Volume Title: Currency Crises

Volume Author/Editor: Paul Krugman, editor

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-45462-2

Volume URL: http://www.nber.org/books/krug00-1

Publication Date: January 2000

Chapter Title: The Mexican Peso in the Aftermath of the 1994 Currency Crisis

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Chapter URL: http://www.nber.org/chapters/c8693

Chapter pages in book: (p. 183 - 236)

6

The Mexican Peso in the Aftermath of the 1994 Currency Crisis

Sebastian Edwards and Miguel A. Savastano

6.1 Introduction

Years after Mexico's 1994 exchange rate crisis important questions remain regarding the country's economic future. Some observers wonder whether Mexico will be able to build the bases for solid and sustainable development. The historical elusiveness of macroeconomic stability in Mexico is at the core of this apprehension. More specifically, a number of observers, both in the private sector and in academic circles, have asked if Mexico will finally be able to escape the perverse cycle of failed stabilization attempts and exchange rate crises. Some have even argued that full dollarization is the only way for Mexico to avoid future crises (Dornbusch 1999).

Most empirical case studies of exchange rate crises—including those on the Mexican 1994 episode—have tended to emphasize the period leading to the currency collapse. Issues related to the pace of credit creation, asset demand, and current account sustainability, among others, have figured prominently in these studies. Almost no work has been done, however, on the behavior of the exchange rate—and other key macroeconomic vari-

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The opinions expressed in this paper are exclusively those of the authors and do not reflect the views of the NBER or the IMF. The authors thank their discussant, Brad De Long, for helpful comments. They are grateful to Agustín Carstens and Abraham Vela from the Banco de México for their comments, for providing some of the data, and for helping clarify a number of issues. Julio Santaella also provided helpful comments. The authors thank Rajesh Chakrabarti and Stacy Maynes for their able assistance.

ables, for that matter—in the period following a crisis. More concretely, very few studies have focused on the strategies followed by the monetary authorities to stabilize the currency in the aftermath of a major exchange rate collapse. And yet, as the recent crises in East Asia, Russia, and Brazil have made abundantly clear, it is what follows the collapse of the exchange rate that determines the extent of "damage" done by the crisis itself.

This paper deals with the 1994 Mexican crisis and its aftermath. We concentrate on the events leading to the exchange rate collapse in December of that year, and we examine the behavior of some key macroeconomic variables in the three years following the crisis. We are particularly interested in addressing two main questions: First, what were the forces behind the apparent stability of the peso-dollar exchange rate during 1996–97? And second, what was the role of Bank of Mexico (BOM) monetary policy in the three years following the crisis? In particular, we are interested in investigating whether, as some analysts argued, the BOM's monetary policy during 1996–97 was geared at maintaining a degree of nominal exchange rate stability that was at odds with the requirements of a floating rate regime. Because the analysis in the paper covers only developments until the end of 1997, it does not examine whether the appointment of a new central bank governor in early 1998 led to a change in the BOM's conduct of monetary policy.

The rest of the paper is organized as follows: Section 6.2 deals with the period that preceded the 1994 crisis. We provide a brief overview of developments in 1990–94 and discuss two (implausible) explanations for the collapse of the peso that, interestingly, resurfaced in the context of the East Asian crises of 1997–98. We argue that throughout 1993–94 most available information suggested that things in Mexico were getting rapidly out of hand. Most analysts, however, badly missed the magnitude of the disequilibrium and thus underestimated the required adjustment in the nominal and real exchange rates following the abandonment of the exchange rate band. We argue that the use of inadequate models to evaluate real exchange rate behavior might have been at the core of the general inability to gauge the seriousness of the situation. Section 6.3 is devoted to analyzing exchange rate behavior in the three years following the crisis (1995–97). We inquire whether during this period the peso-dollar rate behaved in a manner compatible with a floating exchange rate regime. Our analysis, based on a cross-country comparison of exchange rate volatility measures, as well as on the calibration of a simple monetary model, suggests that throughout most of the 1995–97 period Mexico's exchange rate behavior was largely consistent with that of (quasi-)floating rates. Our analysis, however, is also consistent with the notion that during this period the BOM took into account exchange rate developments in conducting monetary policy. Section 6.4 looks at this issue in greater detail and focuses on BOM operating procedures in 1995–97, trying to shed light on

the question, What did the Bank of Mexico really do? Concretely, we use daily data for 1996–97 to inquire whether there is evidence that when conducting monetary policy, the BOM relied on some type of feedback rule that took into account the behavior of the nominal exchange rate. We conclude that notwithstanding the perils of relying on "noisy" high-frequency data, some preliminary evidence supports that view.

6.2 The Road to Collapse: 1991–94

In 1985, three years after coming close to default on its external debt and having ignited the Latin American debt crisis, Mexico embarked on an ambitious market-oriented reform program. Although this process started slowly, by 1989 it had gathered considerable momentum. The overall program, vigorously pushed by the administration of President Salinas de Gortari, had four basic components:[1] (1) the opening of the economy to international competition; (2) a comprehensive process of privatization and deregulation; (3) a stabilization program centered on a predetermined nominal exchange rate and supported by restrictive fiscal and monetary policies; and (4) a broad social and economic agreement between the government, the private sector, and labor unions—known as the Pacto—aimed at guiding price, exchange rate, and wage increases over loosely specified horizons. By 1994, the last year of the Salinas administration, an impressive number of reforms had been implemented, including the approval of the much publicized North American Free Trade Agreement (NAFTA).

6.2.1 The Pacto, Capital Inflows, and the Exchange Rate

Mexico's protracted adjustment to the external crisis of 1982 led to an upward ratcheting of the rate of inflation, which reached a historical high of 140 percent per annum in late 1987. At that point, the Mexican authorities decided to confront the inflation problem head on and designed an ambitious stabilization program centered on a temporary freeze of wages and administered prices agreed in the context of the Pacto. A few weeks after the launching of the program, in late February 1988, the nominal exchange rate was fixed and became the main anchor of the anti-inflationary effort.[2] Between 1988 and 1994 the authorities made several modifications to the exchange rate system, moving first in 1989 to a regime based on a preannounced rate of devaluation—where the rate of devaluation was set below the (actual and expected) rate of inflation—and in November 1991 to a (narrow) exchange rate band with a sliding ceiling. From

1. For a detailed account of Mexico's reform program, see Aspe (1993) and Lustig (1992). See also Loser and Kalter (1992).

2. For comprehensive analyses of the Mexican stabilization program of 1988, see Vela (1993) and Santaella and Vela (1996). See also Aspe (1993).

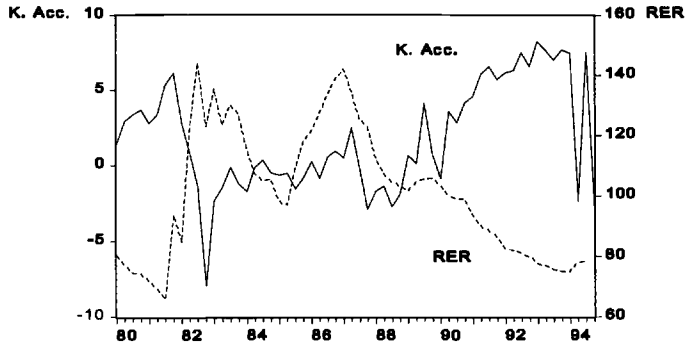


Fig. 6.1 Mexico: capital flows and real exchange rate, 1980–94
Sources: Banco de México and IMF.
Note: K. Acc. = capital flows in billions of U.S. dollars (*left-hand scale*). RER = real exchange rate index, 1990 = 100 (*right-hand scale*).

early 1992 to October 1993—when the NAFTA controversy heated up in the United States—the nominal peso-dollar rate was remarkably stable and invariably remained in the lower half of the band. Throughout most of this period, Mexico's managed exchange rate regime was supported by prudent fiscal and monetary policies.

The rate of inflation fell drastically (to less than 20 percent) in the first eighteen months of the program, but from then on the pace of disinflation became painfully slow. As had happened a decade earlier in Chile, and in other stabilization episodes, the attempt to reduce inflation using the exchange rate as the main nominal anchor gave rise to a substantial and protracted real appreciation of the Mexican peso (see fig. 6.1).[3] Already in 1989 a number of observers argued that this trend would become unsustainable because the country lacked sufficient foreign exchange reserves to finance the rapidly growing current account deficit (Edwards 1998a).

In early 1990, after arduous negotiations, the Brady debt reduction agreement was finally signed, the authorities accelerated the pace of their ambitious structural reform program, and foreign investors rediscovered Mexico. The ensuing surge in private capital inflows allowed Mexico to finance current account deficits on the order of 7 percent of GDP in 1992–94; all along the real exchange rate continued to appreciate, and output growth remained subdued.

In 1992 a public debate began to take place about the consequences of the real appreciation that the peso had experienced since the 1988 stabilization. In early 1992 Dornbusch claimed that "the current problem of

3. In fig. 6.1, and throughout the paper, a decline in the real exchange rate indicates a real appreciation. For a comparison of the Chilean and Mexican stabilization programs, see, e.g., Edwards (1998b).

the Mexican economy is the overvalued exchange rate" (reproduced in Dornbusch 1993, 369), and in November of that year he argued that the daily rate of devaluation of the peso had to be *tripled* in 1993 to 120¢ per day (*Excelsior,* 23 November 1992, 1). Also the World Bank, in its 1993 *Trend in Developing Economies,* noted that in Mexico "growth recovery has . . . been modest . . . [an outcome that] can be traced to a combination of slow productivity growth, a weak US economy, tight fiscal and monetary policies, and *real exchange rate appreciation*" (1993, 325–30; emphasis added). The Mexican authorities responded to these apprehensions with a rehashed version of the "Lawson doctrine" and argued that since the capital inflows were largely private and the fiscal accounts were in surplus, there was nothing to be concerned about. The authorities "substantiated" their view by arguing that rapid increases in productivity that would lead to a strong export expansion, and thus to a narrowing of the current account, were about to take place and stressing that the exchange rate bands and the freely determined interest rates gave enough flexibility to their monetary policy to deal with eventual disruptions in the flow of capital (see BOM 1993, 1994; Aspe 1993; Ortiz 1994). Confident that the approval of NAFTA in late 1993 and the entry to the OECD scheduled for 1994 were a tribute to the sound fundamentals of the Mexican economy, the authorities announced an economic program for 1994, a year of presidential elections, that envisaged single-digit inflation, a pick-up in output growth, and no fundamental change in the core macroeconomic policies.

The size and pace of the capital inflows that Mexico had been absorbing since 1991 gave rise to the notion that the accompanying strengthening of the peso represented an "equilibrium" movement of the real exchange rate that was fully justified by fundamentals. The view that an increase in capital flows will lead to an appreciation of the real exchange rate is of course correct from a simple theoretical perspective. Indeed, in order for the transfer of resources implied by a higher inflow of capital to become effective, a real appreciation is *required.* One problem with this interpretation, however, is that it overlooks that the rate at which capital was flowing into Mexico in 1992–94 (i.e., at 7 percent of GDP per annum) was clearly *not* sustainable in the long run. Considerations of external solvency and current account sustainability indicate unequivocally that flows of this magnitude at some point *have to* decline and that such a decline will encompass a reversal of the real exchange rate appreciation.[4] Interestingly enough, even those analysts who recognized the unsustainable nature of the capital flows badly miscalculated the required real exchange rate adjustment. Indeed, in early 1994 the debate among Mexico skeptics was whether a 20 or a 30 percent devaluation would be required to reestablish

4. On the issue of current account sustainability, see Reisen (1995) and Milesi-Ferretti and Razin (1996).

equilibrium.[5] Very few, if any, observers would have predicted that merely a year after abandoning the band, the peso would lose almost one-half of its value. This inability to grasp the seriousness of the Mexican situation (both before and after the collapse) clearly illustrates the shortcomings of the models commonly used by both private sector and academic analysts to assess the adequacy of real exchange rates. Indeed, most of these models are strictly based on flow considerations—and some of them are little more than glorified versions of purchasing power parity (PPP)—and ignore the interaction between flows and stocks.[6] Models that, on the other hand, pay attention to stocks in general and to the foreign demand for securities issued by emerging markets in particular are, in principle, better equipped to gauge the magnitude of the disequilibrium in circumstances where credibility vanishes (Calvo 1994, 1995).

6.2.2 Mexico in 1994: Two Implausible Stories

Few episodes of currency crisis have received as much attention in the economic literature as that of Mexico in 1994.[7] And yet, five full years after the fateful event, it can hardly be argued that there is consensus on what caused the December 1994 devaluation of the peso or, more precisely, on what was the (approximate) contribution of the various hypotheses put forward to explain the occurrence, timing, and size of the peso collapse. One reason for this state of affairs is that many of the earlier accounts of the Mexican crisis, in their quest to extract quick "lessons" and apportion blame, searched for simple explanations and sought a single culprit. As pointed out by Edwards et al. (1996) and others, however, this episode was highly complex and defies simple explanations. Indeed, as in the old high school exam, the answer to "What caused the Mexican crisis?" will often be "All of the above."

It is beyond the scope of this paper to revisit developments in Mexico during 1994 or to assess, with the benefit of hindsight, the relative validity of the various hypotheses advanced to explain the December devaluation.[8]

5. See Edwards (1998a) for a detailed account of the evolution of different views on Mexico during 1994.

6. See Williamson (1995) for a discussion of some of these models.

7. Analyses of the Mexican crisis can be found in Calvo (1995), Calvo and Mendoza (1996), De Long, De Long, and Robinson (1996), Dornbusch, Goldfajn, and Valdés (1995), Edwards (1996, 1997), Edwards, Steiner, and Losada (1996), Gil-Díaz and Carstens (1996), International Monetary Fund (IMF 1995a, 1995b), Krugman (1995), Leiderman and Thorne (1995), Lustig (1995), Masson and Agenor (1996), Obstfeld and Rogoff (1995), Reynoso (1995), Sachs, Tornell, and Velasco (1996), Warner (1997), and Werner (1996). A more complete list would include most of the studies contained in the July 1996 special issue of the *International Journal of Finance and Economics,* in the July 1996 special issue of *Open Economies Review,* in the November 1996 special issue of the *Journal of International Economics,* and in Edwards and Naim (1997).

8. For a comprehensive discussion of developments leading to the crisis, see Edwards (1997). See also IMF (1995a, 1995b) and Sachs et al. (1996).

But we will take issue briefly with two rather extreme views that, interestingly, regained prominence during the unfolding of the 1997–98 East Asian currency crises. The first view ascribes a negligible role to policy mistakes in the unraveling of the Mexican crisis. This view, endorsed by the BOM since the very beginning,[9] attributes the occurrence (and size) of the peso collapse to the combination of a sequence of adverse and unexpected shocks (domestic and foreign) and various sources of multiple equilibria that gave rise to a self-fulfilling run on the currency (Reynoso 1995; Gil-Díaz and Carstens 1996). The second view, more popular in financial circles, ascribes a central role to the incomplete information made available to foreign investors—in particular, to the paucity and unreliability of official data on key economic variables—in triggering the speculative attacks on the peso (see, e.g., Group of Thirty 1995).

A careful examination of the Mexican episode finds no strong support for either of these two "stories." Let us start with the second one. In the aftermath of the crisis Wall Street analysts and operators argued that the lack of current information on Mexico's international reserve position played an important role in magnifying the crisis. In fact, a post mortem of the crisis sponsored by the Council on Foreign Relations and undertaken by an independent task force chaired by John Whitehead concluded that "full financial information was not forthcoming to all investors" (Council on Foreign Relations 1996, 27). However, at least three pieces of evidence are at odds with the claim that markets did not know (or, more precisely, could not know) what was going on in Mexico in 1994.

First, markets were fully aware (and even supportive) of what turned out to be a crucial modification of Mexico's monetary policy in 1994: the April decision to replace maturing peso-denominated Cetes with the infamous Tesobonos—short-term dollar-linked public debt instruments. This strategy was quite transparent and was even commented on, matter of factly, in financial circles. For example, J. P. Morgan's *Emerging Markets Outlook* of 22 July 1994 noted that "half of the 28-day and 91-day Cetes offered were issued; the central bank would not accept the high yields required by the market to auction the full amount. . . . In the *Tesobonos* auction, yields . . . trended down modestly" (22). And on 23 July 1994 an article in the *Economist* pointed out that "the central bank has also had to issue plenty of *tesobonos*—dollar-linked bonds that are popular with investors that worried about currency risk."[10]

Second, the public and academic debates on the sustainability of Mexico's external position grew louder during the first half of 1994. For instance, in a much publicized piece prepared for the spring meetings of the

9. See, e.g., the op-ed article by former governor Miguel Mancera, "Don't Blame Monetary Policy," *Wall Street Journal,* 31 January 1995.

10. "Pounding the Peso," *Economist,* 23 July 1994, 76.

Brookings Institution Economics Panel, Dornbusch and Werner (1994) argued that the Mexican peso was overvalued by at least 20 percent and urged the Mexican authorities to rapidly find a way to address the problem. These concerns were echoed, albeit on different grounds, by the two prominent discussants of the paper: Guillermo Calvo and Stanley Fischer (Calvo 1994; Fischer 1994). Financial analysts were also aware that the U.S. authorities' decision to extend a US$6 billion swap facility to Mexico, announced on 24 March, one day after the Colosio assassination, reflected the serious concerns those authorities had about the loss of international reserves that the BOM had suffered in the tumultuous first quarter of 1994.[11]

And third, documents released to the U.S. Senate Banking Committee during 1995 indicate quite clearly that the U.S. Treasury was able to keep track of the evolution of Mexico's international reserves throughout 1994 (see D'Amato 1995). For example, a mid-May 1994 memorandum from Assistant Secretary Shafer pointed out that the BOM had reportedly spent US$10 billion since the Colosio assassination to defend the peso. Similar documentation shows that Treasury officials were well aware of the speed at which Mexico's reserves were being depleted in the last weeks of the year.[12] Even though the BOM had maintained during 1994 its long-standing practice of releasing to the public data on its international reserves only three times a year (in April, October, and November) there is no compelling reason why diligent analysts in the private sector could not have produced estimates of Mexico's international reserves as accurate as those of the U.S. Treasury on the basis of available information (on the stocks and flows of Cetes and Tesobonos, trade flows, and so on). Why so many of them did not, or if they did, why they did not react earlier to the deterioration of Mexico's external indicators remains an open question. But in light of the above evidence, it is hard not to conclude that until the very end, foreign investors simply underestimated the probability of a crisis.[13]

The flaws of the first view—the "bad luck" view—become apparent when one examines the policy response to the sequence of shocks that hit Mexico during 1994. As noted earlier, a crucial decision in the area of monetary and exchange rate policy prior to the December crash was taken in April 1994, when the Mexican authorities, in response to the increasing difficulties they were facing in rolling over the country's sizable stock of peso-denominated debt at the (high) yields prevailing at the time,[14] decided to stave off further rises in domestic interest rates by substituting

11. See, e.g., the front page stories in the *Financial Times,* 26 and 28 March 1994.

12. See, e.g., the memoranda dated 18 November and 5 December in D'Amato (1995).

13. The results obtained by Masson and Agenor (1996) provide further support for this conclusion.

14. Interest rates on twenty-eight-day Cetes had almost doubled between February and mid-April 1994, when they reached a level of about 18 percent per annum in the secondary market.

dollar-linked Tesobonos for maturing Cetes while leaving intact the other two pillars of their monetary policy framework—that is, the exchange rate band and the target for nominal base money (and, hence, the sterilization of reserve flows). BOM officials have argued that they had followed a similar strategy in late 1993, when the peso came under pressure due to uncertainties about the ratification of NAFTA by the U.S. Congress, and thus that "it was natural to follow the same strategy after the Colosio assassination" (Gil-Díaz and Carstens 1996, 168). One problem with this line of reasoning, however, is that it ignores the fundamental difference between using debt swap operations to smooth transitory hikes in interest rates and using those operations to keep interest rates below their equilibrium level for a prolonged period of time. The tightening of monetary conditions in the United States in early 1994—which raised the floor for Mexican rates—and the rapid pace at which maturing Cetes were being replaced by Tesobonos several months after the policy had been adopted[15] should have made it clear to BOM officials that their debt strategy was achieving the latter rather than the former. Moreover, the decision to maintain the course of policies unaltered after the August presidential election and after the internal debate that preceded the renewal of the Pacto in September leaves little doubt that the authorities deliberately opted for a policy stance that they hoped would enable them to continue lowering interest rates and preserve the exchange rate band.

One can only speculate about the reasons that led the authorities to miss these propitious opportunities to correct the stance of monetary and exchange rate policy. By the third quarter of 1994, Mexican authorities might well have been under the impression that they had weathered the worst of the speculative pressures and that it was a matter of time before capital inflows would resume at a pace similar to that of 1992–93. Concerns about the adverse effects that higher interest rates (or a depreciation of the peso) might have on the deteriorating situation of the banking system are also likely to have played a role;[16] indeed, the decision to preserve the policy stance could have reflected an attempt to buy additional time to work out a plan to strengthen those financial institutions considered to be in particularly weak positions.[17] Whatever the reasons, there is no question that the Mexican authorities seriously underestimated the risks em-

15. Between the end of March and the end of October 1994 the stock of Tesobonos outstanding increased by almost the same amount as the decline in the stock of Cetes (around US$13 billion).

16. The preoccupation with the financial health of the recently privatized banks had begun in late 1992, when a significant increase in the past-due loan ratio became evident. In 1990, nonperforming loans—which prevailing regulations defined as unpaid installments of principal plus interest, rather than the total value of the loans—were estimated to be only 2 percent of total loans; that ratio increased to 4.7 percent in 1992, to 7.3 percent in 1993, and to 8.3 percent at the end of the first quarter of 1994.

17. In fact, by the end of June 1994 the government-owned banks had designed a debt relief program comprising a combination of write-offs of commercial bank past-due interest and government-issued loan guarantees.

bedded in their chosen course of action. It is quite a stretch to claim, as BOM officials have since the beginning, that this error in judgment (even if well intentioned) does not fall squarely in the category of policy mistakes.

Between June and November 1994 the stock of Tesobonos outstanding more than doubled to a total of US$16 billion. By the end of November the BOM's international reserves, at US$12.9 billion, were barely enough to cover 40 percent of total short-term public debt *or* 10 percent of total short-term liabilities of the banking system. The situation had long surpassed the current account and peso overvaluation sphere and had all the makings of a major financial crisis. It took little to cross the threshold. A few days after President Zedillo was sworn into office (on 1 December) news about renewed tensions in Chiapas led to a further attack on the peso, and on 20 December, when international reserves had fallen to about US$10 billion, the authorities finally opted for a policy correction and lifted by 15 percent the ceiling of the exchange rate band. To everyone's surprise, the announcement of the new exchange rate ceiling was not accompanied by other supportive changes in macroeconomic policies or by a revision of the macroeconomic assumptions for 1995 that had been made public a few weeks earlier. In disbelief, investors—both foreign and domestic—fled, rendering the change in policy ineffective; in one day the BOM lost US$4 billion in reserves. By then, the authorities realized that they had no alternative but to let the peso float. But the mayhem had just started.

6.3 The Mexican Peso during 1995–97: A Freely Floating Exchange Rate?

The behavior of the Mexican peso has been an object of interest to analysts and observers since the crash of December 1994. In the immediate aftermath of the December devaluation, most discussion centered on the possibility that a spiraling collapse of the peso would unleash an inflationary explosion that would wreak havoc with the real economy and the financial system. By late 1995 several observers became wary about what they considered the surprising—and some argued even unwarranted—stability of Mexico's nominal exchange rate. Many analysts were particularly surprised that even though the annual inflation rate was falling rather slowly from its 52 percent peak in December 1995 and had remained in double digits during 1996–97, the peso-dollar exchange rate by, say, mid-October 1997 (7.71 pesos per dollar on 21 October) was essentially at the same level it had been in early January 1996—see figure 6.2*A*. During this period there seemed to be a growing consensus that the relative stability of the nominal exchange rate in a context of double-digit inflation was more the result of measures undertaken by the BOM—allegedly to "smooth out" short-term fluctuations—than the outcome of market forces.

In its 3 October 1997 *Emerging Markets Data Watch,* J. P. Morgan

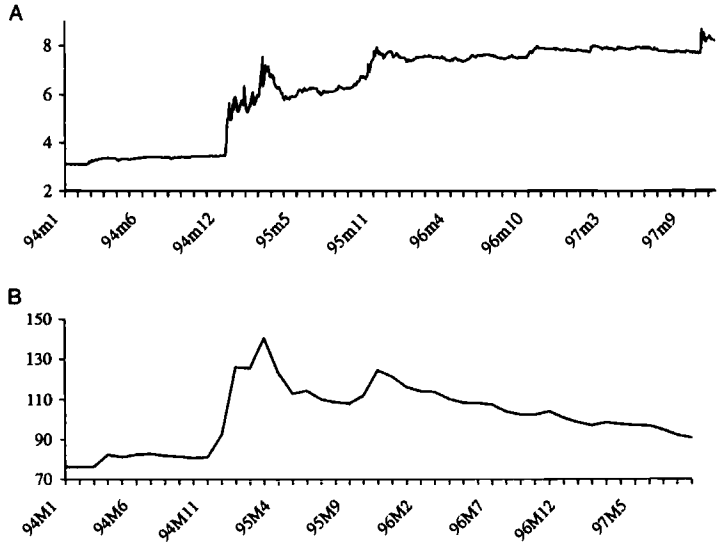


Fig. 6.2 Mexico: nominal and real exchange rates, January 1994–November 1997
Note: A, Pesos per U.S. dollar. *B,* Real exchange rate vis-à-vis U.S. dollar, CPI based, 1990 = 100; increase means depreciation.

stated that "by staying at about NP7.8 throughout 1997 so far, the peso's behavior has reopened the debate on whether it is appreciating too much in real terms. . . . Peso strength has gone further, and lasted longer than we had envisaged [in] our earlier forecasts" (3). This influential financial newsletter went on to say that the surprising strength of the peso was likely to be the result of a deliberate BOM policy stance. Other observers went a step further and saw in the stability of the nominal exchange rate, and the associated appreciation of the real exchange rate in 1996–97 (fig. 6.2*B*), signs of another cycle of policy-induced overvaluation of the peso that could lead to yet another episode of slow growth and overborrowing culminating in a major currency crisis similar to those that had affected the country during the past twenty-five years. For example, the *Economist* argued that the BOM policy stance toward the peso was unduly influenced by political considerations: "Distrustful investors have wondered aloud whether the central bank—which lost much credibility with the collapse—really enjoys independence. . . . The doubters have noted that the government's policy on the peso, which is theoretically free to float, has actually been set by a committee."[18]

Most analysts who expressed concerns about the behavior of the Mexican peso were not explicit, however, about the counterfactual—that is, about the type of behavior the peso should have exhibited if it really were

18. "The Lingering Tequila Effect," *Economist,* 14–28 March 1998, 17.

floating freely. Some could argue that the dismal performance of "traditional" exchange rate models to explain and predict short-term movements of floating exchange rates in the past two decades (Frankel and Rose 1995; Isard 1995) exempts observers from the need to provide some theoretical or empirical support for their concerns. We disagree. For one thing, many of the worries about the real overvaluation of the peso during 1995–97 seem to have been grounded on the notion that either some type of PPP adjustment or a simple flow-based real exchange rate equation—not too different from those used to evaluate the appropriateness of Mexico's real exchange rate in 1993–94—provides a reasonable yardstick to assess the behavior of a floating exchange rate over relatively short periods. However, the notion that exchange rate analyses rooted in PPP are useful for this purpose has been flatly rejected by numerous empirical studies (Froot and Rogoff 1995; Isard 1995). Moreover, as we argued in the previous section, simple real exchange rate models that focus on flows and disregard the behavior of stock variables can produce highly misleading estimates of the degree of real exchange rate misalignment at a particular moment in time, especially under a floating regime.

Twenty-five years of experience with floating exchange rates have produced a substantial body of evidence on their short- and long-term empirical regularities (Baillie and McMahon 1989; de Vries 1994) that cannot be simply dismissed when passing judgment on the evolution of a particular float—even if this happens to be the Mexican peso. The analysis in this section attempts to place the debate about the behavior of the Mexican peso during the early postcrisis period on firmer ground. Specifically, we explore whether—and to what extent—the behavior exhibited by Mexico's nominal exchange rate vis-à-vis the U.S. dollar in 1995–97 conforms to the behavior of other floating rates. To address this question we conduct two types of exercises, one based on a cross-country comparison of simple measures of nominal exchange rate volatility and the other focused on the evolution over time of various "fundamental determinants" of the peso-dollar exchange rate.

For the first exercise we used daily data on the nominal exchange rate vis-à-vis the U.S. dollar of the currencies of Germany, Japan, the United Kingdom, Canada, Australia, New Zealand, and Mexico and on the nominal exchange rate vis-à-vis the German mark of the French franc, for the period January 1991–November 1997 (about 1,800 observations per currency).[19] We calculated the day-to-day percentage change of the eight nominal exchange rates over the whole sample (fig. 6.3) and then computed, for each calendar year, two measures of short-term volatility often

19. The exchange rates used for these calculations consist of the "representative rates" submitted daily by all countries' central banks to the Treasurer's Department of the IMF.

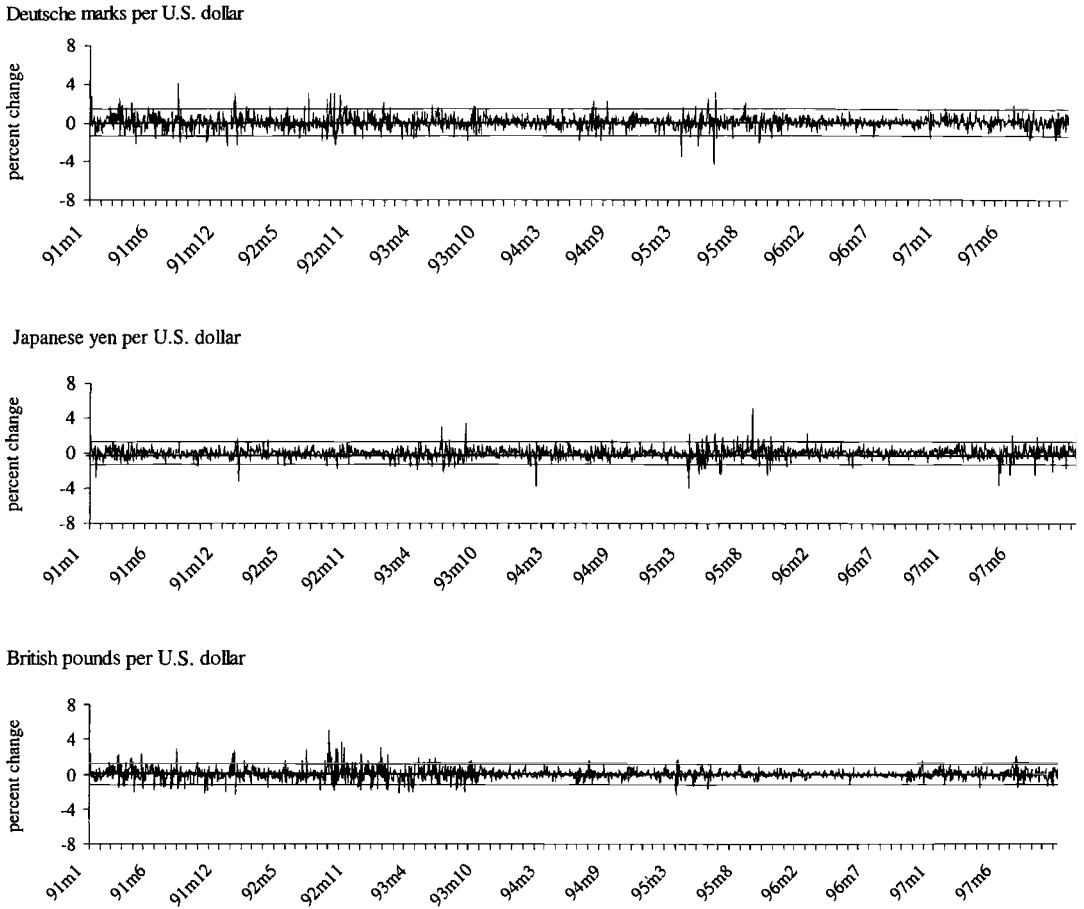
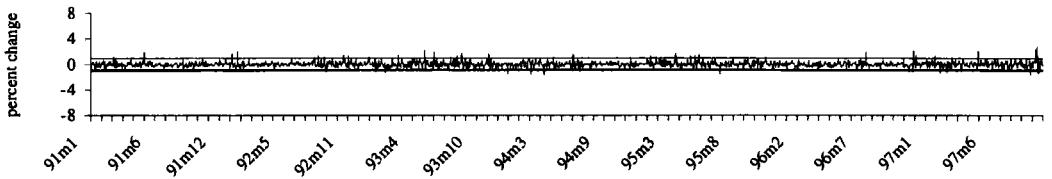


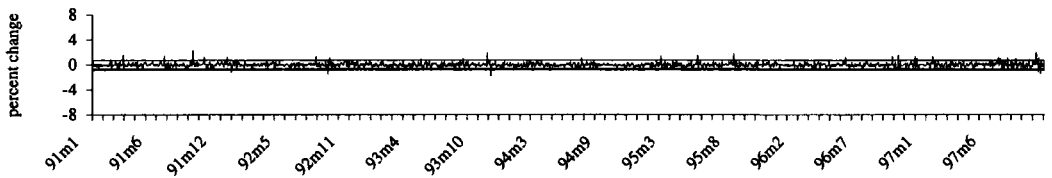
Fig. 6.3 Short-term variability of selected nominal exchange rates, January 1991–November 1997 (day-to-day percentage changes)

Note: Bands for each currency are set at 2 standard deviations of the daily percentage change over the sample period.

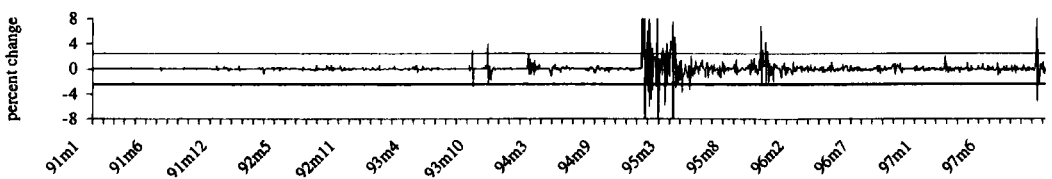
Australian dollars per U.S. dollar



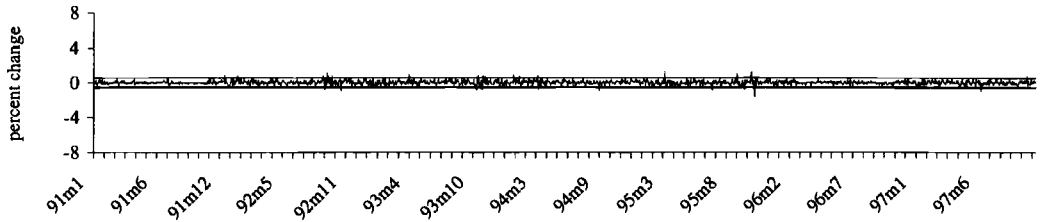
New Zealand dollars per U.S. dollar



Mexican pesos per U.S. dollar



Canadian dollars per U.S. dollar



French francs per deutsche mark

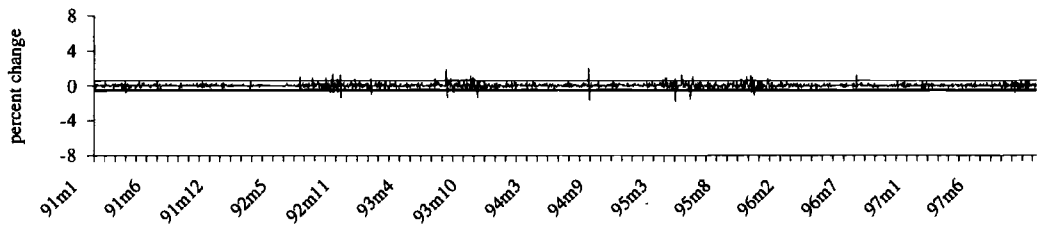


Fig. 6.3 (cont.)

used in empirical analyses of nominal exchange rates: (1) the *mean absolute value* of the day-to-day percentage change and (2) the *standard deviation* of the (actual) day-to-day percentage change (see Baillie and McMahon 1989). We also computed these two measures of volatility for the weekly (end of week) and monthly (end of month) percentage changes of the eight nominal exchange rates during the period.

The results of these computations are presented in tables 6.1, 6.2, and 6.3. These tables reveal three important features of the behavior of the Mexican peso during 1995–97: (1) The peso-dollar exchange rate was considerably less volatile than the other seven exchange rates in the period prior to the devaluation of December 1994 (January 1991–November 1994). (2) The Mexican peso exhibited the highest degree of short-term volatility among this group of currencies in 1995. (3) The short-term volatility of Mexico's nominal exchange rate was broadly in line with that of the other seven currencies in the last twenty-three months of the sample (January 1996–November 1997). The first two findings are hardly surprising: as noted earlier, Mexico's exchange rate system prior to the devaluation consisted of a gradually crawling band with relatively narrow margins in which the central bank intervened heavily to dampen (most) short-term fluctuations, whereas the financial mayhem that beset Mexico in the first quarter of 1995 was reflected primarily in wild daily gyrations in the value of the peso—which were greater than 6 percent (in both directions) on several occasions (fig. 6.3). The third feature, however, is quite interesting. According to the statistics in tables 6.1, 6.2, and 6.3, in 1996–97 the Mexican peso was consistently more volatile than the Canadian dollar and the French franc and, while it was more stable than the currencies of the G-3 and the United Kingdom (countries widely regarded as having the "cleanest" type of float), exhibited a degree of volatility comparable to that of the currencies of Australia and New Zealand (fig. 6.4).[20] This evidence, therefore, suggests that the relative stability of Mexico's nominal exchange rate in the aftermath of the 1994 crisis period was not "excessive" or unusual for a floating rate. At the same time, however, the fact that the peso-dollar rate exhibited a degree of volatility lower than that of the cleanest floaters in the group is not inconsistent with the view that during the period under consideration the BOM took into account, in some way, the behavior of the nominal exchange rate when conducting monetary policy.

Of course, it is possible that by comparing the mean absolute values and standard deviations of high-frequency exchange rate changes during

20. We decided to include the franc-mark exchange rate in the sample even though the French currency did not float freely during the period under study (but instead was linked, through the Exchange Rate Mechanism and monetary policy, to the evolution of the German mark) in order to have comparable data on a country with a managed float where exchange rate stability *has been* a primary objective of monetary policy.

Table 6.1 **Volatility of Daily Exchange Rates, 1991–97**

Year and Measure	Germany (DM/US$)	Japan (yen/US$)	United Kingdom (pound/US$)	Canada (Can$/US$)	Australia (Au$/US$)	New Zealand (NZ$/US$)	France (FFr/DM)	Mexico (peso/US$)
1991								
Number of obs.	258			257				
Mean absolute % change	0.6066	0.4317	0.5678	0.1276	0.2658	0.2510	0.1206	0.0495
Standard deviation of % change	0.8533	0.5787	0.7786	0.1802	0.3635	0.3704	0.1765	0.0821
Maximum absolute % change	4.1440	2.7656	2.8290	0.9158	1.9577	2.3219	0.8803	0.4904
Number of obs. with zero change[a]	12	24	9	15	12	23	13	18
1992								
Number of obs.	260							
Mean absolute % change	0.6505	0.4069	0.6701	0.2226	0.2937	0.2505	0.1800	0.1025
Standard deviation of % change	0.8922	0.5611	0.9520	0.2969	0.4188	0.3539	0.2867	0.1635
Maximum absolute % change	3.1903	3.2460	5.0254	1.1503	2.0030	1.5042	1.4214	0.8406
Number of obs. with zero change[a]	9	20	9	9	12	33	9	35
1993								
Number of obs.	260							
Mean absolute % change	0.5340	0.4818	0.5802	0.2346	0.4106	0.2634	0.2257	0.1573
Standard deviation of % change	0.6935	0.6734	0.7839	0.3076	0.5479	0.3756	0.3423	0.4423

(*continued*)

Table 6.1 (continued)

Year and Measure	Germany (DM/US$)	Japan (yen/US$)	United Kingdom (pound/US$)	Canada (Can$/US$)	Australia (Au$/US$)	New Zealand (NZ$/US$)	France (FFr/DM)	Mexico (peso/US$)
Maximum absolute % change	2.1211	3.4568	3.0316	1.0413	2.2455	1.9604	1.8054	4.0609
Number of obs. with zero change[a]	9	24	9	9	13	31	13	36
1994								
Number of obs.	260							
Mean absolute % change	0.4501	0.4567	0.3071	0.1946	0.3059	0.2193	0.1434	0.4379
Excl. 20–31 December								0.1813
Standard deviation of % change	0.6006	0.6179	0.4194	0.2630	0.4533	0.3011	0.2364	1.9721
Excl. 20–31 December								0.2913
Maximum absolute % change	2.1824	3.7665	1.5282	0.9530	1.7561	1.1191	1.9889	22.5919
Number of obs. with zero change[a]	10	20	9	13	41	24	15	30
1995								
Number of obs.	259							
Mean absolute % change	0.5474	0.6307	0.3435	0.2311	0.3569	0.2660	0.2553	1.3144
Standard deviation of % change	0.8032	0.9214	0.4874	0.3281	0.4818	0.3653	0.3707	2.3005
Maximum absolute % change	4.4128	5.0721	2.4375	1.6231	1.7140	1.7509	1.8348	15.8940
Number of obs. with zero change[a]	9	14	10	16	13	21	17	13

1996								
Number of obs.	260							
Mean absolute % change	0.3202	0.3435	0.2569	0.1396	0.2838	0.2477	0.1285	0.2592
Standard deviation of % change	0.4290	0.4557	0.3556	0.1922	0.4042	0.3504	0.1866	0.3461
Maximum absolute % change	1.7236	2.2562	1.6238	0.6616	2.1690	1.5314	1.1580	1.1565
Number of obs. with zero change[a]	12	22	8	12	15	16	13	15
1997 (January–November)								
Number of obs.	237							
Mean absolute % change	0.4739	0.5167	0.4045	0.1981	0.4209	0.3356	0.1459	0.3363
Standard deviation of % change	0.6086	0.7174	0.5352	0.2585	0.5726	0.4471	0.2039	0.8485
Maximum absolute % change	1.8414	3.6526	2.0122	0.9679	2.7822	2.0083	0.8352	9.7792
Number of obs. with zero change[a]	8	21	5	8	9	19	12	10
1991–97[b]								
Number of obs.	1,794			1,793				
Mean absolute % change	0.5122	0.4661	0.4476	0.1926	0.3329	0.2610	0.1717	0.3800
Standard deviation of % change	0.7142	0.6597	0.6507	0.2663	0.4677	0.3686	0.2676	1.2148
Maximum absolute % change	4.4128	5.0721	5.0254	1.6231	2.7822	2.3219	1.9889	22.5919
Number of obs. with zero change[a]	69	145	59	82	115	167	92	157

[a]Includes national holidays and other nontrading days; excludes weekends.

[b]Up to the end of November 1997.

Table 6.2 **Volatility of Weekly Exchange Rates, 1991–97 (end-of-week exchange rate)**

Year and Measure	Germany (DM/US$)	Japan (yen/US$)	United Kingdom (pound/US$)	Canada (Can$/US$)	Australia (Au$/US$)	New Zealand (NZ$/US$)	France (FFr/DM)	Mexico (peso/US$)
1991								
Number of obs.	51							
Mean absolute % change	1.5918	0.8843	1.4403	0.3086	0.6700	0.7288	0.1491	0.1361
Standard deviation of % change	1.9114	1.1877	1.7526	0.4005	0.9178	0.9317	0.1980	0.1485
Maximum absolute % change	4.4849	3.4043	3.5161	1.1208	3.0275	3.0319	0.6806	0.3829
Number of weeks with zero change	0	2	0	1	0	0	0	0
1992								
Number of obs.	53							
Mean absolute % change	1.4656	0.9306	1.5399	0.5685	0.6065	0.5132	0.2960	0.2104
Standard deviation of % change	1.8843	1.1691	2.2629	0.7004	0.8621	0.6931	0.4735	0.3199
Maximum absolute % change	4.6834	3.0313	11.3738	1.8815	3.3650	2.2762	1.5829	1.1316
Number of weeks with zero change	0	0	0	0	0	2	0	4
1993								
Number of obs.	52							
Mean absolute % change	1.1605	0.9995	1.2965	0.5460	0.9277	0.6493	0.4166	0.2989
Standard deviation of % change	1.4529	1.2546	1.6097	0.7682	1.1398	0.8593	0.5906	0.7026
Maximum absolute % change	4.0163	3.5285	3.9243	2.1415	2.5771	2.9412	1.7629	4.0000

Number of weeks with zero change	0	0	0	1	0	0	0	3
1994								
Number of obs.	52							
Mean absolute % change	0.9526	0.8317	0.7019	0.4570	0.6415	0.4869	0.2889	1.3686
Excl. last two weeks of December								0.4974
Standard deviation of % change	1.2035	1.1292	0.9341	0.5346	0.8204	0.5708	0.4624	6.1638
Excl. last two weeks of December								0.8078
Maximum absolute % change	2.5835	3.4196	2.4401	1.2732	2.3275	1.6709	2.0999	44.3001
Number of weeks with zero change	1	2	0	0	0	0	0	1
1995								
Number of obs.	52							
Mean absolute % change	1.1319	1.4128	0.6646	0.5566	0.8220	0.5882	0.5201	2.6687
Standard deviation of % change	1.6206	1.8974	0.9214	0.7048	1.0354	0.7704	0.6939	3.9325
Maximum absolute % change	5.3676	5.3162	2.6276	1.6569	2.6269	2.1457	2.3369	14.7059
Number of weeks with zero change	0	0	0	1	0	1	0	1
1996								
Number of obs.	52							
Mean absolute % change	0.6358	0.8034	0.6568	0.3076	0.6393	0.5889	0.2064	0.5554
Standard deviation of % change	0.8435	0.9448	0.8557	0.3873	0.8487	0.7521	0.2857	0.7450

(*continued*)

Table 6.2 (continued)

Year and Measure	Germany (DM/US$)	Japan (yen/US$)	United Kingdom (pound/US$)	Canada (Can$/US$)	Australia (Au$/US$)	New Zealand (NZ$/US$)	France (FFr/DM)	Mexico (peso/US$)
Maximum absolute % change	2.1930	2.1091	2.7248	1.2527	2.3468	2.0616	0.7090	2.2754
Number of weeks with zero change	0	0	0	0	1	1	0	0
1997 (January–November)								
Number of obs.	48							
Mean absolute % change	1.0502	1.1412	0.9589	0.5381	0.8936	0.6955	0.1998	0.6305
Standard deviation of % change	1.2782	1.5171	1.2660	0.6719	1.1224	0.9288	0.2458	1.1699
Maximum absolute % change	3.2729	5.2760	4.3556	1.8926	4.0958	3.7168	0.6484	6.3722
Number of weeks with zero change	0	0	0	0	0	2	0	2
1991–97[a]								
Number of obs.	360							
Mean absolute % change	1.1867	0.9956	1.1317	0.4895	0.7498	0.6004	0.3112	0.7085
Standard deviation of % change	1.5453	1.3090	1.5966	0.6407	0.9889	0.8017	0.4740	2.5351
Maximum absolute % change	5.3676	5.3162	11.3738	2.1415	4.0958	3.7168	2.3369	44.3001
Number of weeks with zero change	1	4	0	3	1	6	0	11

[a]Up to the end of November 1997.

Table 6.3 **Volatility of Monthly Exchange Rates, 1991–97 (end-of-month exchange rate)**

Year and Measure	Germany (DM/US$)	Japan (yen/US$)	United Kingdom (pound/US$)	Canada (Can$/US$)	Australia (Au$/US$)	New Zealand (NZ$/US$)	France (FFr/DM)	Mexico (peso/US$)
1991								
Number of obs.	12							
Mean absolute % change	3.3509	1.7903	3.0408	0.8385	1.4008	1.2110	0.2784	0.3922
Standard deviation of % change	5.1158	2.6926	4.4050	0.9610	1.7454	1.4713	0.3518	0.2372
Maximum absolute % change	12.9457	6.8182	10.5445	1.8509	3.2903	3.9749	0.5978	0.5984
Minimum absolute % change	0.2544	0.0000	0.0877	0.2794	0.0255	0.0500	0.0236	0.1878
1992								
Number of obs.	12							
Mean absolute % change	3.2771	2.0783	4.1578	1.3930	1.4079	0.9990	0.4475	0.5079
Standard deviation of % change	4.3586	2.5664	5.6491	1.7522	1.6783	1.2895	0.5343	0.6549
Maximum absolute % change	9.0612	3.9326	13.6201	4.4177	4.3174	2.3689	0.8763	1.1572
Minimum absolute % change	0.0284	0.0401	0.4762	0.5042	0.0527	0.0183	0.0984	0.0163
1993								
Number of obs.	12							
Mean absolute % change	2.6266	2.0684	2.1527	0.9646	2.2055	1.1803	0.7765	0.3294
Standard deviation of % change	3.0404	2.6082	2.9448	1.2106	2.6574	1.2989	1.0415	0.4111
Maximum absolute % change	5.9097	5.5377	5.3288	2.8580	5.1263	2.5948	1.7822	0.8176

(*continued*)

Table 6.3 (continued)

Year and Measure	Germany (DM/US$)	Japan (yen/US$)	United Kingdom (pound/US$)	Canada (Can$/US$)	Australia (Au$/US$)	New Zealand (NZ$/US$)	France (FFr/DM)	Mexico (peso/US$)
Minimum absolute % change	0.8733	0.1202	0.0135	0.0787	0.6992	0.1846	0.0807	0.0515
1994								
Number of obs.	12							
Mean absolute % change	1.6826	1.7654	1.3936	1.0605	1.7563	1.5685	0.2917	5.3873
Excl. December								1.4999
Standard deviation of % change	1.8524	2.3000	1.8476	1.3314	1.9837	1.4846	0.3270	13.7661
Excl. December								2.0748
Maximum absolute % change	3.8889	5.2320	3.8080	2.3447	4.7947	2.7501	0.6299	48.1481
Minimum absolute % change	0.0251	0.2005	0.0000	0.0651	0.3907	0.0831	0.0734	0.0322
1995								
Number of obs.	12							
Mean absolute % change	2.0075	3.4603	1.2954	0.8516	1.4847	1.2757	0.8324	6.2493
Standard deviation of % change	2.9102	5.1158	1.6821	1.1934	1.9293	1.7951	1.0007	7.2188
Maximum absolute % change	6.2296	12.0660	3.2206	2.8163	4.1007	3.6220	1.5444	13.5294
Minimum absolute % change	0.1807	0.1475	0.0310	0.0596	0.2115	0.0468	0.0859	0.9677

1996								
Number of obs.	12							
Mean absolute % change	1.8336	1.8893	1.5026	0.6650	1.3969	0.8328	0.5663	1.6822
Standard deviation of % change	2.2174	2.0307	1.8739	0.8315	1.6273	0.7738	0.6902	2.5443
Maximum absolute % change	4.0670	4.2984	4.0536	1.5710	2.4623	2.3023	1.1425	5.9058
Minimum absolute % change	0.3073	0.0264	0.0514	0.1320	0.0403	0.2545	0.0172	0.0000
1997 (January–November)								
Number of obs.	11							
Mean absolute % change	2.7319	3.0889	1.5150	0.9524	2.0314	1.4074	0.1756	1.4737
Standard deviation of % change	2.9178	3.9472	2.4033	1.1225	1.9259	1.4046	0.2109	2.8232
Maximum absolute % change	5.0685	8.1987	5.9925	1.9682	4.5276	4.2769	0.3881	8.3966
Minimum absolute % change	0.7923	0.8678	0.0061	0.0145	0.0403	0.1448	0.0245	0.0639
1991–97[a]								
Number of obs.	83							
Mean absolute % change	2.4987	2.2964	2.1588	0.9609	1.6647	1.2083	0.4849	2.2987
Standard deviation of % change	3.3278	3.1635	3.2697	1.2305	2.0446	1.5612	0.6511	6.1610
Maximum absolute % change	12.9457	12.0660	13.6201	4.4177	5.1263	4.2769	1.7822	48.1481
Minimum absolute % change	0.0251	0.0000	0.0000	0.0145	0.0255	0.0183	0.0172	0.0000

[a]Up to November 1997.

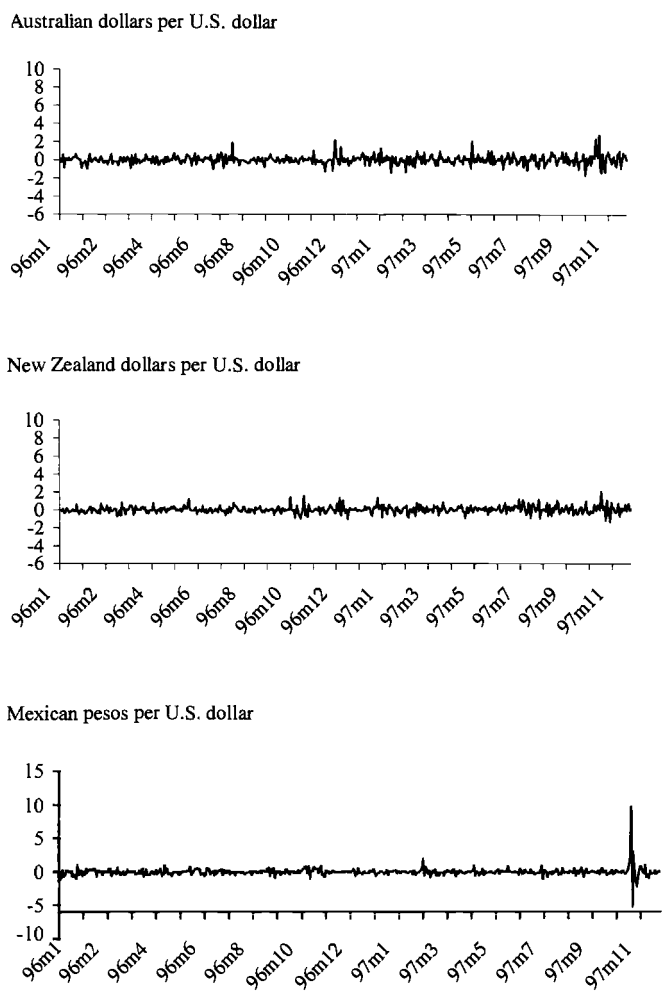


Fig. 6.4 Short-term variability of nominal exchange rates, January 1996–November 1997 (day-to-day percentage changes)

specific calendar years we are imposing arbitrary restrictions on the distribution of nominal exchange rates that prevent us from detecting important peculiarities of the behavior of the Mexican peso. In particular, it may be the case that the volatility measures of the Mexican peso for the years 1996–97 (and even 1995) are unduly influenced by large "volatility clusters" (de Vries 1994) and that, except for a few days (or weeks) with very large exchange rate fluctuations, the nominal peso-dollar rate is "excessively" stable for the most part of the year. To explore whether this is in fact the case, we broke the sample for the years 1995–97 into "turbu-

lent" and "calm" periods for each exchange rate. Specifically, we used the day-to-day percentage changes to construct monthly measures of volatility for each currency and ranked them in descending order. We then used the observations from the three months of each year when volatility was highest for each exchange rate to compute the volatility measures for the turbulent period and the observations from the other nine months to obtain the corresponding measures for the calm period of the year. The outcomes of these calculations are reported in table 6.4. Overall, the results are quite similar to those we obtained using all the observations for each calendar year: the Mexican peso still stands out as the most volatile currency in this group in 1995 (in both the turbulent and calm periods), and perhaps more important, the volatility of the peso-dollar exchange rate continues to be higher than that of the Canadian dollar and the French franc—and similar in magnitude to that of the New Zealand dollar—in the calm periods of 1996–97. Hence, these findings support our earlier conclusion: the relative stability exhibited by the Mexican peso over many intervals during 1996–97 is not at odds with the behavior of exchange rates in other countries generally regarded as having (some variant of) a floating exchange rate arrangement.[21]

One aspect of the behavior of the Mexican peso captured by the indicators in table 6.4, however, seems rather peculiar, namely, the marked shift in the (relative) degree of volatility between turbulent and calm subperiods. In fact, unlike the other currencies, which more or less preserve their pecking order in the scale of volatility in both subperiods, the peso-dollar exchange rate jumps ahead in the scale of volatility in turbulent periods. Indeed, table 6.4 shows that the degree of volatility of the peso-dollar rate during these subperiods was comparable to that of the three most volatile exchange rates in the sample (i.e., the mark-dollar, yen-dollar, and pound-dollar rates). These large shifts in the (relative) degree of volatility across subperiods[22] might reflect a different ("atypical") underlying distribution of nominal exchange rate changes for the Mexican peso or differences in the relation between the nominal exchange rate and other financial variables (e.g., interest rates) in the case of Mexico. We will come back to this issue later in the paper.

For the second exercise we followed the methodology developed by Rose (1994) and Flood and Rose (1995) to analyze the relation between exchange rate volatility and macroeconomic volatility across exchange regimes. The methodology helps to ascertain whether the increase in

21. Werner (1997) reaches a similar conclusion.

22. These shifts are also clear when one compares the ratio between the measures of volatility in turbulent and in calm periods. With the exception of Mexico, these ratios are quite similar across countries and over time (on the order of 1.5 to 1.6—and none, except for two, greater than 2). In the case of Mexico, however, these ratios are much larger than 2 in 1995 and 1997, and on the order of 1.8 in 1996.

Table 6.4 **Volatility of Daily Exchange Rates: "Turbulent" and "Calm" Periods, 1995–97**

Year and Measure	Germany (DM/US$)	Japan (yen/US$)	United Kingdom (pound/US$)	Canada (Can$/US$)	Australia (Au$/US$)	New Zealand (NZ$/US$)	France (FFr/DM)	Mexico (peso/US$)
1995								
Number of obs.	259							
Mean absolute % change	0.5474	0.6307	0.3435	0.2311	0.3569	0.2660	0.2553	1.3144
Standard deviation of % change	0.8032	0.9214	0.4874	0.3281	0.4818	0.3653	0.3707	2.3005
Three most volatile months[a]								
Number of obs.	68	64	66	66	65	66	68	65
Mean absolute % change	0.7354	0.9967	0.4929	0.3112	0.4533	0.3456	0.4015	3.2422
Standard deviation of % change	1.1134	1.2431	0.6464	0.4277	0.5673	0.4599	0.5531	4.2080
Other 9 months								
Number of obs.	191	195	193	193	194	193	191	194
Mean absolute % change	0.4805	0.5106	0.2924	0.2037	0.3246	0.2388	0.2032	0.6685
Standard deviation of % change	0.6617	0.7743	0.4006	0.2712	0.4498	0.3269	0.2803	1.0719

1996								
Number of obs.	260							
Mean absolute % change	0.3202	0.3435	0.2569	0.1396	0.2838	0.2477	0.1285	0.2592
Standard deviation of % change	0.4290	0.4557	0.3556	0.1922	0.4042	0.3504	0.1866	0.3461
Three most volatile months[b]								
Number of obs.	64	65	65	66	65	65	66	65
Mean absolute % change	0.4180	0.4076	0.3577	0.1993	0.3843	0.3433	0.1713	0.3917
Standard deviation of % change	0.5468	0.5862	0.4911	0.2620	0.5825	0.5125	0.2660	0.4789
Other 9 months								
Number of obs.	196	195	195	194	195	195	194	195
Mean absolute % change	0.2883	0.3221	0.2234	0.1193	0.2504	0.2158	0.1139	0.2151
Standard deviation of % change	0.3842	0.4039	0.2960	0.1623	0.3242	0.2780	0.1504	0.2894
1997[c]								
Number of obs.	237							
Mean absolute % change	0.4739	0.5167	0.4045	0.1981	0.4209	0.3356	0.1459	0.3363
Standard deviation of % change	0.6086	0.7174	0.5352	0.2585	0.5726	0.4471	0.2039	0.8485
Three most volatile months[d]								
Number of obs.	63	64	61	65	64	67	66	63

(*continued*)

Table 6.4 (continued)

Year and Measure	Germany (DM/US$)	Japan (yen/US$)	United Kingdom (pound/US$)	Canada (Can$/US$)	Australia (Au$/US$)	New Zealand (NZ$/US$)	France (FFr/DM)	Mexico (peso/US$)
Mean absolute % change	0.6211	0.7051	0.5370	0.2647	0.5827	0.4369	0.2402	0.6449
Standard deviation of % change	0.7420	0.9781	0.6967	0.3361	0.7768	0.5674	0.3032	1.5691
Other 8 months								
Number of obs.	174	173	176	172	173	170	171	174
Mean absolute % change	0.4205	0.4469	0.3585	0.1729	0.3611	0.2956	0.1095	0.2246
Standard deviation of % change	0.5545	0.5818	0.4686	0.2209	0.4784	0.3895	0.1502	0.3077

[a] *Germany:* March, May, and June. *Japan:* March, April, and September. *United Kingdom:* February, March, and May. *Canada:* March, September, and October. *Australia:* February, May, and October. *New Zealand:* February, March, and April. *France:* March, May, and October. *Mexico:* January, February, and March.

[b] *Germany:* January, February, and December. *Japan:* January, February, and April. *United Kingdom:* May, November, and December. *Canada:* January, February, and July. *Australia:* July, November, and December. *New Zealand:* March, October, and December. *France:* January, July, and November. *Mexico:* January, June, and October.

[c] January to November.

[d] *Germany:* January, August, and November. *Japan:* May, June, and August. *United Kingdom:* February, August, and November. *Canada:* January, May, and June. *Australia:* March, October, and November. *New Zealand:* July, August, and October. *France:* August, September, and October. *Mexico:* February, October, and November.

exchange rate volatility brought about by a switch from a fixed (managed) to a floating exchange rate regime is associated with a corresponding increase in macroeconomic volatility. To the extent that this is the case, "standard" macroeconomic fundamentals can be said to account for the high exchange rate volatility that characterizes floating rates (as with the Mexican peso in 1995–97). Conversely, if macroeconomic fundamentals do not change systematically across exchange regimes, one would have to conclude that the sources of the increased exchange rate volatility in a float are not macroeconomic in nature (this is, in fact, the main conclusion of Flood and Rose's analysis of the behavior of the nominal exchange rates of eight OECD economies before and after the breakdown of Bretton Woods). The methodology is useful for identifying potential fundamental determinants of exchange rates and is grounded on sound economic intuition. Simply put, it combines the fact that theoretical models typically assume that there exists a regime-invariant (linear) link between (nominal) exchange rates and "fundamentals" with the empirical observation that the conditional volatility of exchange rates rises sharply whenever a previously fixed or managed exchange rate is allowed to float. The testable corollary of these two premises is that any variable considered a potentially valid fundamental determinant of exchange rates also has to exhibit a significant increase in its conditional volatility with the switch from a fixed to a floating exchange regime.

The mechanics of the exercise are fairly straightforward. In the case of the simple flexible price monetary model of the exchange rate, the exercise starts from the three standard equations: (a) a structural money market equilibrium condition for the domestic country,

$$(1) \qquad m_t - p_t = \beta y_t - \alpha i_t + \varepsilon_t,$$

where m_t is the (natural logarithm of the) money supply in period t, p_t is the (log of the) price level, y_t is (the log of) real income, i_t is the nominal interest rate, ε_t is a money demand shock, and α and β are structural parameters; (b) a comparable equilibrium condition for the foreign country,

$$(1') \qquad m_t^* - p_t^* = \beta y_t^* - \alpha i_t^* + \varepsilon_t^*,$$

that assumes elasticities for real income and the interest rate equal to those of the home country; and (c) the assumption that PPP holds, at least up to a disturbance,

$$(2) \qquad p_t - p_t^* = e_t + v_t,$$

where e_t is the (log of the) nominal exchange rate (units of domestic currency per unit of foreign currency) and v_t is a stationary disturbance. It

then combines (a) through (c) to obtain the familiar exchange rate equation:

$$(3) \qquad e_t = (m - m^*)_t - \beta(y - y^*)_t + \alpha(i - i^*)_t - (\varepsilon - \varepsilon^*)_t - v_t,$$

which can also be expressed as

$$(3') \qquad e_t - \alpha(i - i^*)_t = (m - m^*)_t - \beta(y - y^*)_t - (\varepsilon - \varepsilon^*)_t - v_t.$$

In the case of other structural exchange rate models (e.g., sticky price models, portfolio balance models, and currency substitution models) the procedure would be similar, namely, obtain the reduced-form relation for the nominal exchange rate implied by the model, and then exploit the fact that the left-hand side and right-hand side of that relation represent, in theory, alternative ways of measuring the same latent variable: the "fundamental determinants" of the exchange rate. For example, Flood and Rose (1995) explicitly consider the alternative case of a sticky price model à la Frankel (1979) that relaxes the PPP assumption. Another alternative that would seem relevant for small developing economies—such as Mexico—would be a model that relaxes the assumption that monetary services are provided only by the domestic currency and, hence, allows a role for currency substitution in the determination of the exchange rate. One problem with these alternatives is that their corresponding reduced-form equations have multiple empirical specifications and therefore it is far more difficult to rely on the empirical literature to make reasonable assumptions about the values of the structural parameters necessary to implement the procedure. Thus, to simplify matters, and as a first approximation, we decided to stick to the familiar flexible price monetary model.

Flood and Rose (1995) call the left-hand side of equation (3') the virtual fundamentals (VF):

$$(4) \qquad \text{VF} \equiv e_t - \alpha(i - i^*)_t,$$

and the first two terms of the right-hand side the "traditional fundamentals" (TF):

$$(5) \qquad \text{TF} \equiv (m - m^*)_t - \beta(y - y^*)_t;$$

they also consider a variant of equation (5) that includes the term for money disturbances and call it "augmented traditional fundamentals" (ATF):

$$(6) \qquad \text{ATF} \equiv (m - m^*)_t - \beta(y - y^*)_t - (\varepsilon - \varepsilon^*)_t,$$

which, using equation (3), can be shown to be equal to

$$(6') \qquad \text{ATF} \equiv (p - p^*)_t - \hat{\alpha}(i - i^*)_t.$$

The thrust of this approach consists of comparing the time-series characteristics of VF, TF, and ATF (the only difference between the latter two being the money disturbance term $(\varepsilon - \varepsilon^*)_t$). As noted above, the underlying hypothesis is that if the model is a useful approximation of reality, virtual and traditional fundamentals should exhibit similar time-series properties. If they do not, then either the model is faulty, measurement errors are pervasive, or both. To deal with the possible nonstationarity of the data, Flood and Rose (1995) propose using the conditional volatility (i.e., the standard deviations of the first differences of VF, TF, and ATF) as the metric for the comparison. They also stress that the methodology does not require strong assumptions about the processes of the forcing variables (including, in particular, assumptions about exogeneity); all it requires, aside from the raw economic data, is "reasonable"—that is, empirically sound—assumptions about the values of the structural parameters α and β.

To apply this methodology to the peso-dollar exchange rate we used monthly data for Mexico and the United States for the period January 1991–October 1997.[23] We assumed that Mexico was the domestic country and used consumer price indexes (CPIs) to measure prices, narrow money (M1) data to measure the money supply, industrial production indexes as a proxy for real income, and the return on one-month treasury bills as interest rates.[24] All the series were transformed by natural logarithms, except for the interest rates—which were measured as nominal rates divided by 100. Following Flood and Rose (1995), we chose $\alpha = 0.5$ and $\beta = 1.0$ as the benchmark values in the computation of VF, TF, and ATF and checked the sensitivity of the results to two alternative values for α (0.1, 1.0) and β (0.5, 1.5).

Figure 6.5 shows the plots of the levels (*left*) and first differences (*right*) of the three measures of the fundamentals of the peso-dollar exchange rate using the benchmark values $\alpha = 0.5$ and $\beta = 1.0$ for the period January 1991–June/October 1997. Since we are interested in the conditional innovations of the fundamentals—more precisely, in comparing those innovations before and after the devaluation of December 1994—the plots of the first differences are the objects of greatest interest.[25] Visual inspection of the plots suggests, first, that the volatility of the virtual fundamentals of the Mexican peso increased markedly following the December 1994 deval-

23. All the data for this exercise were extracted from the IMF's *International Financial Statistics*. For a few series—e.g., industrial production indexes—the latest observations at the time of writing were for June 1997.

24. We also used the monetary base to conduct this analysis. The results were essentially the same.

25. If the fundamentals follow a random walk—as conventional unit-root tests applied to high-frequency data on the underlying variables typically suggest—then the first difference is also the innovation (see Edwards and Savastano 1998).

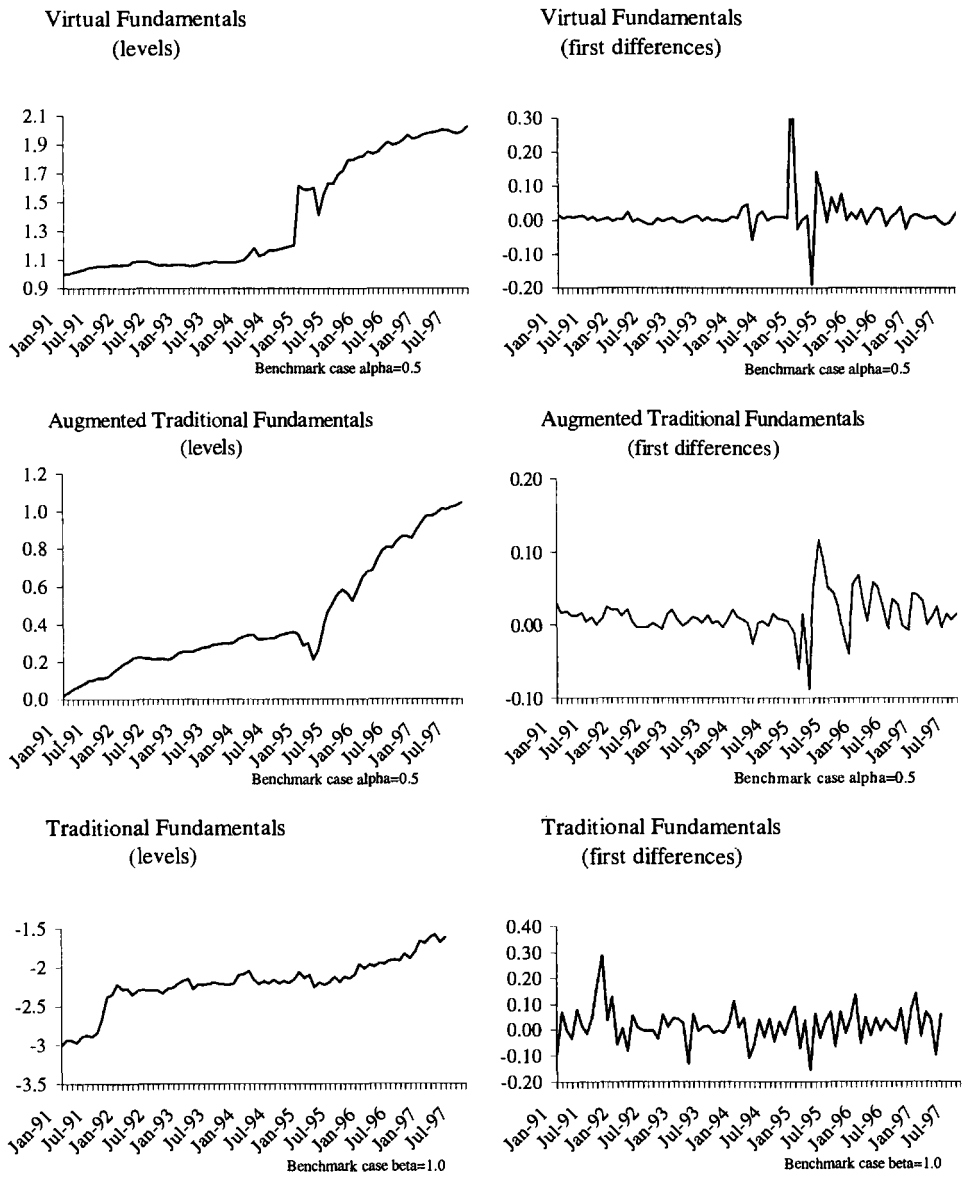


Fig. 6.5 Mexican peso: "virtual" and "traditional" fundamentals, January 1991–October 1997

Table 6.5 **Fundamental Volatility of the Mexican Peso, 1991–97 (monthly data)**

	Standard Deviation of First Differences			
	Full period (1991:1–1997:10)	Predevaluation (1991:1–1994:11)	Postdevaluation (1995:1–1997:10)	Volatility Ratio[a]
Log exchange rate	0.058	0.011	0.087	8.20
Benchmark case $\alpha = 0.5, \beta = 1.0$				
VF	0.056	0.014	0.083	5.84
ATF	0.027	0.009	0.039	3.96
TF	0.069	0.071	0.068	0.96*
Sensitivity				
$\alpha = 0.1$				
VF	0.056	0.011	0.084	7.68
ATF	0.012	0.006	0.014	2.52
$\alpha = 1.0$				
VF	0.066	0.020	0.098	4.85
ATF	0.052	0.017	0.078	4.70
$\beta = 0.5$				
TF	0.061	0.066	0.054	0.83*
$\beta = 1.5$				
TF	0.082	0.080	0.086	1.07*

[a]Ratio of sample standard deviations for the two subperiods (postdevaluation/predevaluation).
*The null hypothesis of equal volatility in the two subperiods cannot be rejected at the 0.05 confidence level (0.05 critical value for $F(30,50)$ is 1.7).

uation; second, that the volatility of the augmented traditional fundamentals was also higher in the period following the devaluation; and, third, that the volatility of the traditional fundamentals did not change systematically after the adoption of a floating exchange rate. The first and last features are broadly in line with the findings of Flood and Rose (1995) for their sample of eight OECD economies (and the first is also consistent with our earlier analysis of the volatility of the peso-dollar rate). However, the second feature—the fact that the volatility of ATF increased after the devaluation—seems at odds with the results obtained by Rose (1994) and Flood and Rose (1995).

The information contained in these plots can be analyzed more rigorously with the help of table 6.5. The table presents estimates of the standard deviations of the first differences of VF, ATF, and TF for the whole period, as well as for the periods before and after the December 1994 devaluation, for different values of the parameters α and β. In addition, the last column contains estimates of the *ratio* of the standard deviations of the first differences of fundamentals in the period following the devaluation (the floating period) to the standard deviation of the corresponding

variables in the period prior to the devaluation.[26] The estimates in the table support our interpretation of the plots in figure 6.4. The sample standard deviations show a marked increase in the level of volatility in the series of VF and ATF since the devaluation of December 1994 for all values of α and similar levels of volatility across periods for all the series of TF. In fact, the estimates of the "volatility ratio" in the last column of table 6.5 indicate that the null hypothesis of no increase in conditional volatility during the float is rejected for all the VF series *and* all the ATF series at any reasonable level of statistical confidence, while such a hypothesis cannot be rejected for any of the TF series. This basic result did not change when we computed the standard deviations (and the volatility ratio) excluding December 1994 and some or all of the observations for 1995 from the second subsample—although in these cases the increases in the level of volatility of the VF and ATF series were considerably smaller.[27]

These results suggest that in contrast with the OECD experiences examined by Flood and Rose (1995), the increase in the level of volatility of the virtual fundamentals of the peso-dollar rate during the first three years of the float *was* accompanied by an increase in the level of volatility of (some) macroeconomic fundamentals. Put differently, in the case of Mexico the evidence from 1995–97 does not rule out completely the possibility that the determinants of nominal exchange rate volatility were macroeconomic in nature. That said, the evidence also indicates that the likely sources of the increase in macroeconomic volatility in that period were shocks to (relative) money demand—which, as we noted earlier, is the only difference between TF and ATF. We find this quite interesting. More unstable (less stable) money demand would normally call for some change in the operating procedures of monetary policy, especially when the shocks are "permanent" (regime-specific) in nature and when those procedures entail some type of targeting of monetary aggregates. According to the evidence above, however, Mexico's monetary policy—crudely proxied by the behavior of TF—did not seem to change significantly after the country adopted a floating exchange rate regime in 1995. In principle, this would tend to undermine the effectiveness of monetary policy, in particular its ability to achieve the desired combination of inflation and output outcomes, and may be a factor behind the anomalies in the behavior of the peso-dollar rate discussed earlier in this section. The finding could also be taken as

26. Following Flood and Rose (1995) we report the ratio of standard deviations rather than the corresponding F-statistics to highlight those cases where fundamental volatility was actually lower during the float than in the previous period. The relevant F-statistic can be obtained by squaring the ratio presented in the table (provided that the ratio is greater than one). Of course, the ratio of regime-specific sample variances that will be obtained by this procedure, suitably adjusted by degrees of freedom, will be distributed as F only if the first differences of the fundamentals are normally distributed (which may not be the case).

27. To conserve space, these results are not reported in table 6.5. They are available on request.

evidence that the BOM continued to take into account the behavior of the exchange rate in conducting monetary policy in the months that followed the December 1994 devaluation. We explore this issue in greater detail in section 6.4.

6.4 The Bank of Mexico and the Peso-Dollar Rate in 1995–97

The peso devaluation of December 1994 imparted a severe blow to the credibility of the BOM. The damage became acutely apparent in the first quarter of 1995, when uncertainties about Mexico's capacity to redeem in full its large stock of short-term debt and about its authorities' resolve to confront the crisis led to an enormous depreciation of the peso that rendered obsolete the monetary program announced by the BOM in mid-January. A critical turning point was reached in March and April, following the securing of the US$52 billion international support package arranged by the IMF and the U.S. Treasury and the authorities' announcement of a revised (and more realistic) set of macroeconomic policies and targets for 1995. The draconian tightening of monetary policy that accompanied these developments—with Cetes interest rates remaining above *70 percent* for several weeks—put an end to the freefall of the peso and gradually restored calm to financial markets.

From then on, the BOM confronted the arduous task of restoring its tarnished credibility. To this effect, its authorities reiterated publicly and repeatedly that the primary objective of its monetary policy was to arrest the inflationary effects of the peso depreciation and to rapidly bring inflation down to moderate levels, that the exchange rate and interest rates would be freely determined by market forces, and that they would refrain from imposing any type of control or restriction on capital movements. The BOM also made it clear that other (secondary) objectives of its monetary policy were to prevent "excessive" fluctuations in the value of the peso, to rebuild its stock of international reserves, and to provide limited (and mainly technical) assistance in the restructuring of the badly damaged banking system. To underscore its resolve to increase the transparency of its actions and policies, the BOM made available to market analysts and the public at large timely information on its balance sheet and other monetary and financial indicators and stepped up its efforts to disseminate and explain the (various) initiatives being adopted to deal with the unfolding crisis in the banking system.

Financial analysts and other observers of the Mexican economy gave a lukewarm reception to these bold initiatives and, throughout 1995, raised repeated objections to the BOM's monetary policy. Some criticized the (revised) annual inflation target of 42 percent—on the grounds of its being either unambitious or unattainable. Others questioned the overall policy framework, in particular, the BOM's decision to adopt—and its intention

to abide by the rules of—a floating exchange rate. The arguments offered in support of these criticisms were quite unwieldy. The most sophisticated observers based their assessment of the stance (and likely consequences) of the BOM's monetary policy on mechanical applications of the quantity theory of money, variants of interest rate parity conditions, or simple PPP-based calculations. Others, a vast majority, based their objections on anecdotal evidence, personal intuition, and noneconomic considerations.

Sometime in 1996 the tenor of the concerns about Mexico's monetary policy started to change. The numerous worst-case scenarios advanced in 1995 were shelved one after another in light of a series of favorable developments including a steady fall in the rate of inflation,[28] signs of an early rebound in output growth, the turnaround of the external current account balance, the repayment in full of the stock of Tesobonos, and Mexico's successful reentry into international capital markets.[29] At this point, a more constructive debate about the actual priorities and operating procedures of the BOM's monetary policy took center stage. In particular, as noted in section 6.3, a number of analysts started to argue that the BOM was gearing its monetary policy, through changes in short-term interest rates, to maintaining an artificially strong peso. Underlying this view was the observation that since mid-1995, periods of relative nominal exchange rate stability and falling interest rates had been interrupted by episodes of exchange rate depreciation and interest rate rises that were reversed quickly and, hence, did not serve to arrest the real appreciation of the peso (see fig. 6.6).[30]

Throughout 1996–97 the BOM systematically dismissed these arguments, considering them misguided and unfounded. Specifically, the BOM maintained the position that its monetary policy was not geared toward attaining or maintaining any particular *level* of the exchange rate *or* of interest rates, that these variables were freely determined by market forces, and that its monetary policy actions were guided solely by the dual objectives of securing its annual inflation target and ensuring orderly functioning of the money and foreign exchange markets (Gil-Diaz 1997). But the

28. The monthly rate of CPI inflation peaked at 8 percent in April 1995, averaged 2.5 percent from June 1995 to April 1996, and stayed below 2 percent from May to November 1996. The twelve-month rate of inflation peaked at 52 percent in December 1995 and fell steadily thereafter.

29. On Mexico's external debt strategy following the 1994 crisis, see Andrews and Ishii (1995) and IMF (1996). For an overview of the main macroeconomic developments in Mexico in 1995 and early 1996, see OECD (1996).

30. Fig. 6.6 shows that from late 1995 to September 1997 it is possible to identify visually at least six episodes, or cycles, of "spikes" in the nominal exchange rate and interest rates followed by relatively long periods of exchange rate stability and falling interest rates; the approximate starting date of these episodes were October–November 1995, February–March 1996, June–July 1996, October 1996, March 1997, and June 1997. The figure also shows that over time, the spikes became smaller in size and there was some upward ratcheting in the nominal exchange rate as well as a clear downward trend in nominal interest rates.

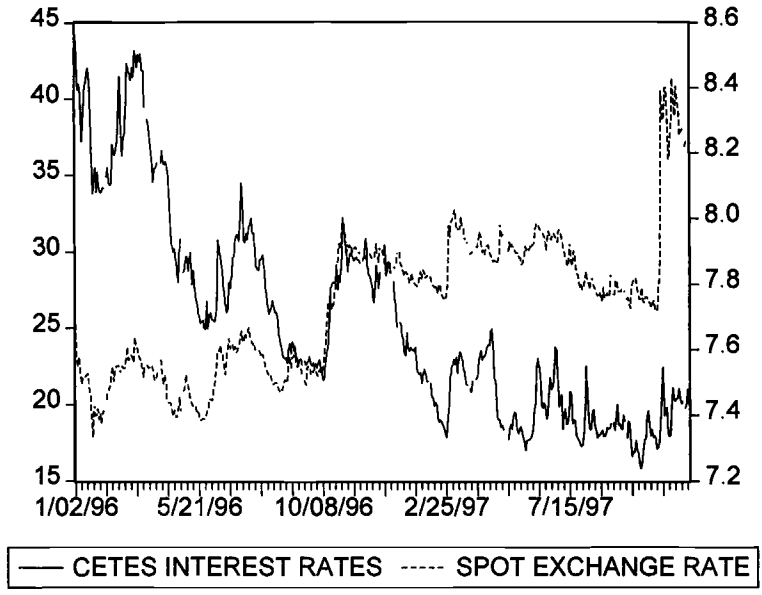


Fig. 6.6 Daily peso-dollar rate and daily Cetes rate (secondary market)

debate on what the BOM really did continued. On 3 October 1997, J. P. Morgan's *Emerging Markets Data Watch* noted: "It has often been argued in the past year or two that Banxico has been exacerbating upward pressure on the peso by tightening monetary policy" (6), and David Malpass, chief economist of Bear Stearns, stated in the *Wall Street Journal* that "Mexico stopped its economic and financial deterioration almost overnight [in the aftermath of the 1994 devaluation] by announcing a feedback mechanism between the exchange rate . . . and . . . monetary liquidity."[31]

Central banks often act in ways that do not exactly correspond to their pronouncements. Notwithstanding the emphasis that the recent literature on central banking places on the *transparency* of monetary policy,[32] there is nothing intrinsically wrong or unusual about that type of behavior. In fact, a number of analysts have used statistical methods to shed light on the systematic component of central banks' actions that is not reflected in their public pronouncements in order to obtain a better understanding of what it is that central banks really do. Taylor's (1993) analysis of the Fed's behavior since the 1960s is perhaps the best known example of this approach. More recently, Clarida and Gertler (1997) tried to infer from the

31. "Free Float to Disaster," *Wall Street Journal,* 20 October 1997, A23.

32. See, e.g., the discussion in Federal Reserve Bank of Kansas City (1996) and Romer and Romer (1997).

data the way in which the German Bundesbank conducts monetary policy and found that in practice, the actual conduct of this policy differed significantly from the official line.[33] In Edwards and Savastano (1998) we used high-frequency (weekly) data to analyze Mexico's monetary policy during the first three years of the float. In the rest of this section we use daily data to investigate the behavior of some key macroeconomic variables—including the behavior of the monetary base—in an attempt to shed some light on the operations of the BOM.

We acknowledge at the outset that given Mexico's very limited experience with a floating exchange rate regime, the task of identifying what the BOM really did in the first three years after the 1994 crash is extremely difficult. In fact, those who have undertaken this type of challenge for advanced countries with at least twenty-five years of data have found it to be a very "complex issue, one that . . . [their] analysis cannot fully resolve" (Clarida and Gertler 1997, 364). But we consider it a worthy endeavor. The rest of the section is divided in two parts: subsection 6.4.1 presents a description and brief discussion of the conduct of monetary policy by the BOM; subsection 6.4.2 undertakes a preliminary examination of the behavior of key macroeconomic variables in the days following large depreciations of the peso.

6.4.1 The Bank of Mexico's Monetary Policy: The Official View

At a very general level, the BOM's approach to monetary policy seems quite standard and straightforward. Abiding by its constitutional mandate to maintain price stability, at the end of every year the BOM—in conjunction with the rest of the economic team—chooses and announces an endpoint inflation target for the following calendar year and specifies a time path for the demand for money consistent with that inflation target and with the expected evolution of output, interest rates, and other macroeconomic variables.[34] Based on a number of considerations, including its relative stability over long periods of time, the monetary aggregate preferred by the BOM is the monetary base.[35] The BOM's conduct of monetary policy throughout the year is therefore geared primarily at keeping the intermediate target (the monetary base) on (close to) its prespecified path, taking due account of new (unexpected) developments in the economy.

33. Bernanke and Mihov (1997) reached a similar conclusion using (slightly) different vector autoregression techniques. The Bundesbank's official view on monetary policy, however, has remained the same (see Issing 1997).

34. The announcement usually takes place in the context of the presentation to Congress of the economic program for the following year, which is spelled out in a document called "Criterios Generales de Política Económica."

35. Since the adoption of a system of zero reserve requirements on deposits in the early 1990s, Mexico's monetary base is approximately equal to the amount of currency in circulation.

Seen in this way, the BOM's approach to monetary policy resembles a conventional two-stage intermediate target procedure, which, given the BOM's revealed preference for the monetary base, can be thought of as a framework of "base money targeting."

At a more detailed level, however, the BOM's conduct of monetary policy looks somewhat less conventional. This is so for two main reasons. First, the BOM combines its annual estimates of the demand for monetary base and (historical) information on seasonal fluctuations in that monetary aggregate to produce quarterly, monthly, and *daily* estimates of the demand for base money. And second, unlike the majority of central banks, the BOM does not use short-term interest rates as an operating target to guide its daily operations or modify the stance of monetary policy. Instead, since 1995 the BOM has used a system of cumulative balances with commercial banks (also known as *reserve averaging around zero*) to guide its daily supply of liquidity to the economy. It is through changes in the BOM's objective for the system's cumulative balance that the monetary authority conveys signals (to banks) about its desired stance of monetary policy (see O'Dogherty 1997).

Strict adherence to this short-term operating procedure implies that in "normal" times (days), the BOM's monetary policy consists mainly of accommodating or satisfying all the liquidity (currency) demanded by the banks provided that they are in compliance with the existing objective for the system's cumulative balance.[36] In those times, BOM actions arguably do not exert a major influence on (nor are they influenced by) the exchange rate or interest rates; all movements in these variables are, in principle, market-determined outcomes (Gil-Díaz 1997). According to the official view, the role of the daily estimates of the demand for monetary base in normal times is rather limited. Those estimates provide a benchmark against which BOM officials can compare the amount of liquidity demanded by the banks on a given day or week, but not much else. The daily assessment of monetary conditions by the BOM board, the argument goes, takes precedence over the (inherently inaccurate) estimates of daily money demand when deciding the amount of liquidity the BOM will inject into the system. A key premise behind this course of action is, clearly, that the banks' daily demand for liquidity reflects (or provides a better estimate of) the "true" demand for monetary base that the BOM has to satisfy to ensure orderly functioning of the money market.

As noted above, however, that operating procedure leaves scope for the

36. The actual measurement of compliance is a rather complicated process that depends crucially on the period over which the cumulative balances are computed (the maintenance period) and the net position of individual banks vis-à-vis the BOM. See Aguilar and Juan-Ramón (1997) and O'Dogherty (1997).

BOM to conduct more "active" monetary policy if it so wishes. Concretely, if for whatever reason the BOM decides at a given point in time that market conditions require or justify a change in the stance of its monetary policy, the BOM will signal that decision to the market (more precisely, to the banks) by changing its objective for the system's cumulative balance. Specifically, BOM officials argue that they can and will announce, and thereafter enforce, a lower objective for the system's cumulative balance if they want to tighten the stance of monetary policy and a higher objective if they wanted to ease monetary conditions. According to their view, these signals—and the ensuing enforcement of the new objectives for the cumulative balance—will alter the short-run behavior of banks and, through their actions, market interest rates in the desired direction: that is, interest rates will rise when the BOM tightens its stance and will fall in the opposite case. These policy-induced changes in market interest rates will, in due course, affect the demand for monetary base also in the desired direction, thus contributing to eliminate the (perceived) disequilibrium in the money market (Gil-Díaz 1997).

We will refrain from assessing the analytical consistency of the BOM's view of monetary policy as described, for example, in the articles cited above. We leave that daunting task for another occasion. We will say, however, that we find it peculiar that the BOM seems more comfortable casting the discussion of its monetary policy over (extremely) short horizons than over the longer term (say, six months or a year). All central banks conduct day-to-day operations in a number of markets using a variety of (direct and indirect) instruments. Few of them feel compelled to describe the nitty-gritty of their daily operating procedures when asked to characterize their framework for monetary policy. There are many good reasons for this, but, in our view, none more important than the long and variable lags that are normally thought to undermine the short-run effectiveness of monetary policy. The BOM's view of monetary policy as equivalent to daily liquidity management turns this old argument on its head. We are also puzzled by the small number of episodes, during 1996–97, in which the BOM acknowledges having modified the stance of its monetary policy, and therefore having influenced the short-run behavior of interest rates and the exchange rate, in response to market developments. By its own reckoning, the BOM changed the stance of its monetary policy fifteen times between 25 September and 25 December 1995 and eight times between December 1995 and November 1996 and kept the stance unchanged (at a "neutral" level—i.e., a cumulative balance of zero) during the first three quarters of 1997 (Gil-Díaz 1997; Aguilar and Juan-Ramón 1997). It follows from this that, according to the BOM, all movements of interest rates and the exchange rate in, say, the first semester of 1997 (or in any other long period between changes in the BOM's objective for the system's cumulative balance) did not justify or elicit a response from monetary

policy. Such an implication merits, at least, a closer look at the data. We took on the challenge.

6.4.2 What Did the Bank of Mexico Really Do in 1996–97? An Exploratory Investigation

In this subsection we use daily data in an effort to gain some understanding of the way in which the BOM conducted monetary policy in the immediate postcrisis period. Our analysis relies on high-frequency data for two reasons: first, the short period of time elapsed since the adoption of the floating system leaves us with no alternative but to use every data point available; second, and as noted before, the BOM stated explicitly that its monetary policy during 1996–97 was aimed at satisfying the demand for monetary base on a daily basis. The subsection is organized as follows: We start by analyzing briefly the evolution of the daily target for the monetary base and comparing its behavior to that of the actual monetary base. This analysis shows that especially during 1997, there were important deviations between target and actual base money. We then examine the behavior of a number of key variables in the periods surrounding thirty large daily peso depreciations.

Figure 6.7 presents daily data on the evolution of target and actual monetary base (in billions of pesos) during 1996–97. The figure shows that between January 1996 (the first date for which we have BOM forecasts of the daily demand for monetary base) and the end of January 1997, the deviations between these two variables were rather small. Starting in February 1997, however, the actual monetary base persistently exceeded the estimated (target) base—the median daily deviation for this period was significantly higher than for the January 1996–January 1997 period. The BOM explained these discrepancies by arguing that during most of 1997 the rate of remonetization was stronger than anticipated and that in estimating the demand for money it had missed important seasonal variations, including the surge in the demand for cash during Mother's Day weekend, and the faster than expected rate of growth of GDP during that year.[37] Figure 6.8 presents the proportional deviations between actual and target base—a variable we have called "excess liquidity." Panel *A* displays the actual deviations between actual and target base, while panel *B* presents a *detrended* excess liquidity index. Both panels, however, tell a similar story: the excess liquidity indexes exhibited considerable variability during 1996–97. An important question is whether these deviations from the daily targets for monetary base (released to the public in late 1996 in an effort to increase the transparency of the BOM's monetary policy) were the

37. On reactions to the overshooting of the base money target in early 1997, see, e.g., "Mexico Central Bank Primes Economy; Critics See Attempt to Sway Elections," *Wall Street Journal,* 27 May 1997. See also a related story in the *New York Times,* 29 May 1997.

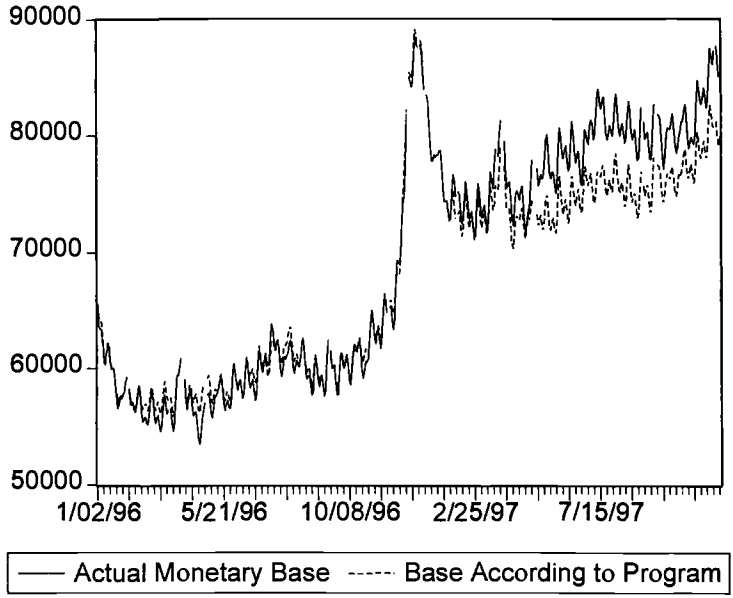


Fig. 6.7 Actual and target monetary base: daily data, 1996–97

result of deliberate policy responses to developments deemed undesirable by the BOM—including exchange rate changes—or whether they represented a combination of noise and the BOM's stated policy of simply accommodating banks' actual demand for liquidity on a daily basis. The analysis below addresses precisely this question.

In table 6.6 we present data on the behavior of a number of key variables in the days surrounding thirty large daily depreciations of the peso-dollar rate during the period January 1995–November 1997. The first ten episodes correspond to the ten largest peso depreciations of 1995, while the other twenty consist of the largest depreciations observed during 1996–97.[38] Column A is the episode's date; column B is the one-day depreciation of the peso; column C contains data on the change (in basis points) in the twenty-eight-day Cetes interest rate in the secondary market one day after the depreciation episode relative to one day prior to the depreciation; column D contains the change in the Cetes primary interest rate in the period spanning from the Cetes auction prior to the depreciation to the first auction after the depreciation; column E presents the change in the monetary base that had been programmed (estimated) to take place in the period spreading from the day prior to the depreciation to five days

38. This allowed us to have episodes from all three years. Since the exchange rate was significantly more volatile in 1995 (see section 6.3), had we chosen the thirty largest depreciations for the three-year period as a whole we would have ended up mostly with 1995 episodes.

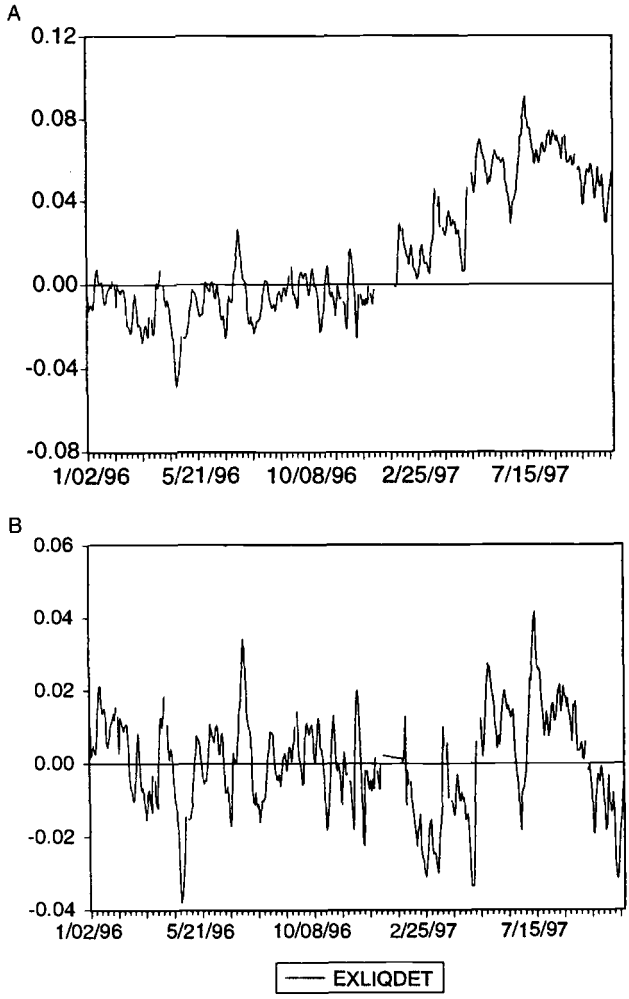


Fig. 6.8 Excess liquidity index: (*A*) daily data and (*B*) detrended, daily data, 1996–97

after the depreciation; column F is the actual change in the monetary base during the same period; and column G presents the change in the detrended liquidity index in the five days following the depreciation.[39]

The information contained in table 6.6 is a first step in the effort to elucidate the behavior of the BOM in the first three years of the float. We

39. The data on the 1995 episodes are restricted to exchange rate and Cetes interest rate movements because data on the BOM's daily estimates of the monetary base for 1995 (if they exist) were not made available to us.

Table 6.6 **Ten Largest Peso Depreciations of 1995 and Twenty Largest Peso Depreciations from January 1996 to November 1997**

Date A	Depreciation (%) B	Change in Cetes Rate from Previous Day (basis points) C	Auction-to-auction Change in Cetes Rate (basis points) D	Programmed Change in Monetary Base over 5 Days E	Actual Change in Monetary Base over 5 Days F	Detrended Cumulative Excess Liquidity over 5 Days G
3 Jan 1995	6.60	700	200	–	–	–
4 Jan 1995	4.76	300	700	–	–	–
6 Jan 1995	6.60	900	700	–	–	–
10 Jan 1995	6.67	200	700	–	–	–
30 Jan 1995	9.64	−233	−444	–	–	–
3 Mar 1995	4.67	0	829	–	–	–
9 Mar 1995	5.45	300	2,439	–	–	–
15 Mar 1995	4.38	500	27	–	–	–
26 Oct 1995	6.63	350	302	–	–	–
8 Nov 1995	4.35	680	575	–	–	–
23 Jan 1996	1.32	170	−80	−1,072.8	−1,104.9	−0.00086
8 Mar 1996	1.02	135	76	2,027	1,957.43	−0.00082

2 May 1996	0.81	330	101	575.2	565.9	0.00843
11 Oct 1996	0.72	105	316	2,607.46	2,498.99	−0.00194
14 Oct 1996	0.84	190	316	538.36	−208.54	−0.01242
16 Oct 1996	0.8	260	180	−1,000.5	−2,650.6	−0.02746
23 Oct 1996	0.77	−55	164	1,400.36	2,433.37	0.01666
30 Oct 1996	0.82	220	11	1,232.57	1,329.14	0.00142
27 Feb 1997	2.23	290	257	1,403.63	1,744.18	0.00361
28 Apr 1997	1.09	−35	−134	−3,077.0	−3,555.5	0.046
15 Jul 1997	0.84	125	−53	−1,777.5	−3,830.3	−0.02609
29 Aug 1997	0.81	35	−206	187.74	86.2	−0.00245
23 Sep 1997	0.89	−55	−26	556.02	750.93	0.00121
23 Oct 1997	1.00	155	368	2,670.19	4,004.68	0.01479
24 Oct 1997	1.01	335	368	3,100.09	5,309.37	0.02542
27 Oct 1997	6.24	375	368	1,885.79	4,110.53	0.02632
30 Oct 1997	1.08	55	−199	2,376.86	3,102.17	0.00682
6 Nov 1997	0.79	310	222	3,138.21	2,909.63	−0.00603
7 Nov 1997	1.67	30	222	3,554.94	4,230.98	0.00489
12 Nov 1997	1.08	20	−82	2,608.33	4,970.69	0.02654

are particularly interested in understanding the behavior of interest rates and of the monetary base in the days following a large depreciation. If the BOM was concerned about the value of the peso, we would expect the monetary base to fall in the days following a sharp exchange rate jump; likewise, we would expect an increase in nominal interest rates during those periods.[40] In analyzing this table it is useful to consider three subperiods. The first covers 1995, a year of great turbulence in Mexico's foreign exchange market. The second period runs from January 1996 through mid-1997 and corresponds to the period when, according to many private analysts, the BOM geared its policy toward maintaining a stable peso. The final period covers the latter part of 1997, when the BOM became less reluctant to let the peso depreciate (Edwards and Savastano 1998).

Several interesting facts emerge from this table. First, in twenty-two of the thirty episodes there is an increase in the auction-to-auction primary Cetes interest rates. Second, and highly related, in twenty-six of the thirty episodes the secondary market Cetes interest rate rises in the day following the depreciation. A possible explanation for these results—and one we explore in greater detail in Edwards and Savastano (1998)—is that the BOM reacted to (relatively) large losses in the value of the peso by tightening liquidity relative to its daily target, thus putting upward pressure on interest rates. The BOM has acknowledged that it indeed tightened liquidity in the periods following some, but not all, of these depreciation episodes. For example, on 9 November 1995 the BOM lowered significantly its objective for the system's cumulative balance—a measure that at least according to the official view, would signal a willingness to *relax* (rather than tighten) the monetary stance. A similar measure was taken in 23 and 25 January 1996 (Aguilar and Juan-Ramón 1997). Interestingly, however, the BOM denied that it *systematically* tightened liquidity in response to large peso depreciations during this period and also that it defended or targeted any particular *level* of the peso-dollar rate. Moreover, as noted before, according to official pronouncements, there was no change in the stance of monetary policy (exchange rate motivated or not) between October 1996 and November 1997. The BOM's (semi)official explanation for the apparently systematic relation between peso depreciations and interest rate rises captured in table 6.6 is that the increases in (Cetes) interest rates are market-determined outcomes; concretely, they are simply a reflection of a higher expectation of depreciation in the context of interest arbitrage conditions. One problem with this explanation is that it requires the public's expectations of peso depreciation to exhibit some degree of persistence; econometric analysis of the time-series properties of (actual) daily depreciations, however, suggests strongly that they were "white noise" during 1996–97.

40. Naturally an increase in interest rates could also reflect an increase in the expectations of devaluation. For reasons we explain below, this does not seem to be the case, however.

Columns E, F, and G in table 6.6 help to shed some light on monetary policy in the periods surrounding large peso depreciations. We are particularly interested in comparing the actual monetary stance taken by the BOM in the days following these depreciations with the policy implied by the original forecasts. We compared the cumulative targeted and cumulative actual increases in the monetary base five, ten, and fifteen days following each depreciation episode. Interestingly enough, these figures suggest an important change in behavior in late September 1997, when the BOM signaled that it would be willing to adopt a more relaxed monetary stance. As may be seen, between January 1996 and August 1997—a period that has been characterized as more "conservative"—monetary policy was tighter than programmed in eight of the twelve depreciation episodes. We can also see that after September 1997, following the BOM announcement of a more relaxed monetary stance, the pattern of base money tightening following a large depreciation all but disappeared. Although this analysis is very preliminary and does not control for the potential role of other variables, it does suggest that from January 1996 to September 1997 the BOM did take into account the behavior of the peso when deciding how much liquidity to provide, every day, to the banking system. In Edwards and Savastano (1998) we explore this issue further and conclude, based on results from various econometric tests, that during 1996–97 the BOM indeed had a feedback rule linking the rate of expansion of base money to the rate of depreciation of the peso.

6.5 Concluding Remarks

The Mexican peso crisis of December 1994 shocked politicians, analysts, and pundits. Many asked how a country wildly hailed as an example of economic strength could collapse so rapidly. Shock was followed by panic, as domestic and international investors flew the country and tried to undo their positions. As 1995 unfolded it seemed increasingly clear that default on the rapidly maturing Tesobonos was more than a distant possibility. It took a massive bailout package put together by the IMF and the U.S. Treasury to generate some tranquility in the markets in mid- to late 1995.

From early on the Mexican authorities stated that stabilizing the value of the peso, within the context of a freely floating exchange rate regime, was one of their most important policy objectives. During most of 1995 this objective seemed highly elusive. Starting in 1996, however, the peso began to exhibit an impressive degree of stability. So much so that a number of analysts in the media and in academic and financial circles began to wonder whether this stability was consistent with a freely floating regime. Some even argued that it was "déjà-vu all over again" and that the BOM was manipulating monetary policy in order to maintain artificially a strong peso. At the core of this concern was the notion that by following

this policy the BOM was setting the stage for another round of currency overvaluation that would end in a crash.

In this paper we have tried to explain the relative stability exhibited by the peso-dollar nominal exchange rate since late 1995. Specifically, we approached this issue from two main angles: First, we asked whether the behavior of the peso-dollar rate since 1995 is broadly comparable to or consistent with the behavior of a "typical" floating exchange rate. Our answer to this question was a qualified yes. Second, we focused on thirty large one-day depreciations to ascertain whether the BOM reacted in a systematic manner to those events. Our answer to this question was another qualified yes, but perhaps more strongly qualified than the first one.

We address the first question in section 6.3, where we used standard measures of exchange rate volatility (the mean absolute value of percentage changes and the standard deviation of percentage changes) to compare the behavior of the peso-dollar rate from 1991 to 1997 with that of seven other floating exchange rates—all of them from industrial countries. We conducted the comparison at daily, weekly, and monthly frequencies for every year and checked whether the "calendar-year window" imposed arbitrary restrictions on the distribution of exchange rates that may prevent us from detecting important peculiarities in the behavior of the Mexican peso. The two most interesting findings from this exercise were, first, that the degree of volatility of the Mexican peso in 1995 was an order of magnitude higher than that of the typical floating exchange rate and, second, that in 1996–97 the degree of volatility exhibited by the Mexican peso was broadly in line with that of the seven other currencies in the sample.

The first finding simply reflects that the financial mayhem that beset Mexico in 1995 turned the peso into a complete outlier in terms of volatility. This suggests to us that in periods when the fundamental issue is lack of confidence in the government's response to an external liquidity crisis—that is, in periods of widespread panic—there are simply no good yardsticks for assessing the behavior of floating exchange rates. The fundamental priority in those periods is to arrest the freefall of the currency through a credible tightening of monetary policy. The second finding, on the other hand, suggests that the relative stability of the Mexican peso in 1996–97 was not "excessive" or grossly at odds with the behavior of other floating rates. True, the peso was less volatile than the currencies of countries widely regarded as having the "cleanest" floats (the G-3 and the United Kingdom), but it was as or more volatile than other floating exchange rates.

In the second part of section 6.3 we applied the methodology developed by Flood and Rose (1995) to examine the relation between nominal exchange rate volatility and macroeconomic volatility in several OECD countries to the case of Mexico. Our results suggest that unlike the OECD experiences, the increase in volatility of the peso-dollar rate under the current float was accompanied by an increase in the volatility of some macroeconomic fundamentals. We took this as an indication that the evidence

did not rule out the possibility that the determinants of nominal exchange rate volatility in Mexico between 1995 and 1997 were indeed macroeconomic in nature. It also left open the possibility that the observed behavior of the peso-dollar rate was indeed related to the conduct of monetary policy.

In section 6.4 we looked in some detail at the relation between exchange rate changes and monetary policy. There are three reasons why we thought this question was interesting: First, throughout 1996–97 the BOM denied emphatically that it relied on any type of feedback rule or mechanism linking the exchange rate to monetary policy. Interestingly, it did so in response to both criticism and praise from outside observers of the alleged use of such a feedback rule since the adoption of the float. Second, many observers were mystified by the BOM's pronouncements regarding the way in which it conducts monetary policy. In particular, it is peculiar that the BOM (in its official and semiofficial pronouncements) treats its day-to-day liquidity management operations as equivalent to its framework for monetary policy—rather than as an important but secondary part of it, as most central banks do. And third, and related to the other two, the BOM not only frames its discussion of monetary policy over extremely short horizons, but it allegedly relies on daily estimates of the demand for monetary base produced at the beginning of each year to guide its monetary policy.

To address the question, What did the BOM really do in 1995–97? we looked at the behavior of interest rates and base money in the period surrounding thirty large daily depreciations of the peso during those years (daily depreciations that range from 0.7 to 9 percent). In our view, the results from this analysis provide some preliminary support for the conjecture that during the period under consideration, the BOM took into account the short-run behavior of the nominal exchange rate for conducting monetary policy. This conjecture is also consistent with results obtained from time-series analysis with high-frequency data that are reported in Edwards and Savastano (1998). Although it is too early for a final verdict, the evidence examined suggests that in spite of its shortcomings, Mexico's monetary policy between 1995 and 1997 contributed to the achievement of two key policy objectives: it helped to arrest the freefall in the value of the peso while allowing a considerable degree of exchange rate flexibility, and it helped to reduce inflation at a pace that very few observers deemed achievable by mid-1995.

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Comment J. Bradford De Long

Sebastian Edwards and Miguel Savastano make four major points:

Throughout 1993–94 most available information suggested that things in Mexico were getting badly out of hand.
Most analysts, however, completely missed the magnitude of the disequilibrium—and thus the magnitude of the crisis.

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