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# Epilogue

## Foreign-Exchange-Market Operations in the Twenty-First Century

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### E.1 Introduction

After the United States ended its activist approach to foreign-exchange-market intervention, many other advanced economies soon followed suit, but while such operations faded, they never disappeared. Among the large developed economies, Japan frequently intervened in the foreign-exchange market until early 2004, and the European Central Bank, with the Federal Reserve's participation, gave intervention a one-off try in 2001. The Great Recession seemed to pique interest in intervention again as exchange-rate volatility increased, and as threats of "currency wars" were heard. Switzerland undertook substantial foreign-exchange operations both for monetary-policy and exchange-rate objectives. The Great Recession also saw the metamorphosis of official swap lines into a mechanism for channeling foreign-currency liquidity to strapped commercial banks. Among the developing and emerging market economies, particularly in China, foreign-exchange operations have remained a mainstay of macroeconomic policy and development strategy.

In this epilogue, we briefly describe five recent developments as they relate to the Federal Reserve's history with foreign-exchange operations. First, we argue that Japan's success with intervention has been broadly similar to the United States' experience. The United States is not unique. We also suggest that Japan's continued interest in such operations occurs because the interventions have not overtly conflicted with the aims of monetary policy in that country. Such a clash contributed to the end of intervention in the United States. Second, we describe Switzerland's recent experience with foreign-exchange-market operations. Switzerland offers a comparison of sterilized and nonsterilized interventions and a modern example of the

fundamental trilemma of international finance. Switzerland cannot stabilize its exchange rate, maintain an independent monetary policy, and allow free cross-border financial flows. Third, we chart the renewed use of swap lines. They continue to signal central-bank cooperation, but whereas in the past that collaboration focused on protecting the US gold stock or on frustrating speculative sales of foreign currencies, it now aims primarily at financing dollar lender-of-last-resort operations abroad. The global integration of financial markets and the reserve-currency status of the dollar may demand such a function. We speculate that this new swap mechanism could remain a key instrument of central-bank operations going forward. Fourth, we briefly discuss intervention among the developing and emerging market economies. We, like others, argue that in their pursuit of exchange-rate stability, these economies run the danger of displacing those very market mechanisms that help traders and manufacturers cope with market volatility. Fifth, we review China's exchange-rate policies. In recent years, China has sterilized part of its interventions, but should sterilized intervention work any better in China than in Switzerland or the United States? All these issues provide fodder for further research.

## **E.2 Japanese Intervention**

Unlike most other large developed economies, Japan has undertaken fairly frequent—and at times massive—interventions. Between April 1991 and March 2004, the main period of intense Japanese activity, the Ministry of Finance bought or sold US dollars on 340 days, or approximately one out of every ten business days. Roughly 90 percent of the transactions were purchases of US dollars, and the median dollar purchase (\$789 million) was more than three times as large as the median dollar sale (\$223 million). Over this time period, Japan generally moved aggressively to prevent sharp appreciations of the yen, especially when Japanese macroeconomic fundamentals were weak. An exchange rate below ¥125 per dollar seemed to trigger the dollar purchases (Ito 2003, 2005, 2007; Ito and Yabu 2007). As a result of these operations, which totaled nearly \$615 billion, Japan accumulated a huge portfolio of US dollar-denominated reserves.<sup>1</sup>

American economists find Japanese intervention particularly interesting because of institutional similarities between the two countries. The Bank of Japan—like the Federal Reserve System—conducts its monetary policy independent of governmental fiscal authorities. The Japanese Ministry of Finance, however, has sole authority for intervention; the Bank of Japan only operates as its agent. Likewise, the US Treasury has primary responsibility for US intervention, although the Federal Reserve does maintain its own portfolio. As with all official US foreign-exchange transactions, Japanese interventions are routinely sterilized. In Japan, the Ministry of Finance issues fiscal bills to obtain the yen for intervention purchases of dollars. The

yen is then reinjected into the banking system when the Bank of Japan conducts the transactions. The Ministry of Finance will place any yen acquired through dollar sales on account with commercial banks, thereby sterilizing the transactions. In any event, the Bank of Japan has the capacity to sterilize any intervention operation that conflicts with its monetary-policy objectives. The institutional similarities suggest that both countries seem to view sterilized intervention as a policy instrument capable of affecting exchange rates without sacrificing the domestic objectives of their monetary policies.

Using the same methodology as we adopt in this book (see the empirical appendix), Chaboud and Humpage (2005) tested the effectiveness of Japanese intervention and found results broadly similar to those for the United States.<sup>2</sup> Over the entire 1991–2004 period, when the Ministry of Finance was most active, Japanese purchases or sales of US dollars demonstrated little correspondence with same-day yen depreciations or appreciations, but they were associated with more moderate movements of the yen-dollar exchange rate. This broadly similar finding suggests that the United States is not an entirely unique case, and that intervention has some modest effects.

In contrast to the consistency of the dollar's reaction to US interventions between 1973 and 1995, the yen's response to Japanese operations between 1991 and 2004 changed substantially with the Ministry of Finance's operating strategies (Ito 2003, 2005; Chaboud and Humpage 2005; Ito and Yabu 2007). During the first four years of the operations—as with the entire period—Japanese interventions were only associated with more moderate movements in the yen-dollar exchange rate. In sharp contrast to the first period, between 1995 and 2002, following the appointment of Eisuke Sakakibara as director general of the Ministry of Finance's international bureau, the typical size of a transaction increased tenfold, but interventions occurred much less frequently and persistently. Then, purchases of dollars were associated with a same-day depreciation of the yen that often represented a reversal in the yen's direction. Between late 2002 and early 2004, following the appointment of Hiroshi Watanabe as director general, the typical size of an intervention fell by about one-half, but the frequency and persistence increased substantially. All of the transactions in this last period were unilateral purchases of dollars, and the Bank of Japan often concealed its presence in the market by placing standing orders with banks that entered the market under their own names. In this last period, interventions only seemed to moderate appreciations in the yen against the dollar.

Chaboud and Humpage (2005) also found that the probability of a successful Japanese transaction increased with its size. Acting in concert with the United States, however, had little if any effect on the probability that a Japanese intervention would be successful. (The United States participated in only twenty-two of the 340 Japanese interventions between 1991 and 2004.) Likewise, Bordo, Humpage, and Schwartz (2012) found that the probability of a successful US intervention increased with its size. Coordination

dinating a US operation with another central bank—as in the Japanese case—had little impact on the likelihood of its success.

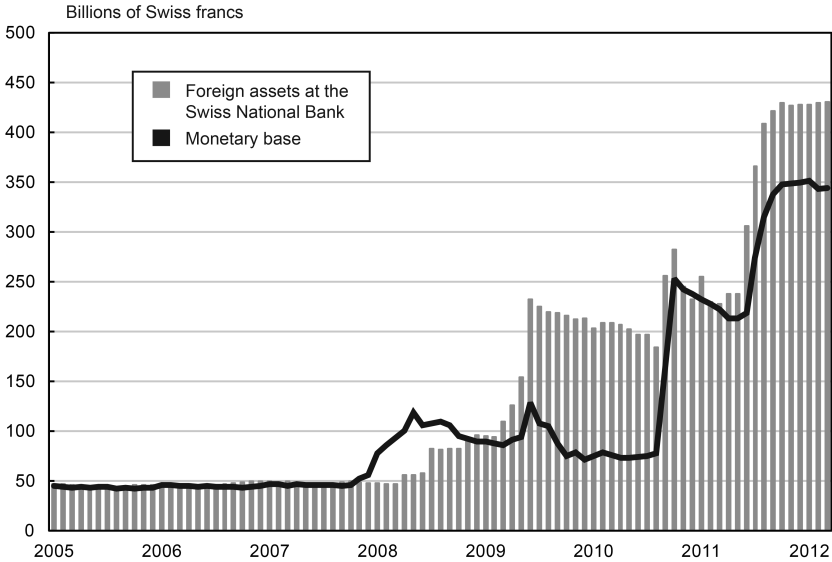
Since March 2004, the Bank of Japan has only intervened on four occasions. On 15 September 2010, the bank bought ¥2.1 trillion worth of dollars. On 18 March 2011, shortly after a devastating earthquake and tsunami, Japan intervened in concert with the United States and other G7 countries to slow a yen appreciation (Neely 2011). The Bank of Japan bought ¥0.7 trillion worth dollars at that time. On 4 August 2011, the Bank of Japan bought ¥4.5 trillion worth of dollars—then a record amount. On 31 October 2011, however, the Bank of Japan bought ¥9.1 trillion worth of dollars—a new record amount. By summer 2011, the yen was trading at postwar highs relative to the dollar. Each of these operations has been associated with a short-lived depreciation of the yen. While the yen has not retreated from its postwar highs, it has, nevertheless, remained fairly stable since August 2011.

As documented in this book, FOMC participants frequently objected to sterilized interventions because the transactions often were at odds with US monetary-policy goals, and therefore weakened the Federal Reserve's credibility with respect to price stability. At a critical time in the late 1980s and early 1990s, the Federal Reserve bought foreign exchange when the FOMC was trying to tighten policy. In contrast, most Japanese interventions since 1991 have consisted of dollar purchases during a period of slow economic growth with very low inflation—even frequent bouts of deflation—and often with policy rates at the zero bound (McCallum 2003). Under such circumstances, Japan's frequent dollar purchases seemed broadly consistent with the needed thrust of Japanese monetary policy and probably did not damage the Bank of Japan's credibility. Still, the potential for sterilized intervention to create uncertainty about monetary policy remains a key reason that central banks in major developed countries avoid its use. Japanese monetary authorities may someday encounter the same problem.

### **E.3 Swiss Intervention**

Prior to the recent international financial crisis, the Swiss National Bank had not intervened in the foreign-exchange market since August 1995. The bank ended its hiatus in 2009, when financial inflows—seeking safe haven against the ongoing financial crisis—moved substantial funds into Swiss francs. The appreciation of the Swiss franc threatened an already weakened Swiss economy with deflation. The Swiss National Bank's subsequent actions provided a modern example of the difficulties associated with foreign exchange operations—the topic of this book. They illustrated that sterilized intervention cannot systematically influence exchange rates independently of a country's monetary policy (Humpage 2013).

The Swiss National Bank operates with a mandate for price stability and bases current policy on a forecast of inflation. In early 2009, the

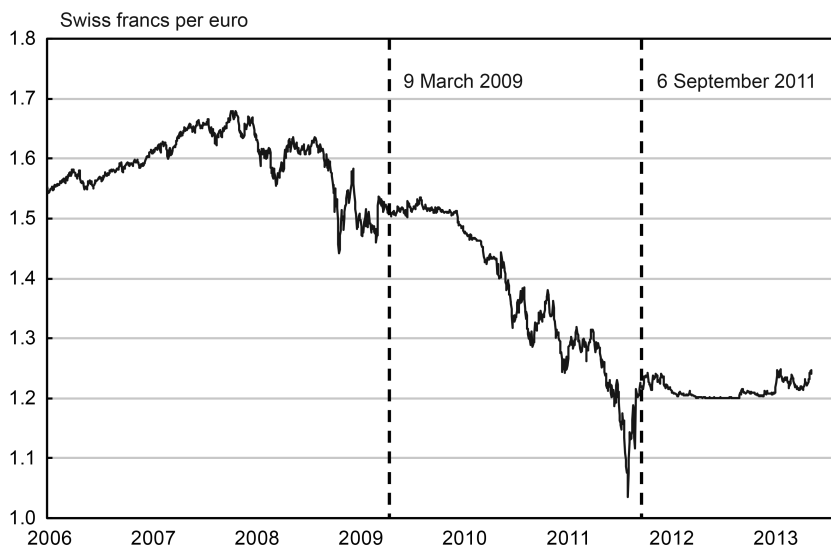


**Fig. E.1** Swiss National Bank's foreign assets and monetary base, December 2005–February 2012

*Note:* Data are from the Swiss National Bank.

Swiss National Bank began to view monetary conditions as inappropriately restrictive despite strong money growth and recent declines in short-term interest rates, because the Swiss franc had been appreciating sharply against the euro since the fall of 2007 (Swiss National Bank 2009, 34).<sup>3</sup> If the franc's appreciation was indeed an indicator of a too-tight monetary policy, a broad-based deflation might ensue.

On 12 March 2009, the Swiss National Bank eased monetary policy. Its actions included a policy-rate cut, the purchase of Swiss private-sector bonds, and foreign-exchange interventions. Immediately after announcing the policy changes, the bank aggressively bought euros in the foreign-exchange market. The Swiss franc depreciated sharply from Swiss franc (SF) 1.48 per euro on 11 March 2009, to SF1.54 per euro three days later. Throughout the month, the bank's holding of foreign-exchange reserves—mostly euros, but some dollars—grew by an amount equivalent to SF9.4 billion (Swiss National Bank 2009, 72).<sup>4</sup> Most of these purchases appeared as an increase in the Swiss monetary base, so for the most part the operation consisted of nonsterilized interventions (see figure E.1). In April, the Swiss monetary base rose even more sharply—absent clear indication of further intervention. By then, the Swiss monetary base had doubled in just six months. Although the franc's depreciation stalled after 16 March, it did not appreciate further that year, leaving a net depreciation by year's end



**Fig. E.2** Swiss franc exchange rate, 3 January 2006–17 May 2013

*Note:* Data are from the Swiss National Bank.

(see figure E.2). As the year closed, the bank was projecting inflation above 2 percent in early 2012, so with the franc holding steady, the bank announced that it would henceforth only intervene against an “excessive” appreciation (Swiss National Bank 2009, 40–41).

Between April 2009 and February 2010, the Swiss monetary base contracted by 30 percent. During this period, foreign-exchange swaps, which the bank had undertaken in late 2008 and early 2009 to provide foreign banks with Swiss franc liquidity, were automatically rolling off the bank’s balance sheet. The contracts were now reversing, shrinking the Swiss National Bank’s balance sheet, and pulling Swiss francs from the market (Swiss National Bank 2009, 53). The Swiss National Bank took no other monetary policy actions to offset these swap reversals. In effect, the Swiss interventions were sterilized.

In early 2010, the European sovereign-debt crisis worsened, and safe-haven inflows caused the franc to appreciate sharply. Swiss foreign-exchange reserves increased by an amount equivalent to SF138 billion between January and May 2010, suggesting heavy intervention, but only about 40 percent of the acquisitions were reflected in the monetary base (Swiss National Bank 2010, 32). By and large, these operations were sterilized. Although the Swiss monetary base briefly spiked to an historical high in May 2010, the base had generally been contracting.

By mid-2010, the Swiss National Bank stopped intervening and again began operations to reduce liquidity in the banking system (Swiss National

Bank 2010, 32, 41–47). By mid-2011, the Swiss monetary base was smaller than in March 2009, despite the bank's substantial accumulation of foreign-exchange reserves. On balance since February 2009, the franc had appreciated nearly 30 percent against the euro, reaching an historic high in early August 2011. The Swiss foreign-exchange operations, which by design or by happenstance were sterilized, had failed to prevent the Swiss franc's appreciation.

During August 2011, the bank announced a series of new measures to inject liquidity into financial markets, with the objective of stemming the Swiss franc's appreciation against the euro. The bank now viewed the Swiss franc as "massively overvalued" and a renewed downside threat to price stability (Swiss National Bank 2011, 36). The bank would undertake foreign-exchange swaps, selling Swiss francs spot and repurchasing them forward. In addition, the bank would repurchase Swiss National Bank bills, which it had sold to drain liquidity from financial markets, and would undertake liquidity-providing repurchase agreements (Swiss National Bank 2011, 51). The announcements did not indicate whether or not the bank intended to purchase foreign exchange outright, but the bank's holdings of foreign-exchange reserves increased substantially in August 2011. The Swiss monetary base began to expand, indicating that the bank had not sterilized its recent foreign-exchange purchases, and the Swiss franc immediately began to depreciate against the euro.

After depreciating nearly 14 percent between 10 August and 29 August 2011, the franc underwent a stunning temporary reversal, climbing more than 6 percent in four days. In response, on 6 September 2011, the bank announced that it would "no longer tolerate" the franc exchange rate below SF1.20 per euro and that it was "prepared to buy foreign currency in unlimited quantities" to maintain this floor (Swiss National Bank 2011, 38). The Swiss National Bank then acquired SF71.5 billion worth of foreign-exchange reserves in August and an additional SF26.9 billion worth of foreign-exchange reserves in September 2011. The Swiss monetary base increased by even more in both months, indicating that the monetary authorities had not sterilized these foreign-exchange purchases, but had reinforced the interventions' monetary impact. Since September 2011, the Swiss National Bank has successfully maintained its exchange-rate floor against the euro, often through heavy nonsterilized purchases of foreign exchange (Swiss National Bank 2012, 34). In doing so, the bank has allowed its monetary base to more than double since early 2011.

The Swiss National Bank's experience since 2009 illustrates that sterilized interventions do not provide central banks with a way to systematically influence their exchange rates independent of their monetary policies. The interventions in March 2009, which increased the monetary base and therefore were nonsterilized, affected the exchange rate, as did the operations in and after August 2011, when the Swiss National Bank allowed a



quadrupling of the monetary base to maintain the Swiss franc-euro floor. In contrast, the interventions after April 2009 and before August 2011, which did not raise the monetary base, failed to guide the Swiss franc lower against the euro. Instead, the franc appreciated substantially.

#### **E.4 Swap Lines**

On 12 December 2007, the FOMC reestablished swap lines with key foreign central banks as a way of channeling emergency dollar funding to foreign depository institutions that otherwise lacked access to Federal Reserve borrowing facilities.<sup>5</sup> Although targeted to foreign banks, the FOMC understood that these lending facilities could ease dollar funding pressures more broadly. Initially, the FOMC extended swap lines only to the European Central Bank and the Swiss National Bank, but the lines grew as the financial crisis unfolded, and by mid-2009, fourteen central banks, including some key emerging market central banks, had access to Federal Reserve System swap facilities. As the subsequent narrowing of various risk spreads suggests, the swap lines successfully calmed market uncertainty (Goldberg, Kennedy, and Miu 2010; Fleming and Klagge 2010).

After 2000, financial-market innovation and sustained globalization spurred growth in banks' foreign-currency-denominated assets.<sup>6</sup> European banks in particular greatly increased their holdings of dollar-denominated loans and securities. Banks funded these dollar positions largely in short-term, wholesale markets, either by borrowing dollars or—more often—by acquiring domestic currencies and converting them into dollars via foreign-exchange swaps. Although both funding routes created maturity mismatches, the latter seemed particularly risky. In 2007, according to the Bank for International Settlements, 78 percent of foreign-currency swap turnover reflected contracts with maturities of less than seven days (McGuire and von Peter 2009, 54, fn. 10). The maturity mismatch left banks vulnerable to rollover problems.

As the global financial crisis spread in late 2007, heightened financial-market credit risk dried up dollar funding. Banks not only found it increasingly difficult to fund their exposures, but many acquired additional dollar assets as they backstopped structured investment vehicles (Fleming and Klagge 2010). Maturity mismatches lengthened, and a severe dollar shortage emerged. Although US branches of foreign banks that held reserves could borrow from the Federal Reserve, most foreign banks could not.

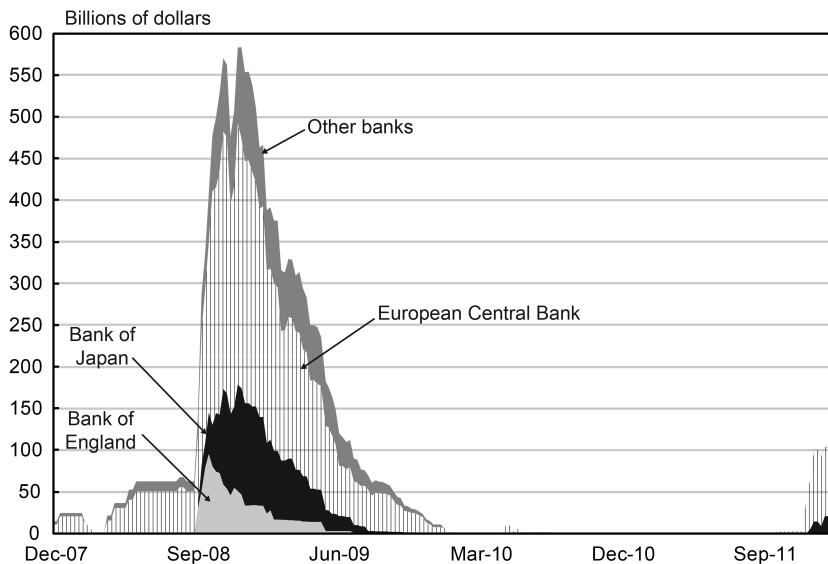
On 12 December 2007, the Board of Governors of the Federal Reserve System established the Term Auction Facility, which offered emergency dollar loans to US depository institutions. At the same time, the Federal Open Market Committee established special liquidity swap lines with the European Central Bank and the Swiss National Bank. These swap lines essentially extended the Term Auction Facility's reach beyond US borders by financing term dollar funding facilities for foreign banks.

As with previous swap lines, the central banks involved in the new arrangements would conduct the spot and the forward legs of any transaction at the same exchange rate, thereby eliminating exchange risk. The European Central Bank and the Swiss National Bank drew on these swap lines at one- or three-month terms as they extended dollar liquidity to eligible commercial banks in their jurisdictions. The loans that the European Central Bank and the Swiss National Bank made to commercial banks were collateralized, and the interest rates on the dollar funds initially were equal to the lowest acceptable auction rate under the Federal Reserve System's Term Auction Facility. The European Central Bank and the Swiss National Bank assumed all counterparty risk. The Federal Reserve did not invest the euros or Swiss francs that it acquired when its counterparts drew on the lines. Instead, the Federal Reserve held the foreign currencies in noninterest bearing deposits with the respective foreign central bank, and the foreign central banks paid the Federal Reserve the same interest that they earned on loans to their commercial banks. According to Fleming and Klagge (2010, 2–3): “This arrangement avoided reserve-management difficulties that might arise at foreign central banks if the Fed were to invest its foreign currency holdings in the market.” Initially the swap lines with the European Central Bank and the Swiss National Bank amounted to \$20 million and \$4 million respectively, but the amounts quickly expanded to \$55 million and \$12 million respectively, just prior to the Lehman Brothers collapse on 15 September 2008.

Initially, too, the Federal Reserve sterilized the swap operations by selling Treasury securities from its portfolio. The Federal Reserve's balance sheet showed little increase during 2007 and in the first half of 2008, but after the Lehman Brothers collapse, the Federal Reserve's balance sheet expanded rapidly (see figure E.3).

Dollar funding problems greatly intensified following the Lehman Brothers failure, and the Federal Open Market Committee accordingly expanded the special liquidity swap facilities in tandem with foreign central banks' dollar liquidity operations. By the end of September 2008, the Federal Reserve had offered swaps to nine central banks. The total facility had grown from \$24 million to \$620 million. By late October 2008, the Federal Reserve eliminated the overall limit on the facilities for the Bank of England, the Bank of Japan, the European Central Bank, the Swiss National Bank, and five more central banks—the Bank of Brazil, the Bank of Korea, the Bank of Mexico, the Bank of New Zealand, and the Monetary Authority of Singapore—obtained swap lines. Aizenman and Pasricha (2009) suggest that the Federal Reserve primarily extended swap lines to those emerging market economies in which US banks had high exposures. At the program's peak in December 2008, swaps outstanding totaled more than \$580 billion and accounted for over 25 percent of the Federal Reserve System's total assets (Fleming and Klagge 2010, 5).

The swap lines allowed foreign central banks to channel dollar liquidity directly to domestic financial institutions, and the swaps expanded in size



**Fig. E.3 Federal Reserve dollar liquidity swaps by counterparty, 19 December 2007–3 February 2012**

*Note:* Data are from the Federal Reserve.

and maturity structure along with the lending facilities of the foreign central banks.<sup>7</sup> The programs that the foreign central banks offered varied in terms of eligibility, collateral requirements, and auction types. On 13 October 2008, in the wake of the Lehman Brothers collapse, the Bank of England, the Bank of Japan, the European Central Bank, and the Swiss National Bank began offering “full allotments” of dollar liquidity—that is, as much as local commercial banks desired—at a fixed interest rate equal to 100 basis points over the overnight index swap (OIS) rate.<sup>8</sup> To accommodate their full allotment format, the Federal Open Market Committee removed the limits on swap drawing by these four central banks. As market turmoil calmed in 2009, and as market rates no longer exceed the OIS rate by more than 100 basis points, central-bank lending facilities were no longer advantageous to financial institutions. Swap drawings fell off in turn.

Use of the swap lines peaked in December 2008 (see figure E.3). The European Central Bank (ECB), whose outstanding drawings reached \$300 billion in late 2008, was the biggest single user of the facility, followed by the Bank of Japan and the Bank of England. Although swap borrowing fell off in 2009, funding markets continued to differentiate between strong and weak financial institutions (Goldberg, Kennedy, and Miu 2010, 19–20). After a couple of extensions, the initial swap lines expired on 1 February 2010. Brazil, Canada, New Zealand, and Singapore never drew on their swap lines.

By most accounts the swaps were successful in channeling dollar liquidity and calming markets (Goldberg, Kennedy, and Miu 2010).

Unlike most previous swap agreements, the post-2007 lines were not reciprocal. The Federal Reserve did not use (or invest) the foreign exchange that it acquired through the swaps. In April 2009, the Federal Reserve established parallel swap lines with the Bank of Canada, the Bank of England, the Bank of Japan, the European Central Bank, and the Swiss National Bank that allowed the Federal Reserve to draw foreign currencies against dollars. These lines could channel emergency funding through the Federal Reserve to US banks experiencing liquidity problems in foreign currencies. The Federal Reserve never drew on these lines.

The 1 February 2010 swap-line hiatus was short-lived. On 9 May 2010, as the European debt problem roiled still-fragile financial markets, the Federal Reserve reestablished swap lines with the Bank of Canada, the Bank of England, the Bank of Japan, the European Central Bank, and the Swiss National Bank at a rate of 100 basis points over the OIS rate. With the exception of the swap line with the Bank of Canada, which maintained an overall limit of \$30 billion, the other facilities were again open-ended to allow foreign central banks to auction dollar liquidity in a fixed-rate full-allotment format. On 30 November 2011, to make the facilities more attractive to commercial banks, the participating central banks lowered the interest rate on these lines to 50 basis points over the OIS rate. In addition, on 30 November 2011, the Bank of Canada, the Bank of England, the Bank of Japan, the European Central Bank, and the Swiss National Bank agreed to make temporary swap lines available to each other so that emergency liquidity was available in each of the currencies to each of the participants. All of these lines were scheduled to expire on 1 February 2014. At its October 2013 meeting, however, the FOMC made the liquidity swap lines with these five key central banks available indefinitely.

Some controversy arose over extending swap lines to countries that held substantial amounts of reserves—presumably dollar reserves. William Poole, the president of the Federal Reserve Bank of St. Louis, voted against establishing swap lines with the European Central Bank and the Swiss National Bank. He viewed the lines as unnecessary given the size of the dollar-denominated reserves held by these institutions (FOMC *Minutes*, 11 December 2007, 1, 9). In the end, however, most of the countries that received swap lines (in dollars or in other currencies) did not seem to hold sufficient reserves to meet the liquidity demands of the financial crisis (Moessner and Allen 2010; Obstfeld, Shambaugh, and Taylor 2009). Swaps can augment reserves and—what is often equally important—signal central-bank cooperation.

Besides these Federal Reserve swap lines, other central banks—notably the Bank of Japan, the European Central Bank, the Swiss National Bank, and the People's Bank of China have established swap arrangements with

many emerging market economies (Moessner and Allen 2010; Aizenman, Jinjarak, and Park 2010). The ECB made euro swaps available to many European countries outside of the European Monetary Union to stem liquidity shortages, although not all countries experiencing euro liquidity problems received swap lines. Likewise, the Swiss National Bank made Swiss franc swaps available to countries experiencing Swiss franc liquidity shortages (Auer and Kraenzlin 2011). The Bank of Japan extended a yen swap line to South Korea and the Japanese Ministry of Finance extended a dollar swap line to India (Moessner and Allen 2010, 32–33).

East Asia has had an extensive swap network in place since 2000, as a means of offering financial support should a financial crisis like the one experienced in 1997 and 1998 reemerge. These swaps are designed to foster closer economic integration in the area (Moessner and Allen 2010, 32). The People's Bank of China extended new swap lines during 2008 and 2009 in part to provide a backstop against financial stress, but largely to promote the use of nondollar currencies, notably the renminbi, in regional trade and investment (Moessner and Allen 2010, 33). Besides Asian countries, the People's Bank extended swap lines to the National Bank of Belarus and the Central Bank of Argentina.

The precedent of using swaps for the emergency provision of liquidity denominated in key currencies now seems fairly well established. The dollar lines clearly enhance the currency's role as the key international reserve currency and may be necessary if that role is to continue. These swap arrangements are likely to persist.

### **E.5 Foreign-Exchange Operations in Developing and Emerging Market Economies**

Unlike the major developed countries, which generally stopped intervening after the mid-1990s, the developing and emerging market economies continue frequent operations in their foreign-exchange markets. These small, open economies show a striking aversion to exchange-rate volatility (Calvo and Reinhart 2000). Exchange-rate volatility can often have serious macroeconomic consequences in these economies because they frequently lack hedging facilities that protect domestic firms from volatility. Ironically, the frequent interventions that developing and emerging market countries undertake, together with other policies that they pursue to increase the effectiveness of those interventions, can limit the very financial development that they so badly need.

Assessing the intervention activities in developing and emerging market economies is not straightforward. Their financial markets are underdeveloped and often tightly regulated. They often impose restrictions on cross-border financial flows. Their interventions are not always sterilized, and hence are a product of monetary policy as much as exchange-rate policy. Their motives

for buying or selling foreign exchange vary widely—beyond what we have heretofore considered intervention. Still, because of their unique characteristics, these countries provide useful laboratories for understanding the behavior of exchange rates and the effectiveness of intervention.<sup>9</sup>

In many developing and emerging market economies, the foreign-exchange market is a—if not the—key asset market, and the local central bank is often the dominant player in that market. Almost by definition, foreign-exchange markets in these developing and emerging market countries are underdeveloped, particularly at the interbank level (Canales-Kriljenko 2004). They lack liquidity and a broad array of financial products, particularly hedging facilities. Besides attempting to stabilize exchange rates, central banks in these countries often act as a fiscal agent for the government, buying and selling foreign exchange to finance cross-border expenditures, to service foreign-currency-denominated debts, or to adjust foreign-exchange reserves. In countries where the government is a key source of foreign-exchange earnings—for example, oil-producing nations—central banks may play an important role in channeling foreign-exchange receipts to the market. Because of their familiarity with the market, central banks may also act as their governments' administrators of the foreign-exchange market. In that role, they often cast a broad web of regulations upon market participants, deciding who might trade foreign exchange, specifying the markets in which they operate, and limiting their positions and exposures. Central banks may also enforce macroeconomic controls on cross-border financial flows.

In surveys of foreign-exchange activity in developing and emerging market economies Canales-Kriljenko (2003, 2004) found that most central banks in these countries participate in the market irrespective of the underlying exchange-rate regime. They often intervene heavily in markets characterized as flexible or floating. Surprisingly, however, less foreign-exchange intervention occurs under credible fixed exchange-rate regimes. If an exchange-rate peg is credible, foreign-exchange intermediaries tend to act as stabilizing speculators, minimizing the need for official intervention (Canales-Kriljenko 2003, 6–7).

The key objective of frequent intervention in developing and emerging-market economies is to limit exchange-rate volatility. As noted, foreign-exchange markets in these countries tend to be thin, concentrated among a few traders, and generally underdeveloped, which can magnify the response of foreign-exchange rates to economic shocks or new information. Because developing and emerging market economies are often not well diversified, lack credibility with respect to their macroeconomic-policy objectives, and rely heavily on traded goods and foreign financing, exchange-rate volatility can quickly translate into macroeconomic instability. The lack of hedging facilities in particular is an important structural problem linking exchange-rate volatility to macroeconomic instability.

While exchange-rate stability is the key reason for intervention in developing and emerging market economies, acquiring foreign-exchange reserves and providing foreign exchange to market participants are often important objectives of a central bank's market operations. Developing and emerging market countries often buy foreign exchange to accumulate foreign-currency reserves. Many countries see holding substantial portfolios of foreign-exchange reserves as a means of building investor confidence by strengthening their debt-repayment capabilities, and maintaining external liquidity (Canales-Kriljenko, Guimarães, and Karacadağ 2003).<sup>10</sup> Moreover, buying and selling foreign exchange is necessary if the central bank is the key intermediary for foreign exchange in countries where the government is the chief foreign currency recipient.

When operating in the foreign-exchange market, only about one in five developing or emerging market economies routinely sterilizes their interventions (Canales-Kriljenko 2003, 8). Some countries simply undertake monetary policy using an exchange-rate target and dealing in foreign exchange; persistent sterilization would be antithetical to such an operation. For many others, sterilization is difficult or socially costly. They may lack financial instruments with which to quickly sterilize an operation, or the instruments may be of short duration, and therefore require frequent rolling over or management (Morano 2005 16; Mohanty and Turner 2005). Heavy persistent sterilized purchases of foreign exchange may eventually raise questions about the monetary authority's ability to service their outstanding government or central-bank securities. Likewise, frequent sterilized intervention in thin or otherwise underdeveloped money markets may also distort relative prices among asset categories. The interest cost of sterilization bonds to the monetary authority can easily exceed the interest returns on their liquid foreign-currency assets, while the return on the sterilization bonds to commercial banks can fall far short of their opportunity cost (Lardy 2008). All this fosters inefficiencies through sterilization.

Still, according to Canales-Kriljenko (2003), the interventions that emerging market economies undertake in their less-developed local markets—even when completely sterilized—are very often more effective than the interventions that advanced countries undertake in their fully developed markets. This can even be the case if the central bank in question lacks credibility with respect to its domestic-policy objectives.

Central banks in developing and emerging market economies frequently have the advantage of being big fish in little ponds. They often intervene in amounts that are large relative to the size of local foreign-exchange-market turnover, their own monetary bases, and the stock of their outstanding government bonds. Hence it is very likely that either a portfolio-balance mechanism, an order flow channel, or an expectations effect is open to them. Sometimes central banks in developing and emerging market economies achieve their relative size advantage through their regulatory powers and their use of

exchange controls. Such regulations as surrender requirements, prohibitions of interbank trading, or restrictions on taking net-open positions, effectively increase the size of intervention relative to market turnover because they either reduce the size of the foreign-exchange market or concentrate foreign exchange at the central bank, or both. Foreign exchange controls in many countries require their residents to use the domestic currency—instead of a foreign currency—when making payments to other residents, and often limit their ability to hold foreign-currency deposits in banks. Some also impose controls on the use of their domestic currency by nonresidents. These all decrease the effective size of the foreign-exchange market, increasing the impact of intervention.

The key role of central banks as foreign-currency intermediaries in some local foreign-exchange markets, the important role of central banks as regulators in many local foreign-exchange markets, and the lack of an extensive interbank segment in these markets are also very likely to confer an informational advantage on the central bank. If so, a central bank might be able to successfully exploit an expectation channel through its intervention. A strict policy signaling channel, however, would be impaired if the central bank lacked policy credibility or if ongoing structural change in the economy loosened the connection between financial and real variables (Canales-Kriljenko, Guimarães, and Karacadağ 2003).

In contrast, the portfolio-balance channel does not depend on the credibility of the monetary authorities. Galati, Melick, and Micu (2005) originally speculated that the portfolio-balance effect could potentially operate in emerging market economies, even though empirical evidence generally offers little support for a portfolio-balance channel among advanced economies. As previously mentioned, emerging market countries are likely to hold larger portfolios of foreign-exchange reserves relative both to the local exchange market and to the stock of outstanding local-currency bonds than their wealthier counterparts. These are sufficient conditions, but the key necessary condition is also likely to hold: The degree of substitution between bonds denominated in their own currencies and bonds denominated in reserve currencies is very likely to be small. Hence, the risk premium is likely to be larger and more sensitive to changes in the relative stocks of assets.

A temporary order-flow mechanism may also operate better in a developing or emerging market economy than in an advanced market because of the relative size and importance of central banks in underdeveloped markets. In addition, as explained above, central banks in emerging market economies may have better information about order flow than other market participants.

Unlike their advanced-country counterparts, central banks in emerging market economies often use “oral interventions” to affect exchange rates. Because emerging market central banks often regulate their exchange markets more heavily than developed countries—that is, grant licenses, authorize



individual dealers, regulate the market—they derive considerable leverage from their regulatory authority. Ideally, verbal intimidation might complement an expectations mechanism, but excessive use could clearly hamper market development (Canales-Kriljenko 2003, 24).

In the limit, as the literature clearly suggests, the relative success that developing and emerging market economies may have in conducting effective foreign-exchange-market operations can intensify the very problem that they seek to avoid. In their desire to foster stability through intervention, regulation, and control, monetary authorities in these countries often discourage private-sector financial innovation and maintain the market's immaturity. When such operations hamper financial-market development, they can actually intensify the macroeconomic consequences of exchange-rate volatility.

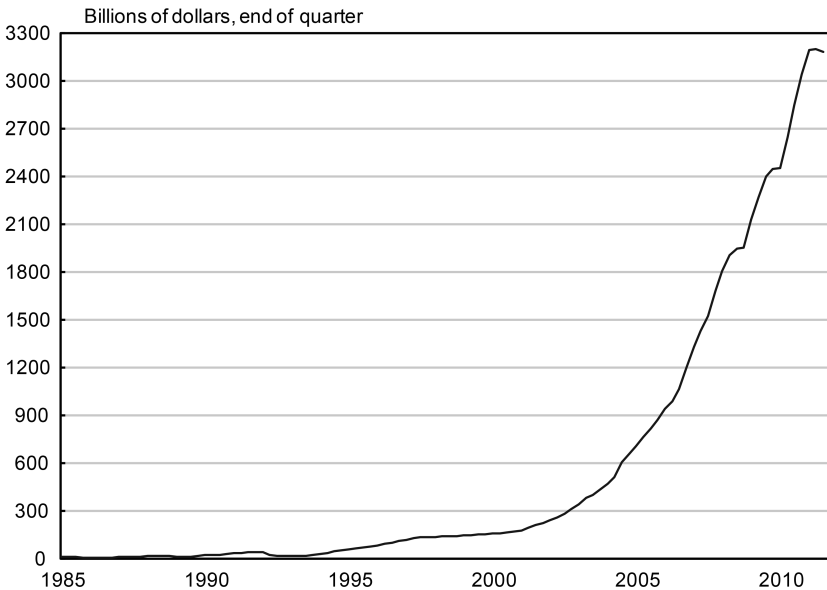
### **E.6 China's Renminbi-Dollar Peg**

No country's exchange-rate practices have incited as much controversy as China's have generated. United States policymakers in particular have accused China of artificially undervaluing the renminbi relative to the dollar in order to achieve a trade advantage. China's massive accumulation of foreign-exchange reserves is, indeed, testament to such charges, but whatever trade advantage China obtains from undervaluing the renminbi should be transitory. China's control over its nominal exchange rate does not extend to its real exchange rate. Price level pressures, emanating primarily from its exchange-rate practices, must eventually induce a real renminbi appreciation and erode any competitive edge that the undervaluation provides. This process has been occurring. Although the People's Bank of China has sterilized a substantial part of the reserve accumulation since 2002, this has not prevented inflation and a real appreciation. The renminbi appreciated 30 percent against the dollar in real terms and 40 percent on a real trade-weighted basis between mid-1995 and the end of 2013.<sup>11</sup>

Over the past seventeen years, China's exchange-rate regime has shifted back and forth between a peg against the US dollar and, generally, a tightly controlled appreciation. In July 2005, after pegging the renminbi at ¥8.3 per dollar over the previous decade, China undertook a controlled appreciation of its currency against the US dollar.<sup>12</sup> The People's Bank of China interrupted the appreciation briefly with a renewed peg between July 2008 and June 2010 in response to adverse spillovers from the global financial crisis. Between June 2010 and January 2014, the renminbi again underwent a controlled appreciation against the dollar, bringing the total nominal appreciation since mid-1995 to 30 percent against the dollar. Since then the People's Bank of China has encouraged a renminbi depreciation, although the size of the depreciation has thus far been minimal.

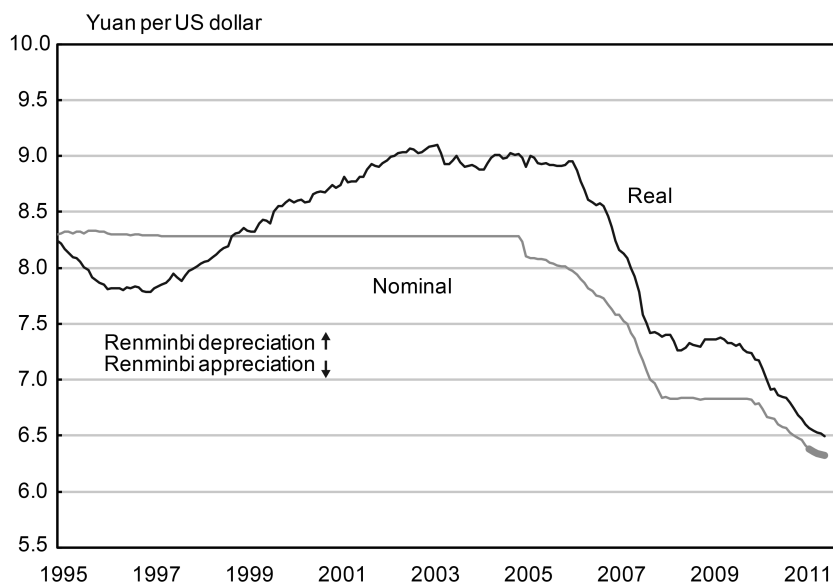
In addition to systematically undervaluing its currency, China also discourages private financial outflows, largely by limiting the amount of foreign currencies that China's residents might hold and their ability to invest those currencies abroad in foreign assets. These controls, in conjunction with China's exchange-rate policies, have resulted in a massive accumulation of foreign exchange reserves, even during the years of renminbi appreciation. Between mid-1995 and December 2011, China's official foreign-exchange reserves rose from \$250 billion (equivalent) to \$3.2 trillion. Most of this foreign-exchange-reserve accumulation, however, took place after 2001 with important monetary consequences (see figure E.4).

Prior to 2003, the Chinese monetary base increased modestly relative to the country's rapid growth rate. The disparity was such that China often experienced deflation between 1997 and 2003, and the renminbi depreciated against the dollar on a real basis despite the nominal peg (see figure E.5). In 2003, however, the situation changed. Reserve accumulation picked up, as did China's monetary base and its inflation rate. Since then, China's accumulation of foreign-exchange reserves has been especially heavy. To limit the inflation consequences of its exchange-rate policies, the People's Bank started selling sterilization bonds to local commercial banks.<sup>13</sup> From the end of 2003 through 2009, the People's Bank offset 41 percent of its reserve



**Fig. E.4** China's official foreign exchange reserves, March 1985–December 2011

*Note:* Data are from the International Monetary Fund.

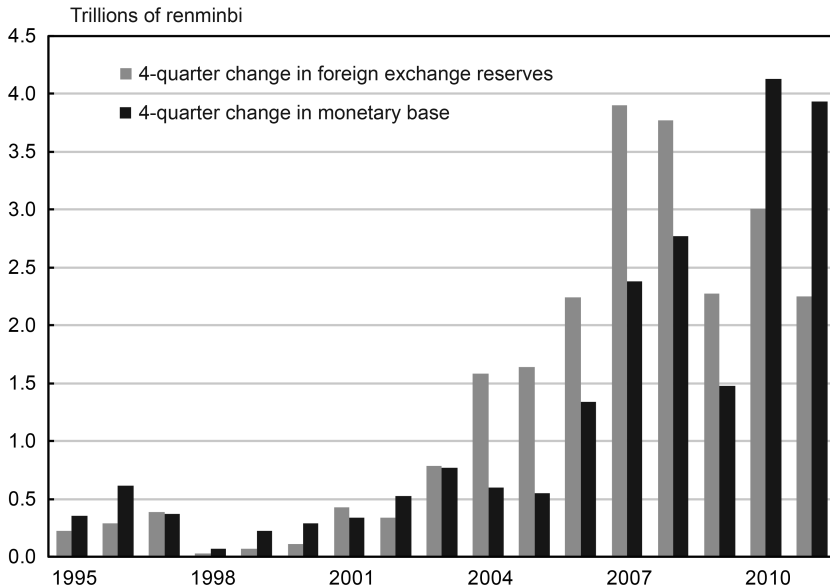


**Fig. E.5 Renminbi-dollar exchange rates, June 1995–January 2012**

*Notes:* The real exchange rate is calculated using consumer price indexes. Data are from the US Bureau of Labor Statistics, China National Bureau of Statistics, and the International Monetary Fund.

accumulation, but the monetary base continued to grow sharply (see figure E.6). In addition, the People's Bank increased reserve requirements on banks nineteen times, from 6 percent to 17.5 percent.<sup>14</sup>

This operation is puzzling. China's sterilized intervention could only maintain the peg or limit nominal appreciation if a portfolio-balance mechanism were at work, and as we have shown, the empirical support for such a mechanism—at least among advanced economies—seems nonexistent. Because China undervalues the renminbi, it experiences an excess demand for its currency. In defense of the peg or to limit appreciation, the People's Bank of China must buy foreign exchange and must issue sufficient renminbi base money to meet that excess demand. Effectively, this requires nonsterilized intervention—an expansion of the money supply—to prevent a renminbi appreciation. When China subsequently sterilizes the resulting monetary-base growth, the excess demand for renminbi cannot be met through a supply of renminbi. To maintain the peg or limit appreciation, the issuance of sterilization bonds must raise the nominal interest rate sufficiently—via an increased risk premium—to reduce the demand for renminbi. Has this happened? Demonstrating that the People's Bank of China sterilizes part of the reserve accumulation is necessary, but not sufficient, for explaining the renminbi's peg or its limited nominal appreciation.



**Fig. E.6 Sterilization of foreign-exchange-reserve flows in China, 1995–2011**

*Note:* Data are from the International Monetary Fund.

Although the People's Bank of China did seem to offset part of the monetary impact from its reserve accumulation between 2004 and 2009, the monetary base nevertheless generally grew faster after 2003 than it did before that date. In 2010 and 2011, the monetary base outpaced reserve growth by nearly two to one. Although the People's Bank of China increased reserve requirements from 15.5 percent to 21.5 percent over the past two years, China has experienced a sharp run-up in its inflation rate, and a continued real renminbi appreciation.

China may undervalue its nominal exchange rate, but it has not controlled its real exchange rate, and the latter—not the former—ultimately determines equilibrium. While it is still too early to tell, the real appreciation may have restored nominal equilibrium, and China's experience may illustrate adjustment under a peg when sterilized intervention and financial restraints ultimately prove ineffective.