countries but also in advanced countries. Examples of such studies include Sauer and Bohara (2001), Dell'Ariccia (1999), and Chowdhury (1993).

out-of-sample forecasting.³ Exchange rate volatility is simply the standard deviation of the error term.

- A second view is that macroeconomic fundamentals play an important role in explaining the behavior of exchange rates. Some authors hold that these fundamentals are important only in the long run but have little to offer in explaining short-run movements, while others believe that macroeconomic fundamentals have explanatory power both in the long run and the short run.⁴
- A third school of thought holds that neither macroeconomic fundamentals nor the random walk model adequately account for exchange rate behavior at short horizons. Rather, short-run exchange rate movements are attributed to market microstructure factors, including inventory management and information aggregation by foreign exchange dealers. Specifically, the microstructure approach suggests that non-dealers learn about fundamentals affecting the exchange rate, and this knowledge is reflected in the orders they place with dealers. Dealers in turn learn about fundamentals from order flow. The outcome of this two-stage learning process results in the formation of a price (see Lyons, 2001).

Design of the Study

The analysis of the factors affecting exchange rate volatility is based on a broad cross section of 85 developing and transition economies in 2001. Volatility in the cross section is related in the first instance to macroeconomic fundamentals—most notably inflation, real GDP growth, the fiscal deficit (in percent of GDP), and the openness of the economy (measured by the sum of exports and imports relative to GDP).^{5, 6} Controlling for the effect of these macroeconomic variables, a wide range of structural factors is then examined one by one. These factors include, among many others, the prevailing exchange rate regime; the status with respect to the acceptance of obligations of Article VIII, Sections 2, 3, and 4 of the IMF's Articles of Agreement; and features of the foreign exchange market structure and regulation drawn from the *Survey*, discussed in Chapter IV.⁷

This approach complements the microstructure approach to foreign exchange markets. It differs from much of the existing microstructure literature, which uses data on order flows as indicators of buying or selling pressures in the domestic foreign exchange market, but does not seek to identify the ultimate factors affecting order flows.⁸ This chapter, however, estimates directly the effect of macroeconomic and structural factors on exchange rate volatility. Future

³See Meese and Rogoff (1983). The authoritative survey of the literature on the random walk hypothesis in Frankel and Rose (1995) concludes that attempts to overturn the results of Meese and Rogoff have failed. Further support for the random walk hypothesis is provided in Rogoff (1999). Here Rogoff concludes that, at least for the major currencies and more generally for countries with low inflation, the random walk model has not been overturned by more recent empirical work. He also argues that the difficulties in relating financial variables to fundamentals is a more general problem and not one confined exclusively to exchange rates.

⁴McDonald (1999) notes that there is by now considerable empirical work favoring the view that models of the exchange rate that include fundamentals can outperform the random walk even at short time horizons.

⁵It has long been argued that the more closed economies require a larger change in the exchange rate to bring about a given adjustment in the balance of payments, relative to GDP.

⁶These variables were selected from a larger set of potential macroeconomic controls using a model selection algorithm. The variables identified by the algorithm are also ones that would normally suggest themselves on theoretical grounds.

⁷The structural characteristics are measured using dummy variables, which divide countries into two groups: those that possess a particular characteristic and those that do not.

⁸Order flow is transaction volume that is signed. The sign is positive if the initiator of the deal wants to buy and negative if he wants to sell.

research could examine how the macroeconomic and structural fundamentals influence the more technical factors, such as order flows and bid-ask spreads, emphasized in the microstructure literature.

Particular attention was given to the robustness of the results. To this end, the regressions reported below were reestimated using a large number of random subsamples of countries. This procedure, known as resampling, provides information on whether the results hold only for the particular sample of countries chosen, or whether they also hold for other samples of countries. The resampling strongly confirmed the validity of the main results. Moreover, the results were not substantially affected when exchange rate volatility was calculated at weekly and monthly horizons, in addition to the results using volatility estimated from daily data presented below.

The measure of volatility used is based on the nominal effective exchange rate (NEER), rather than on exchange rates with a single major currency used as an anchor, like the U.S. dollar. The objective is to capture the effect of cross-currency changes on the value of the domestic currency.⁹ Moreover, the NEER expresses the value of the domestic currency in terms of the currencies of the main trading partners. The use of NEER volatility is appropriate when the sample includes countries that peg to or closely follow different international currencies. A country pegging to the U.S. dollar but trading mainly

with countries in the euro area (for example, Egypt until mid-2000) would still be subject to significant nominal effective exchange rate volatility. NEER volatility is computed as the standard deviation in 2001 of the logarithm of the daily exchange rate (also known as the daily return).^{10, 11}

Principal Results of the Cross-Sectional Analysis

NEER volatility is related in the expected fashion to key domestic macroeconomic variables. While exchange rate volatility may also depend on external developments, the cross-sectional analysis reveals that a large fraction of the disparities between volatilities across countries can be explained by domestic developments (Table 5.1). Nominal variables play an especially important role, which is not surprising given that nominal exchange rate volatility is the variable to be explained.¹² NEER volatility is higher in countries with higher inflation and higher fiscal deficits, and lower in countries with faster real GDP growth and more open economies. These results were highly robust. As noted previously, these macroeconomic variables are included as controls in examining the effect on NEER volatility of various structural factors and thus allow for an estimation of the marginal effect of each structural factor on exchange rate volatility. Other macroeconomic variables—notably the current account deficit, private capital flows

⁹Very few studies have focused on the volatility of the nominal effective exchange rate, partly because of limitations in data availability. The IMF's Information Notice System database computes monthly values for the NEER, but the frequency of the resulting time series is too low to allow the use of econometric techniques for analyzing exchange rate volatility. Accordingly, daily values of the NEER for 85 countries were computed for this study. The indices are based on data from Datastream and Bloomberg on exchange rates to the U.S. dollar or the pound sterling and have been computed using the trade weights and methodology of the IMF's Information Notice System.

¹⁰That is, $\log(e_t) - \log(e_{t-1})$, where e stands for the nominal effective exchange rate.

¹¹Canales-Kriljenko and Habermeier (forthcoming) also consider alternative measures of volatility based on the steady-state variance of a GARCH model of the daily returns. The GARCH model seeks to capture persistence over time in the standard deviation of the daily returns (Bollerslev, 1986). Another issue examined in that paper is whether the underlying NEER processes are integrated which, if true, could result in significant distortions in simple measures of volatility in a time series or panel data context.

¹²Simple regressions (not presented) indicate that individual nominal variables explain up to 70 percent of the variance of NEER volatility. Money market interest rates showed a particularly strong correlation with NEER volatility, but data were only available for 21 countries.

Table 5.1. Exchange Rate Volatility and Main Characteristics of Foreign Exchange Markets in Developing and Transition Economies, 2001¹

	Full Sample ²		Robustness Analysis ³		
	Sign	Significance	Sign	Percent sign ⁴	Percent significant ⁵
Macroeconomic control variables ⁶					
Consumer Price Inflation	positive	***	positive	100	99
GDP growth	negative	***	negative	100	99
Fiscal deficit/GDP	positive	*	positive	92	78
External Trade/GDP	negative	**	negative	100	100
Exchange rate regimes					
Hard pegs	positive		positive	94	0
No separate legal tender	negative		negative	98	2
Currency board arrangements	positive		positive	95	11
Intermediate regimes	negative	**	negative	100	85
Other conventional fixed peg arrangements ⁷	negative		negative	65	0
Against a single currency	positive		positive	71	0
Against a composite	negative		negative	96	0
IMF-supported or other monetary program	positive		positive	96	0
Crawling pegs	negative		negative	100	0
Exchange rates within crawling bands	negative	***	negative	100	98
Floating regimes	positive	*	positive	100	32
Managed floating ⁸	positive		positive	53	0
Independently floating	positive	**	positive	100	85
IMF jurisdiction					
Article VIII status	negative	**	negative	100	88
With exchange restrictions and multiple currency practices	negative		negative	100	0
Article XIV status	positive	**	positive	100	88
With exchange restrictions and multiple currency practices	positive	**	positive	100	83
Article XIV restrictions	positive	*	positive	100	64
Article VIII restrictions	positive	**	positive	100	87
Without exchange restrictions and multiple currency practices	positive	**	positive	100	88
Foreign exchange market structure					
Dealer markets ⁹					
Decentralized ⁹	negative	**	negative	100	83
With electronic trading platforms	negative	*	negative	100	72
Auction markets	negative		negative	72	0
Periodic	positive		positive	98	0
Continuous	negative		negative	93	0
With Reuters brokered systems	negative		positive	52	0
Other selected factors					
Restrictions on monetary use of domestic currency by nonresidents					
Holding domestic notes and coins.	negative	*	negative	100	81
Denominating nonfinancial contracts in domestic currency	negative	**	negative	100	99
Net foreign exchange open position limits ¹⁰	negative	**	negative	100	84
Existence of a foreign exchange dealers' association	negative	**	negative	100	89
Emerging markets	negative	*	negative	100	72
Forward markets	negative		negative	99	9

Source: IMF staff estimates.

¹The cross-section regressions are estimated by ordinary least squares, controlling for macroeconomic variables. The dependent variable is NEER volatility measured as the standard deviation of the log of daily NEER returns in 2001. Most variables are dummy variables so that a significant positive variable would mean a higher mean volatility of the group after controlling for macroeconomic variables. Significance at the 1, 5, and 10 percent level are expressed as three, two, and one asterisks, respectively.

²A total of 85 countries were included in the regression.

³To test the robustness of the results, a bootstrap analysis was conducted by which 100 regressions were run on randomly selected subsamples representing 90 percent of the number of observations in the full sample.

⁴Percent of regressions with the corresponding sign.

⁵Percent of regressions in which the variable was statistically significant at the 10 percent significance level.

⁶The control variables were chosen by a model selection algorithm among a list of 20 candidate variables. Among the variables that were not significant were the current account deficit, net private sector capital flows, and different measures of reserve adequacy.

⁷Including de facto peg arrangements under managed floating.

⁸With no preannounced path for the exchange rate.

⁹Excludes countries where banks cannot hold net open positions or conduct foreign exchange operations on their own behalf.

¹⁰Includes net open position limits expressed in percent of capital or as a fixed nominal amount.

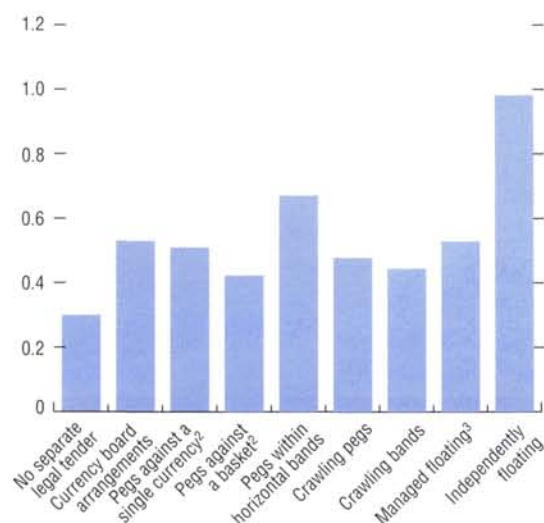
relative to GDP, and the volatility of the terms of trade—were not found to be significantly correlated with NEER volatility.

Surprisingly, measures of the adequacy of foreign exchange reserves were not strongly correlated with NEER volatility. Reserves were not found to be statistically significant, whether measured relative to the money base, short-term debt owed to the countries reporting to BIS, imports of goods, or GDP; however, the coefficients had the correct sign, with higher reserves negatively correlated with NEER volatility, except when reserves were measured relative to short-term debt. Countries satisfying the “currency board criteria,” with international reserves exceeding the money base at the prevailing exchange rate, did not have a statistically significant lower level of NEER volatility.

The exchange rate regime may also have an effect on NEER volatility. Several authors have argued that flexible exchange rate regimes have higher nominal and real exchange rate volatility than fixed regimes.¹³ A visual inspection of the average NEER volatility across regimes suggests that volatility is higher for independent floating but otherwise not significantly related to the degree of flexibility of the exchange rate regimes (Figure 5.1). Statistical analysis confirms that countries following an independently floating regime exhibit significantly higher volatility (Table 5.1).¹⁴ Also, countries with a crawling band regime appear to have been successful in lowering NEER volatility below the level that would correspond to their macroeconomic developments and degree of openness. Related arguments are presented in Williamson (2000). Although less flexible exchange rate regimes

Figure 5.1. Daily Exchange Rate Volatility Across Exchange Rate Regimes, 2001¹

(In percent)



Sources: IMF (2001); and IMF, 2001 Annual Report on Exchange Arrangements and Exchange Restrictions.

¹Volatility is measured as the standard deviation of the daily returns. Each observation represents the simple average of country volatilities in each group.

²Includes tightly managed floats.

³Managed floating with no preannounced path for the exchange rate (excluding tightly managed floats).

¹³Examples of this view include Mussa (1986) and Flood and Rose (1999). Other authors have provided a theoretical explanation for higher volatility in flexible regimes in terms of the effect of the choice of regime on the evolution and information content of order flows, within the framework of the market microstructure literature (see Killeen, Lyons, and Moore, 2001).

¹⁴The result is essentially the same when the regression controls for inflation only, suggesting that countries following independently floating regimes have higher nominal and real exchange rate volatility.

do not markedly reduce NEER volatility, such regimes do reduce volatility vis-à-vis the anchor currency or basket of currencies. A key purpose and benefit of exchange rate arrangements, such as a conventional fixed peg, a currency board, or dollarization, may be the establishing of a more credible nominal anchor for monetary policy and the improving of prospects for achieving lower inflation.

The acceptance of Article VIII obligations is also related to NEER volatility.¹⁵ Volatility was significantly lower for the group of countries that have accepted the obligations of Article VIII. Conversely, it was significantly higher for countries that maintain Article XIV status. It is difficult to determine whether Article XIV status is a cause or a symptom of exchange rate volatility. It is possible that the policies followed by Article XIV countries, including the use of exchange restrictions, limit the development and depth of the foreign exchange market and thus raise daily NEER volatility. On the other hand, it is also conceivable that countries experiencing higher exchange rate volatility, possibly for reasons beyond their control, have been more reluctant than others to accept the obligations of Article VIII, Sections 2, 3, and 4.

Some structural features of the foreign exchange market are also correlated with NEER volatility. Notably, countries in which foreign exchange transactions are carried out by dealers exhibit lower volatility. This result may reflect the greater liquidity typically associated with these types of foreign exchange market structures. Countries with a foreign exchange dealers association also tended to exhibit lower volatility.

Countries restricting the use of domestic currency by nonresidents had lower NEER volatility. In particular, controls on the use of domestic currency in the denomination of nonfinancial contracts and controls on nonresi-

dents' holdings of domestic notes and coins seemed to be associated with lower volatility.

Limits on banks' foreign exchange positions also tended to lower NEER volatility. Specifically, countries adopting limits on the net open foreign exchange position had lower volatility. This result may reflect the constraints that these prudential rules place on speculative position taking. It is conceivable, however, that in some instances limits on foreign exchange positions could result in higher volatility, as dealers seek to lay off unwanted exposures. This effect, which is known as "hot potato" trading, is discussed in Lyons (1997) and Lyons (1995).

A broad range of other variables were also examined, but were not found to be strongly associated with NEER volatility. These included:

- restrictions on the domestic monetary use of domestic and/or foreign currencies
- the presence or absence of forward foreign exchange markets¹⁶
- country size, whether measured by surface area, population, or GDP in U.S. dollars
- type of legal code and most other sociocultural factors
- country classification used in the IMF's *World Economic Outlook* or *International Financial Statistics*. Exceptions were countries in the Western Hemisphere, which had lower volatility and Africa, which had higher volatility.

The findings presented in this chapter provide a starting point for additional investigation. An eventual update of the *Survey on Foreign Exchange Market Organization* would be most useful, as this would permit a more thorough check of the robustness of the findings. It would also allow for an intertemporal study of the factors associated with exchange rate volatility, which is likely to provide significant information above

¹⁵These obligations are to avoid multiple currency practices and restrictions on international current payments and transfers.

¹⁶The data did not permit testing for the effect of other types of derivatives on NEER volatility.

and beyond the cross-sectional analysis reported here. It could also be used to examine the relationship between structural features of the foreign exchange market and exchange regime transitions.

References

- Bleaney, M., and D. Greenaway, 2001, "The Impact of Terms of Trade and Real Exchange Rate Volatility on Investment and Growth in Sub-Saharan Africa," *Journal of Development Economics*, Vol. 65 (August), pp. 491–500.
- Bollerslev, T., 1986, "Generalized Autoregressive Conditional Heteroskedasticity," *Journal of Econometrics*, Vol. 31 (April), pp. 307–27.
- Canales-Kriljenko, J., and K. Habermeier, forthcoming, "Nominal Effective Exchange Rate Volatility and Foreign Exchange Market Microstructure," IMF Working Paper (Washington: International Monetary Fund).
- Chowdhury, A., 1993, "Does Exchange Rate Volatility Depress Trade Flows? Evidence from Error-Correction Models," *Review of Economics and Statistics*, Vol. 75 (November), pp. 700–06.
- Dell'Ariccia, G., 1999, "Exchange Rate Fluctuations and Trade Flows: Evidence from the European Union," *IMF Staff Papers*, International Monetary Fund, Vol. 46 (September-December), pp. 315–34.
- Flood, R., and A. Rose, 1999, "Understanding Exchange Rate Volatility Without the Contrivance of Macroeconomics," *Economic Journal: The Journal of the Royal Economic Society*, Vol. 109 (November), pp. F660–72.
- Frankel, J., and A. Rose, 1995, "Empirical Research on Nominal Exchange Rates," *Handbook of International Economics*, Vol. 3, pp. 1689–1729.
- Ghosh, A., and others, 1995, "Does the Nominal Exchange Rate Regime Matter?" IMF Working Paper 95/121 (Washington: International Monetary Fund).
- International Monetary Fund, 1984, IMF Occasional Paper No. 28 (Washington: International Monetary Fund).
- Killeen, W., R. Lyons, and M. Moore, 2001, "Fixed Versus Flexible: Lessons From EMS Order Flow," NBER Working Paper No. 8491 (Cambridge, Massachusetts: National Bureau of Economic Research).
- Lyons, R., 1995, "Foreign Exchange Volume: Sound and Fury Signifying Nothing?" NBER Working Paper No. 4984 (Cambridge, Massachusetts: National Bureau of Economic Research).
- , 1997, "A Simultaneous Trade Model of the Foreign Exchange Hot Potato," *Journal of International Economics*, Vol. 42 (May), pp. 275–98.
- , 2001, *The Microstructure Approach to Exchange Rates* (Cambridge, Massachusetts: MIT Press).
- McDonald, R., 1999, "Exchange Rate Behaviour: Are Fundamentals Important?" *The Economic Journal*, Vol. 109 (November), pp. 673–91.
- Meese, R., and K. Rogoff, 1983, "Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample?" *Journal of International Economics*, Vol. 14 (February), pp. 3–24.
- Mussa, M., 1986, "Nominal Exchange Rate Regimes and the Behavior of the Real Exchange Rates: Evidence and Implications," *Carnegie Rochester Conference Series on Public Policy*, Vol. 25, pp. 117–214.
- Reinhart, C., and K. Rogoff, 2002, "The Modern History of Exchange Rate Arrangements: A Reinterpretation," NBER Working Paper No. 8963 (Cambridge, Massachusetts: National Bureau of Economic Research).
- Rogoff, K., 1999, "Monetary Models of Dollar/Yen/Euro Nominal Exchange Rates: Dead or Undead?" *Economic Journal*, Vol. 109 (November), pp. F655–59.
- Sauer, C., and A. Bohara, 2001, "Exchange Rate Volatility and Exports: Regional Differences Between Developing and Industrialized Countries," *Review of International Economics*, Vol. 9 (February), pp. 133–52.
- Williamson, J., 2000, *Exchange Rate Regimes for Emerging Markets: Reviving the Intermediate Option* (Washington: Institute for International Economics).