4

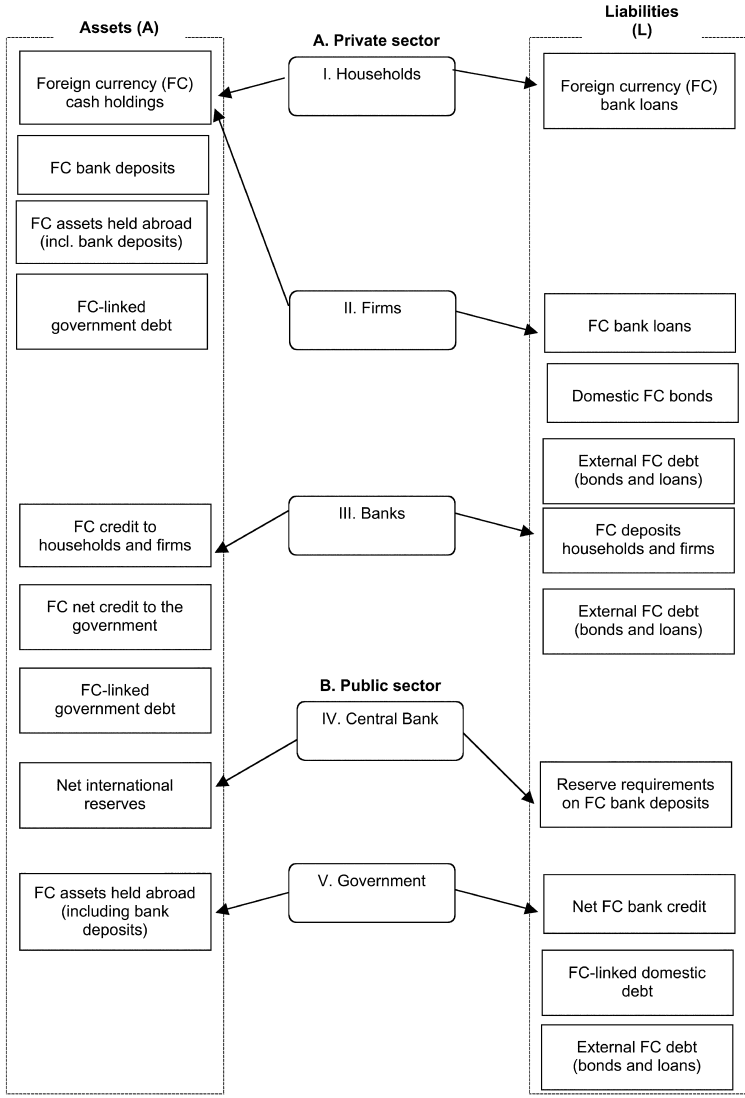
Aggregate Effective Currency Mismatch

Our preferred definition of currency mismatch—that is, the sensitivity of net worth or of the present discounted value of net income to changes in the exchange rate—is indeed much harder to measure than original sin. But it offers better guidance to what one should try to measure. Although no single measure captures all the relevant features of currency mismatches throughout the economy, we believe it is possible to get useful rough estimates of mismatch both across countries and for a given country over time by relying jointly on a number of available mismatch variables as well as by constructing a new measure of aggregate effective currency mismatch. Moreover, other potentially valuable indicators of currency mismatch could be obtained in the future—particularly for the corporate sector—if data collection for them were accorded higher priority.

As discussed earlier, empirical work suggests that the ratio of short-term external debt to international reserves has been a useful leading indicator of the probability of getting into a currency crisis. A recent IMF study (Aturupane et al. 2004) reports, inter alia, that virtually all emerging economies with access to international capital markets, which experienced a crisis during the January 2000–December 2002 period, had a ratio of short-term debt to reserves of greater than one. The ratio of broad money balances (M2) to reserves also appears to have value in signaling currency crises. These short-run liquidity measures are available for a large group of emerging economies.

Other indicators of currency mismatch—encompassing both sectoral and aggregate measures—are also worth monitoring because they can reveal sectoral mismatch vulnerabilities that may be submerged within the aggregate, or because they permit one to control for factors (like local

Figure 4.1 Foreign currency balance sheet of a partially dollarized economy



Source: Reinhart, Rogoff, and Savastano (2003a).

currency–denominated bonds and bank loans and the responsiveness of noninterest income flows to a change in the exchange rate) that ought to affect the severity of crises, or because they cover a wider range of foreign-currency assets and liabilities.

Figure 4.1, taken from Reinhart, Rogoff, and Savastano (2003a), shows components that would ideally make up sectoral foreign-currency bal-

Table 4.1 Australia: Foreign-currency exposure by financial sector, end-June 2001 (billions of Australian dollars)

Instrument	Banks	RBA and CBAs	Other financial corporations	General government	Other resident sectors	Total all sectors
Foreign currency–denominated financial debt assets	–69.8	–36.9	–33.6	–5.5	–10.6	–156.5
Foreign currency–denominated debt liabilities	186.5	8.8	61.4	4.1	60.1	321.0
equals						
Net debt position	116.7	–28.1	27.8	–1.4	49.5	164.5
Principal of foreign currency–derivative contracts in a bought position	–435.3	–11.3	–69.8	–0.4	–31.7	–548.4
Principal of foreign currency–derivative contracts in a sold position	325.8	32.1	61.8	8.9	34.9	463.4
equals						
Net debt position unhedged after derivatives	7.2	–7.4	19.8	7.2	52.6	79.5
Foreign-equity assets	–30.7	0.0	–84.0	0.0	–113.9	–228.5
equals						
Foreign-currency exposure	–23.4	–7.4	–64.1	7.2	–61.2	–149.0

RBA = Reserve Bank of Australia
CBAs = State and Territory Central Borrowing Authorities

Source: ABS (2001).

ance sheets. The rub is that, while data for some of these components (like international reserves, foreign-currency bank deposits held at home, and external foreign-currency debt) are now available for many emerging economies, data on other components (such as foreign-currency cash holdings, foreign-currency credit extended by banks to domestic households and firms, and foreign currency–linked domestic debt) are in much more limited supply.

Tables 4.1 and 4.2—the former for an industrial country (Australia) and the latter for an emerging economy (Thailand)—illustrate how sectoral balance sheets (usually taken from national sources) can be used to gauge currency mismatches and vulnerabilities.

Table 4.2 Thailand: Intersectoral asset and liability position, end-December 1996 (millions of dollars)

Issuer of the liability (debtor)	Holder of the liability (creditor): General government and Bank of Thailand	Commercial banks	Nonbank sector	Rest of the world	Total
General government and central bank (Bank of Thailand)					
Domestic currency		2,394	11,885		14,279
Total other liabilities		5,555		5,152	10,707
Short term		3,616[a]		34	3,650
Medium and long term		1,939[a]		5,118	7,057
Commercial banks (including BIBFs)					
Total liabilities	10,327		139,299	48,790	198,417
Deposits and other short term:	9,366		131,866	28,858	170,090
In foreign currency			448	28,189	28,637
In domestic currency	9,366		131,417	669	141,453
Medium and long term:	961		7,434[a]	19,932	28,327
Equity (capital)					23,439
Nonbank sector					
Total liabilities		206,715		61,701	268,416
Short term:		555[a]		18,831[b]	18,831
Medium and long term		31,542[b]		42,870[b]	42,870
Equity (capital)				4,745	136,252
Rest of the world[b]					
Total liabilities	38,694	7,029			45,723
Currency and short term	38,694	2,580			41,274
Medium and long term		4,449			4,449
Equity			481		

BIBFs = Bangkok International Banking Facilities

a. In domestic currency.
b. In foreign currency.

Source: Allen et al. (2002).

Table 4.1 provides data on sectoral foreign-currency exposure for the Australian economy as of end-June 2001. The Australian Bureau of Statistics (ABS) collected the data, with the assistance of the Reserve Bank of Australia, as a supplement to the *Survey of International Investment*. According to the ABS (2001), the aim was to capture quantitative and qualitative data about Australian enterprises' foreign-currency exposure and the risk management practices associated with that exposure. More than 230 resident enterprises with significant foreign-currency exposure

were approached (including general government entities), and the response rate was 77 percent. Information was requested about foreign-equity assets, foreign currency–denominated assets and liabilities, the notional value of derivative contracts with a foreign-currency component, the policies enterprises adopted on hedging foreign-currency exposure, and foreign currency–denominated receipts and payments expected from trade in goods and services in the following year (i.e., in the 12 months to end-June 2002).

Several results in table 4.1 are worth highlighting. The general government sector was the only one with a net foreign currency liability exposure, after accounting for hedging activities and foreign-equity positions; its net foreign currency liability position was A$7.2 billion. Although the "banks" subsector had considerably larger foreign currency–denominated financial debt liabilities (A$186.5 billion) than its foreign currency–denominated financial assets (A$69.8 billion), its hedging activities in the derivatives markets plus a sizable foreign-equity asset position turned its total foreign-currency exposure into an A$23.4 billion net asset position. Summing the sectoral exposures, Australian resident enterprises had an aggregate net foreign-currency asset position of A$149 billion.

The Australian sectoral balance sheet drives home the point that in countries where residents are widely using derivatives markets to hedge foreign exchange exposures, it is highly desirable to try and obtain information on those hedging activities to measure currency mismatch.[1] The Australian example likewise illustrates the valuable information that can be retrieved from surveys on foreign exchange exposure (including exposure in the nonbank and government sectors), if more governments were prepared to conduct them.

Table 4.2, taken from Allen et al. (2002), provides a picture of sectoral asset and liability positions in Thailand just before its 1997 crisis (end of December 1996). While short-term liabilities to the rest of the world were very small ($34 million) in the government sector, short-term liabilities in foreign currency were huge for commercial banks (almost $29 billion) and the nonbank sector (almost $19 billion). Thailand's aggregate short-term foreign-currency debt was therefore on the order of $48 billion. On the asset side, the monetary authorities—the Bank of Thailand (BOT)—held roughly $39 billion in foreign reserve assets, although the BOT already had some forward and swap obligations not shown in its balance sheet. Table 4.2 also shows that the banking system's foreign assets were just over $7 billion. Allen et al. (2002) estimate that of the $207 billion in claims of the commercial banking system on the domestic nonbank sector, about

1. The ABS (2001) study also includes a detailed breakdown of derivative contracts by type (i.e., forwards, interest rate swaps, futures, and currency options) and by sector, as well as a disaggregation of hedging activities by instrument (i.e., foreign-equity assets, debt liabilities, and fixed-income assets).

$32 billion was denominated in foreign currency. In the end, these sectoral balance sheets permit Allen et al. (2002) to draw the following conclusions about Thailand's currency mismatch: In December 1996, there was a roughly $10-billion financing gap between the government's foreign reserves and the country's total external foreign-currency liabilities falling due in the short term; the maturity and currency mismatches of commercial banks vis-à-vis nonresidents were enormous (on the order of $26 billion if none of the short-term liabilities was rolled over); and nonbank corporations and households had perhaps even larger mismatches than the commercial banks. The sectoral analysis also shows that currency risk was essentially being passed on from the commercial banks to the nonbank sector; since the latter had relatively little foreign currency–denominated revenue, the large devaluation that subsequently occurred was sure to generate large-scale insolvencies in the nonbank sector and ultimately sizable loan delinquencies and a systemic banking crisis.

New Measure of Aggregate Effective Currency Mismatch

At the aggregate level, a rough but nonetheless useful measure of aggregate effective currency mismatch (AECM) can be constructed using the international banking statistics of the Bank for International Settlements (BIS), the IMF's data on the international liquidity position of the monetary authorities and on the claims and liabilities of financial institutions, and some estimates of the currency composition of the total bond and banking markets. The main purpose of such a measure is to provide a shorthand stress test of the consequences for the domestic economy of an aggregate currency mismatch—*if* there were a large depreciation of the local currency. Our AECM measure has three components: net foreign-currency assets, exports (or imports) of goods and services, and the foreign-currency share of total debt.

Specifically, net foreign-currency assets (NFCA) are defined as follows:

$$\text{NFCA} = \text{NFAMABK} + \text{NBKA\$} - \text{NBKL\$} - \text{IB\$} \quad (1)$$

where NFAMABK is net foreign assets of the monetary authorities and deposit money banks, from line 31 of the monetary survey in the IMF's *International Financial Statistics*; NBKA$ is foreign-currency assets of nonbanks (cross-border) held with BIS reporting banks; NBKL$ is foreign-currency liabilities of nonbanks (cross-border) to BIS reporting banks; and IB$ is international debt securities (bonds) outstanding, denominated in foreign currency.

Note that NFCA can be either negative (denoting a net liability posi-

tion in foreign exchange) or positive (denoting a net asset position in foreign currency); a smaller negative figure for NFCA therefore denotes a smaller currency mismatch. When NFCA is negative (positive), a depreciation of the local currency will decrease (increase) net worth. In this book, we are mainly interested in crisis vulnerability, so we concentrate most of our attention on emerging economies with a negative foreign-currency mismatch.

Whereas data on nonbank exposures and international debt securities are collected by currency denomination, those on net foreign assets (as consolidated in the Fund's monetary survey) are not. As such, one has to assume that both foreign assets and liabilities are denominated exclusively in foreign currency; this will tend to overstate foreign-currency liabilities for those few emerging economies with relatively low shares of foreign currency in external liabilities (e.g., the Czech Republic, Poland, and South Africa). A second shortcoming of the data is the limited coverage of the foreign assets of corporations and households. The BIS statistics pick up some assets held with banks abroad, but there are reasons to expect that foreign-currency assets held abroad by corporations and households exceed those figures.

Next, the foreign-currency share of total debt (FC%TD) is written as follows:

$$\text{FC\%TD} = \frac{\text{NBKL\$} + \text{BKL\$} + \text{DCP\$} + \text{IB\$} + \text{DB\$}}{\text{NBKL} + \text{BKL} + \text{DCP} + \text{IB} + \text{DB}} \tag{2}$$

Here, the suffix "$" refers to debt denominated in foreign currency, and NBKL is liabilities of nonbanks (cross-border) to BIS reporting banks, in all currencies; BKL is liabilities of banks (cross-border) to BIS reporting banks, in all currencies; DCP is domestic credit to the private sector, as reported in line 32 of the monetary survey in the IMF's *International Financial Statistics*; IB is international debt securities (bonds) outstanding, in all currencies; and DB is domestic debt securities (bonds) outstanding, in all currencies.

In the baseline calculations, all domestic bonds and domestic bank loans (domestic credit) are assumed to be denominated in domestic currency—that is, (DB$/DB) and (DCP$/DCP) = 0. FC%TD must fall between zero and plus one.

Finally, let us denote the country's exports and imports of goods and services as XGS and MGS, respectively. These trade variables are a proxy for the response of net-interest income flows to a change in the exchange rate and for the country's ability to service foreign-currency debts.

These elements can be combined to construct an overall currency mismatch variable. Since we have not proposed a formal model of mismatch, the choice of a specific functional form is to some extent arbitrary, in particular the weights attached to each element. One possibility is simply

to multiply the elements (NFCA, FC%TD, XGS, and MGS). Accordingly, we define the AECM measure as follows:

$$\text{AECM} = (\text{NFCA}/\text{XGS})\,(\text{FC\%TD});\ \text{AECM} < 0 \tag{3a}$$

Equation (3a) says that an emerging economy's (negative) AECM will be lower if its export receipts are higher and the share of foreign currency in total debt financing is lower. Observe also that equation (3a) is equivalent to expressing the effective mismatch as the product of the ratio of net foreign-currency assets to GDP, the ratio of GDP to exports, and the foreign-currency share of total debt, and is written as

$$\text{AECM} = (\text{NFCA}/\text{GDP})\,(\text{GDP}/\text{XGS})\,(\text{FC\%TD}) \tag{4}$$

Equation (4) makes it clear that higher export openness (i.e., a low value for GDP/XGS) lowers the effective mismatch.

While equations (3a) and (4) are appropriate where the economy has a net liability position in foreign currency (AECM $<$ 0), they need to be modified slightly when the economy has a net asset position (AECM $>$ 0). When there is a net liability position, an exchange rate depreciation induces a negative "balance-sheet effect" (net worth falls) and a positive "competitive effect" (exports rise and imports fall); in other words, the competitive effect offsets the balance-sheet effect and makes the effective mismatch smaller. In contrast, when there is a net asset position in foreign currency, the balance-sheet effect (net worth rises) and the competitive effect (exports rise and imports fall) go in the same direction—that is, the competitive effect reinforces the balance-sheet effect and makes the mismatch larger. Replacing exports in equation (3a) with imports when AECM is positive recognizes the different implications of exports and imports for foreign exchange availability and allows an exchange rate–induced fall in imports to make the mismatch larger;[2] as such, when AECM is positive, the expression is written as

$$\text{AECM} = (\text{NFCA}/\text{MGS})\,(\text{FC\%TD});\ \text{AECM} > 0 \tag{3b}$$

Tables 4.3 to 4.6 show for a group of emerging economies over the 1993–2002 period key components of the AECM, the effective mismatch indicator itself, and a modified version of the effective mismatch indicator that takes account both of the (estimated) share of foreign currency in domestic bank loans to the private sector and of the share of exchange rate–

2. This is in the same spirit of using the ratio of external debt to exports to track external debt sustainability, while using the ratio of international reserves to imports to track reserve adequacy.

Table 4.3 Net foreign-currency assets, 1994–2002
(billions of dollars)

Region/country	1994	1995	1996	1997	1998	1999	2000	2001	2002
Latin America[a]	**–43.6**	**–51.1**	**–66.3**	**–85.5**	**–120.5**	**–131.7**	**–128.2**	**–169.8**	**–182.4**
Argentina	–16.7	–24.6	–30.9	–41.2	–54.2	–62.6	–70.4	–103.9	–99.9
Brazil	4.0	6.6	–1.9	–25.4	–40.4	–47.1	–49.1	–64.2	–75.6
Chile	3.7	4.9	5.2	2.0	–0.3	1.3	0.5	–3.8	–6.6
Colombia	3.4	1.0	–1.4	–2.7	–4.4	–4.1	–3.0	–3.5	–4.4
Mexico	–54.2	–57.2	–63.9	–45.4	–46.3	–43.8	–34.6	–18.2	–19.4
Peru	7.0	6.6	8.4	6.8	6.1	6.2	7.9	8.1	8.3
Venezuela	9.2	11.6	18.3	20.4	18.8	18.3	20.4	15.6	15.3
Asia, large economies[a]	**139.0**	**146.9**	**157.6**	**185.6**	**250.0**	**348.0**	**442.9**	**559.6**	**671.7**
China	35.5	52.0	84.5	137.0	155.7	181.5	226.5	304.4	373.5
India	11.4	9.8	12.0	13.7	17.0	22.5	28.4	39.0	60.8
Korea	–3.2	–10.7	–36.8	–58.4	–23.9	16.4	45.0	52.8	46.7
Taiwan	95.3	95.9	97.9	93.3	101.3	127.6	143.0	163.3	190.7
Other Asia[a]	**1.2**	**–13.1**	**–32.2**	**–78.0**	**–37.7**	**–5.3**	**5.3**	**20.1**	**28.4**
Indonesia	–13.5	–14.0	–14.5	–27.8	–19.8	–11.5	–4.7	2.1	8.3
Malaysia	17.1	14.3	9.6	–4.5	8.9	16.1	13.3	12.9	7.9
Philippines	3.4	1.9	–3.8	–12.2	–9.1	–9.3	–11.6	–12.8	–14.6
Thailand	–5.8	–15.2	–23.5	–33.4	–17.8	–0.6	8.3	17.9	26.8
Central Europe[a]	**0.7**	**16.8**	**18.6**	**18.2**	**25.4**	**28.4**	**31.4**	**39.5**	**39.4**
Czech Republic	4.1	8.2	7.4	6.7	10.8	14.0	14.4	18.0	25.1
Hungary	–9.5	–6.2	–6.4	–6.8	–6.2	–4.9	–5.0	–2.3	–4.6
Poland	6.1	14.9	17.6	18.3	20.8	19.4	22.0	23.8	18.9
Russia	13.9	11.1	3.6	–15.0	–34.3	–21.4	1.4	11.0	16.4
Israel	6.0	6.4	9.3	13.6	16.4	15.4	15.9	14.3	14.1
Turkey	–12.3	–10.3	–11.5	–15.0	–19.0	–19.6	–37.2	–39.4	–46.2
South Africa	–10.6	–10.8	–13.4	–11.4	–12.4	–6.1	–5.8	–2.6	3.2

a. Sum of the countries shown.

Note: Net foreign-currency assets equal net foreign assets of the monetary authorities and deposit money banks, from line 31 of the monetary survey in the IMF's *International Financial Statistics* plus foreign-currency assets of nonbanks (cross-border) held with BIS reporting banks minus foreign-currency liabilities of nonbanks (cross-border) to BIS reporting banks plus international debt securities (bonds) outstanding, denominated in foreign currency; outstanding year-end positions shown.

Sources: IMF's *International Financial Statistics*, national sources, and Bank for International Settlements.

linked instruments in domestic public debt.[3] For purposes of comparison, table 4.8 provides Eichengreen, Hausmann, and Panizza's (2002) calculations of original sin ratios for the same countries.

A reassuring feature of the estimates of net foreign-currency assets, shown in table 4.3, is how large negative currency mismatches either lead

3. The time-series behavior of the export openness ratio is not shown, as it was presented earlier in table 3.2.

or are contemporaneous with currency and banking crises in this group of emerging economies. In this connection, we draw attention to the large negative net foreign-currency positions in Mexico in 1994–96, the Asian-crisis countries (Korea, Indonesia, Malaysia, the Philippines, and Thailand) in 1997–98, Russia in 1998, Argentina in 2001–02, Brazil in 2002, and Turkey in 2000–02. In terms of dollar values, the largest negative net foreign-currency position by far was Argentina's imbalance in 2001–02 (at around $100 billion); next in line were Brazil ($76 billion), Mexico ($64 billion), Korea ($58 billion), Turkey ($46 billion), Russia ($34 billion), Thailand ($33 billion), and Indonesia ($28 billion). It is also evident from table 4.3 that some emerging economies have had positive net foreign-currency positions consistently over the past decade and that some others—including all the Asian-crisis countries except for the Philippines—have turned negative net foreign-currency positions into positive ones. In 2002, China and Taiwan were the economies with the largest positive net foreign-currency positions (at $373 billion and $191 billion, respectively).

Table 4.4 gives our (baseline) estimates of the foreign-currency share of total debt, under the assumption that both domestic bank loans and domestic bonds are exclusively denominated in domestic currency. Several observations are in order. To begin with, the foreign-currency share of the total debt market is much lower virtually everywhere than the foreign-currency share of cross-border bank loans and international bonds (as represented, say, in original sin ratios). For the larger Asian emerging economies taken as a group (China, India, Korea, and Taiwan), the foreign-currency share of the total debt market is estimated to be less than 5 percent (in 2002). The second observation is that the foreign-currency share is much higher in Latin America than in the other emerging-market regions. Foreign-currency shares vary considerably within regional groups with, for example, Argentina's estimated foreign-currency share being higher than others in Latin America; the same could be said of Russia among European emerging economies and of the Philippines among the former Asian-crisis economies. As regards trends over time, table 4.4 suggests that the foreign-currency share has risen moderately (over the 1994–2002 period) in Latin America, fallen sharply in larger Asian emerging economies, and fallen less markedly in both the former Asian-crisis countries and Central Europe. Foreign-currency shares have increased notably in Argentina, Brazil, Chile, and the Philippines.

Table 4.5 presents the baseline AECM estimates. Since our estimates of the AECM "normalize" the nominal net foreign-currency asset positions for variations in both export openness and the foreign-currency share of total debt, they invite time-series and cross-country comparisons of currency mismatch. Going back again to the most prominent crisis episodes within our sample group, we observe that the size of the estimated currency mismatch is typically larger in the run-up to and espe-

Table 4.4 Foreign-currency share of total debt, 1994–2002
(percent)

Region/country	1994	1995	1996	1997	1998	1999	2000	2001	2002
Latin America[a]	**22.9**	**25.3**	**26.9**	**26.8**	**25.6**	**29.3**	**29.2**	**28.7**	**32.9**
Argentina	32.9	36.4	40.2	41.4	43.2	44.7	46.2	49.2	58.9
Brazil	15.1	15.8	16.6	17.1	14.3	18.4	19.6	19.0	23.7
Chile	17.8	17.3	18.7	22.8	23.3	23.7	22.7	24.4	26.8
Colombia	34.7	34.2	36.1	36.3	36.0	35.9	33.0	33.8	34.5
Mexico	26.8	39.4	46.3	40.5	44.4	40.1	37.0	33.9	33.8
Peru	38.6	40.5	44.0	38.7	34.5	29.2	26.3	23.1	24.6
Venezuela	44.6	38.7	44.5	47.4	48.3	48.4	41.6	38.4	47.9
Asia, large economies[a]	**10.2**	**10.6**	**11.4**	**12.1**	**9.0**	**7.3**	**6.2**	**5.5**	**4.8**
China	10.6	9.6	9.0	8.3	6.5	4.8	3.8	3.1	2.1
India	7.5	8.1	8.3	9.2	8.7	7.4	6.3	5.1	4.6
Korea	16.0	18.1	21.9	31.5	19.3	15.9	14.3	12.9	11.5
Taiwan	5.0	4.7	4.5	4.8	4.6	3.9	3.1	4.0	5.5
Other Asia[a]	**23.2**	**26.0**	**26.1**	**31.9**	**25.9**	**22.8**	**22.2**	**20.9**	**19.8**
Indonesia	33.0	32.6	32.9	46.7	42.9	33.1	32.0	28.9	22.5
Malaysia	13.9	13.8	14.6	19.8	17.7	16.9	15.8	15.9	18.2
Philippines	12.4	13.4	17.7	25.3	26.1	29.1	31.9	33.0	35.2
Thailand	26.4	32.8	32.5	35.2	23.3	18.8	17.9	15.7	12.7
Central Europe[a]	**19.2**	**19.6**	**18.0**	**19.5**	**19.2**	**20.1**	**19.8**	**18.0**	**16.9**
Czech Republic	11.5	13.7	14.2	16.8	14.2	13.5	13.5	15.1	13.0
Hungary	30.2	33.8	31.8	32.5	34.5	37.2	34.9	31.8	25.1
Poland	11.8	10.6	8.9	11.3	12.0	13.3	14.6	12.4	13.9
Russia	35.3	26.7	22.1	22.1	47.2	42.1	37.0	34.1	35.5
Israel	3.1	3.4	3.6	4.9	5.5	7.1	7.3	8.5	9.0
Turkey	40.6	35.6	33.0	33.5	31.2	31.2	31.4	24.6	22.9
South Africa	7.2	8.5	10.6	9.8	10.2	9.2	10.4	16.1	13.0

a. Calculated with aggregates of countries shown.

Note: See definition of foreign-currency share of total debt on page 43.

Sources: IMF's *International Financial Statistics*, national sources, and Bank for International Settlements.

cially during the crisis; again, see Mexico in 1994–96; Korea, Indonesia, Malaysia, the Philippines, and Thailand in 1996–98; Russia in 1997–99; Argentina in 1999–2002; Brazil in 2001–02; and Turkey in 2000–02. Comparing across crisis episodes, the effective mismatch in the recent Argentine crisis was by a factor of ten the largest one is our sample. Argentina's effective currency mismatch in 2001–02 was huge because the size of the net foreign-currency mismatch itself was so big relative to the size of the economy, because the foreign-currency share of total debt was significantly higher in Argentina than in other crisis episodes, and because its degree of export openness was low (particularly before 2002)

Table 4.5 Original AECM estimates, 1994–2002 (assuming zero foreign-currency share of domestic debt)

Region/country	1994	1995	1996	1997	1998	1999	2000	2001	2002	Foreign-currency share of total debt (2002)
Latin America										
Argentina	–28.40	–35.79	–43.80	–55.14	–75.09	–100.37	–104.42	–164.91	–207.88	58.90
Brazil	1.22	1.57	–0.60	–7.14	–9.87	–15.72	–14.99	–18.19	–25.14	23.70
Chile	4.56	4.52	4.45	1.86	–0.39	1.58	0.53	–3.99	–7.86	26.77
Colombia	7.07	1.76	–3.54	–6.20	–10.65	–9.37	–5.45	–6.96	–9.64	34.46
Mexico	–20.56	–25.90	–27.67	–15.14	–15.91	–11.90	–7.11	–3.60	–3.80	33.83
Peru	37.42	27.37	36.61	24.02	20.00	20.57	21.69	20.09	21.15	24.61
Venezuela	31.64	26.50	54.12	50.06	44.95	52.55	42.91	27.24	43.30	47.88
Asia, large economies										
China	3.37	3.70	4.95	6.95	6.16	4.59	3.48	3.48	2.42	2.10
India	2.56	1.77	2.21	2.49	2.71	2.69	2.61	2.93	3.84	4.56
Korea	–0.45	–1.31	–5.26	–11.09	–2.93	1.81	3.34	3.98	2.93	11.54
Taiwan	4.66	3.71	3.56	3.37	3.77	3.82	2.75	5.14	8.00	5.47
Other Asia										
Indonesia	–9.53	–8.61	–8.13	–21.57	–16.80	–7.65	–2.33	1.30	3.91	22.50
Malaysia	3.51	2.27	1.54	–0.96	2.34	3.57	2.23	2.39	1.56	18.18
Philippines	1.64	0.78	–1.98	–7.68	–6.95	–6.89	–8.80	–12.09	–13.42	35.15
Thailand	–2.71	–7.11	–10.68	–16.24	–6.29	–0.16	2.09	4.08	4.68	12.70
Central Europe										
Czech Republic	2.16	3.68	3.09	3.39	4.50	5.56	5.17	6.46	6.97	13.02
Hungary	–23.78	–10.65	–9.33	–8.75	–7.29	–5.87	–5.01	–1.90	–2.69	25.08
Poland	3.37	5.37	4.24	4.82	4.71	5.11	5.61	5.06	4.23	13.94
Russia	7.57	3.60	0.93	–3.23	–18.97	–10.58	0.80	5.16	7.07	35.46
Israel	0.51	0.54	0.77	1.59	2.24	2.40	2.22	2.51	2.66	8.98
Turkey	–17.91	–10.83	–9.68	–10.75	–12.17	–14.25	–24.37	–19.76	–20.17	22.87
South Africa	–2.55	–2.64	–4.00	–3.08	–3.70	–1.65	–1.65	–1.20	1.33	13.05

AECM = aggregate effective currency mismatch

Source: Authors' calculations.

relative to that in most other crises.[4] But the estimates in table 4.5 actually *understate* the size of the effective mismatch in Argentina in 2001–02 because the actual foreign-currency share of total debt is even higher than indicated by the estimates in the table. The next largest effective currency mismatches were those for the Mexican crisis, the Brazilian crisis (2002), and the Turkish crisis (2000)—all estimated to be roughly the same order of magnitude. Interestingly enough, effective currency mismatches during the Asian financial crisis are judged to have been significantly smaller (except in the case of Indonesia)—reflecting those countries' high export openness and relatively low foreign-currency share of total debt.[5] Korea's effective currency mismatch in 1997, for example, is estimated at less than half the size of those during the Mexican, Brazilian, and Turkish crises. In 2002, the largest effective currency mismatch was in Argentina, followed in descending order by Brazil, Turkey, and the Philippines.

In table 4.6, we revise our AECM estimates to reflect that domestic bank loans and domestic bonds are *not* exclusively denominated in domestic currency in all emerging economies. To get a fix on the share of foreign currency in domestic bank loans going to the private sector, we relied primarily on the estimates given in Reinhart, Rogoff, and Savastano (2003a); for those emerging economies not represented in that paper, we drew on the database in Arteta (2002, 2003). For China, Nicholas Lardy provided us with an estimate of the share of bank loans denominated in foreign currency which he put together from national sources. The five emerging economies in our sample with the highest share of foreign currency in domestic bank loans (1994–99 average) were Peru, Argentina, Turkey, Indonesia, and Hungary; among the economies with very low shares were Brazil, India, Taiwan, the Philippines, Venezuela, Malaysia, China, and Korea. To capture the share of foreign currency–linked instruments in domestic government debt, we again leaned on the estimates in Reinhart, Rogoff, and Savastano (2003a). Unfortunately, their estimates cover only 10 of the countries in our sample; still, the countries covered are generally considered to be the ones with the highest shares of linked

4. In some preliminary regression analysis, we found that, ceteris paribus, the *lower* the country's export openness, the higher the foreign-currency share of total debt. This is the opposite of what one would expect to find if there were good risk assessment in place. It is also opposite to what has been found in firm-level studies where firms that export tend to have a higher share of foreign-currency debt. This negative correlation between the foreign-currency share of debt and export openness is suggestive of economywide distortions (perhaps related to the currency regime and/or the official safety net) that create the wrong incentives for hedging currency risk.

5. In contrast, ratios of short-term external debt to reserves would suggest that the aggregate mismatch in some Asian-crisis countries (Korea) in 1997 was larger than recent mismatches in Latin America; this reflects, inter alia, the different nature of the two mismatch indicators, with short-term debt to reserves signaling near-term liquidity strains and the AECM signaling the severity of crises (contingent on a large change in the exchange rate).

Table 4.6 Modified AECM estimates, 1994–2002 (assuming nonzero foreign-currency share of domestic debt)

Region/country	1994	1995	1996	1997	1998	1999	2000	2001	2002	Foreign-currency share of total debt (2002)
Latin America										
Argentina	–69.74	–79.97	–89.64	–108.73	–143.77	–186.56	–189.33	–282.38	–309.58	87.71
Brazil	1.79	2.38	–0.90	–10.73	–15.72	–23.05	–21.44	–26.15	–32.84	30.95
Chile	7.05	7.08	6.74	2.61	–0.54	2.18	0.74	–5.45	–10.39	35.37
Colombia	8.65	2.16	–4.27	–7.44	–12.81	–11.20	–6.60	–8.36	–11.50	41.12
Mexico	–32.48	–34.32	–33.54	–18.91	–19.22	–14.56	–8.74	–4.50	–4.77	42.50
Peru	80.62	56.25	69.84	51.62	47.72	56.11	64.06	66.07	65.51	76.23
Venezuela	31.74	26.62	54.29	50.20	45.08	52.68	43.03	27.33	43.39	47.97
Asia, large economies										
China	4.88	5.52	7.55	10.87	10.61	9.03	7.65	8.71	8.08	7.01
India	2.56	1.77	2.21	2.49	2.71	2.69	2.61	2.93	3.84	4.56
Korea	–0.57	–1.59	–6.16	–12.36	–3.50	2.29	4.37	5.35	4.07	16.02
Taiwan	4.66	3.71	3.56	3.37	3.77	3.82	2.75	5.14	8.00	5.47
Other Asia										
Indonesia	–17.08	–15.49	–14.56	–30.92	–25.31	–13.61	–4.24	2.54	9.13	52.53
Malaysia	3.62	2.34	1.59	–0.98	2.39	3.65	2.29	2.45	1.60	18.59
Philippines	1.64	0.78	–1.98	–7.68	–6.95	–6.89	–8.80	–12.09	–13.42	35.15
Thailand	–3.73	–9.06	–13.65	–20.31	–8.95	–0.25	3.21	6.53	8.14	22.07
Central Europe										
Czech Republic	5.32	7.68	6.36	6.17	8.39	10.03	9.30	10.86	11.30	21.12
Hungary	–37.77	–15.86	–13.85	–12.81	–10.31	–7.82	–6.80	–2.68	–4.13	38.46
Poland	6.60	11.05	9.89	9.84	9.37	9.58	9.83	9.44	7.30	24.07
Russia	7.81	3.98	1.13	–4.06	–19.61	–11.07	0.84	5.38	7.38	37.04
Israel	2.28	2.23	3.13	5.03	6.52	6.15	5.74	6.00	6.01	20.30
Turkey	–26.52	–17.33	–16.21	–17.73	–21.05	–24.38	–41.70	–38.38	–41.32	46.84
South Africa	–3.01	–3.05	–4.53	–3.53	–4.25	–1.93	–1.89	–1.31	1.49	14.63

AECM = aggregate effective currency mismatch

Source: Authors' calculations.

debt. Where data on exchange rate–linked domestic public debt were missing, we assumed as a first approximation that the foreign-currency share was zero. The five emerging economies with the highest shares of exchange rate–linked domestic public debt were Argentina, Peru, Turkey, Brazil, and Russia; those with relatively low shares were China, Thailand, Venezuela, India, Korea, Malaysia, and South Africa.

As expected, the recognition of foreign-currency debt into both domestic credit and domestic bonds serves to increase our estimates of both the foreign-currency share of total debt and the size of the AECM—compare the entries in table 4.6 with those in tables 4.4 and 4.5. What is perhaps most interesting is the diversity of changes across countries from this modification in assumptions about the currency composition of domestic (bank and bond) debt. In three emerging economies (Argentina, Peru, and Indonesia), the new assumptions produce a new foreign-currency share of total debt that is equal to 50 percent or higher; indeed, in Argentina and Peru, that share rises to 88 and 76 percent, respectively, while in Indonesia it increases to 52 percent. With much higher foreign-currency shares, the AECM rises as well: in Argentina, the (peak) AECM climbs (in 2002) from 208 to 310 percent of exports, while in Indonesia, the (peak) AECM in 1998 advances from 17 to 25 percent of exports. The change in assumptions also has large consequences for Turkey: the foreign-currency share of total debt increases from 23 to 47 percent, and the (peak) AECM almost doubles in 2000 from 24 to 42 percent of exports. In sharp contrast, the change in assumptions produces very small changes in foreign-currency shares and AECMs in India, Korea, Malaysia, Taiwan, Venezuela, the Philippines, Russia, and South Africa. In the middle of the pack lie Brazil, Mexico, Chile, Hungary, and Thailand, where the rise in peak AECMs is moderate. And finally, in China, the Czech Republic, Poland, and Israel, the increases in foreign-currency shares and AECMs are large but start from a rather low level; these are also economies that have consistently run positive net foreign-currency positions over the 1994–2002 period.

Modification of AECM

The estimates in tables 4.5 and 4.6 represent in our view a significant improvement over what has been available heretofore on aggregate currency mismatch; nevertheless, our estimates of AECM should be regarded as only a "first pass" at what could be accomplished. They are based on data that are available for all larger countries, from IMF and BIS sources. National data sources will often be richer. In this connection, several alternative formulations of the AECM could be explored further, four of which are mentioned next.

First, we could attempt to incorporate cross-country and time-series variation in *leverage ratios* into our mismatch indicator. As discussed in

Table 4.7 Total debt as a percent of GDP, 1994–2002

Region/country	1994	1995	1996	1997	1998	1999	2000	2001	2002
Latin America[a]	**73.0**	**67.9**	**71.0**	**75.1**	**83.8**	**83.7**	**78.2**	**86.5**	**86.7**
Argentina	49.8	51.8	57.1	64.9	73.6	81.3	84.5	90.8	183.0
Brazil	84.3	75.7	84.2	91.7	110.4	118.3	107.6	136.2	118.2
Chile	124.3	115.3	115.3	124.9	130.6	139.4	142.1	155.1	162.4
Colombia	33.7	35.9	44.4	46.1	56.1	62.2	66.9	77.0	74.7
Mexico	81.6	78.2	64.5	61.9	56.5	56.7	50.3	50.6	51.6
Peru	17.4	19.1	21.0	29.4	33.6	41.2	40.1	41.5	39.3
Venezuela	58.3	44.4	38.4	35.8	36.7	36.9	35.4	40.3	50.5
Asia, large economies[a]	**114.0**	**110.8**	**117.3**	**112.6**	**146.3**	**150.9**	**150.4**	**159.1**	**181.7**
China	111.0	108.9	115.7	127.8	148.0	161.9	168.4	172.9	205.6
India	70.7	63.7	70.4	64.8	70.0	76.3	78.8	83.2	91.2
Korea	108.9	108.5	113.6	84.0	181.7	163.7	151.9	176.7	201.6
Taiwan	186.5	184.9	194.0	181.0	218.5	211.0	193.5	205.4	206.0
Other Asia[a]	**104.9**	**108.8**	**118.3**	**101.7**	**172.8**	**147.3**	**133.2**	**138.8**	**136.9**
Indonesia	66.6	67.7	71.7	55.7	119.8	92.8	78.0	76.2	75.5
Malaysia	168.6	176.3	199.8	172.2	238.3	225.0	220.9	238.4	236.7
Philippines	100.7	97.8	113.0	102.4	128.9	118.3	112.3	119.4	116.7
Thailand	120.7	127.3	133.6	120.4	201.3	177.7	150.7	153.7	158.4
Central Europe[a]	**90.0**	**81.6**	**77.5**	**75.8**	**83.5**	**81.9**	**81.9**	**86.4**	**98.5**
Czech Republic	94.0	96.2	91.5	91.8	109.9	107.3	108.2	104.3	114.9
Hungary	154.3	141.3	137.3	123.9	131.2	121.5	122.4	123.4	136.7
Poland	61.3	54.9	53.1	54.6	59.8	60.6	62.2	70.3	79.2
Russia	24.1	32.7	38.1	49.4	36.8	49.3	38.7	35.9	39.6
Israel	203.9	187.0	188.9	183.0	175.9	192.2	184.3	194.1	213.7
Turkey	50.9	50.1	56.2	60.3	69.9	84.5	98.7	150.3	134.1
South Africa	136.5	129.6	119.2	123.2	128.6	133.6	121.3	99.7	148.7

a. Calculated with aggregates of countries shown.

Note: Total debt is equal to liabilities of nonbanks (cross-border) to BIS reporting banks, in all currencies, plus international debt securities (bonds) outstanding, in all currencies, plus domestic debt securities (bonds) outstanding, in all currencies, plus domestic credit to the private sector, as reported in line 32 of the monetary survey in the IMF's *International Financial Statistics*. Outstanding year-end positions shown.

Sources: IMF's *International Financial Statistics*, national sources, and Bank for International Settlements.

appendix A, a more general equilibrium treatment of the sensitivity of net worth and net income to a change in the exchange rate would take on board the possibility that the shock causing the exchange rate to change (depreciate) might simultaneously affect (increase) the cost of borrowing. Similarly, the authorities might react to an exchange rate depreciation by increasing interest rates. In both cases, a high degree of leverage would alter the effects of a change in the exchange rate. One would also expect that, ceteris paribus, the larger the total debt relative to the size of the economy, the larger the effect of a currency mismatch in debt markets. Table 4.7 shows the ratio of total debt to GDP for our sample of emerging

economies. It is evident that this debt ratio varies significantly across countries and within countries over time. In some initial experiments, we allowed the ratio of total debt to GDP to increase the mismatch indicator. The main results can be inferred from table 4.7. On a regional level, the relatively high leverage in Asian emerging economies tended to increase their AECMs vis-à-vis less-leveraged economies in Latin America, offsetting to some extent regional differences in mismatches attributable to differences in export openness. In Argentina, which has quite a low ratio of total debt to GDP, the leverage adjustment narrowed the gap between the peak mismatch and the rest of the field—for example, the leverage adjustment considerably raised Thailand's peak AECM (in 1997) and also those for Korea (in 1997) and Brazil (in 2000–02). In contrast, Russia's relatively low leverage ratio reduced its peak AECM. In Turkey, the increase in the total debt ratio over the 1994–2001 period contributed to the large aggregate currency mismatch in 2000–01. The pattern of aggregate effective mismatches increasing markedly remained in the run-up to and during financial crises.

Second, instead of using the *stocks* of bank loans and bonds as weights to derive the foreign-currency share of total debt, one could use financing *flows* to weight the various currency shares. This carries some attraction since the stocks of debt can sometimes produce a misleading impression of current financing opportunities—for example, when the domestic banking system is experiencing serious problems, new financing from banks may be close to zero or negative, even if the stock of bank loans outstanding is very large. Some simulations were done along these lines using the individual-country data on bond issues and new bank loans. More often than not (at least for the 1997–2002 period), the flow weights tended to produce somewhat lower foreign-currency shares of total debt and hence lower AECMs, but a disadvantage of the flow formulation was that the flows varied so much from year to year that they produced high (time-series) variability in the foreign-currency share of total debt—at least for those emerging economies where the foreign-currency share was quite different across the various financing components. Perhaps some combination of stock and flow weights may ultimately prove to be useful.

Yet a third scenario would employ a different weighting scheme (as between exports and GDP) to scale net foreign-currency assets. In this connection, it could be argued that for larger emerging economies, exports underestimate the share of tradables in GDP, and therefore a somewhat broader scaling variable would be appropriate to capture the sensitivity of noninterest flows to a change in the exchange rate. To cite one possibility, net foreign-currency assets could be scaled by giving exports a weight of two-thirds and GDP a weight of one-third.

Fourth, one could attempt to get a more comprehensive measure of foreign-currency assets and liabilities than is available from our defini-

tion of net foreign-currency assets in equation (1). For some emerging economies, debt owed to BIS reporting banks is significantly lower than total debt owed to foreigners; similarly, there are other foreign-currency debt flows, such as trade credit extended by nonfinancial corporations, that are not fully covered in our formulation of net foreign-currency assets. One could obtain a more comprehensive measure by deriving a currency-weighted transformation of a country's net international investment position (NIIP). The problem is that the NIIP data show only liabilities/assets vis-à-vis nonresidents—not assets and liabilities broken down by currency of denomination. Hence, assumptions about the currency composition of each broad component of the external balance sheet would have to be made in order to derive an estimate of the aggregate currency mismatch. Where available, data on the currency composition of external bond and banking flows and benchmarks from portfolio surveys could be used to inform such estimates. Once each major component of the NIIP is assigned a currency denomination, a weighted average estimate of the aggregate currency mismatch could be derived (where the weights are the value of each component in total foreign assets or total foreign liabilities). According to Allen et al. (2002), 78 countries now include their NIIPs in their submissions to the IMF's *International Financial Statistics*; from mid-2002 on, all countries that subscribe to the Fund's Special Data Dissemination Standard are expected to disseminate their NIIPs and publish quarterly external debt data. In summary, the use of NIIP data can provide a valuable cross-check on the mismatch variable defined here. One reason such a cross-check is important is that there are major conceptual and statistical discrepancies between debtor-based statistics (usually the international investment position statistics) and creditor-based statistics (e.g., from BIS banking statistics). Efforts to examine and document such discrepancies are important.[6]

For purposes of comparison, table 4.8 presents the original sin ratios (calculated by Eichengreen, Hausmann, and Panizza 2002) for the same 22 emerging economies listed in most of the earlier tables.[7] Recall that when the foreign-currency shares of cross-border bank loans and international bonds are both one, the original sin ratio is also one. The results in table 4.8 and those in tables 4.5 and 4.6 paint utterly different pictures. In

6. For an exploration of this, see BIS (2002). The origin of this study was that the statistical authorities in some emerging markets noted striking differences between their estimates of external debt and the joint BIS-IMF-OECD-World Bank statistics on external debt, which were heavily based on creditor data sources. For an overview, see von Kleist (2002). The volume contains a comparison of the data for Chile, China, the Czech Republic, India, Latvia, Mexico, the Philippines, Poland, and Thailand.

7. We chose OSIN2 ratios from Eichengreen, Hausmann, and Panizza (2002) for table 4.7.

Table 4.8 Original sin ratio in emerging economies

Region/country	1993–98	1999–2001
Latin America		
Argentina	0.98	0.97
Brazil	1	1
Colombia	1	1
Mexico	1	1
Peru	1	1
Venezuela	1	1
Asia, large economies		
China	1	1
India	1	1
Korea	1	1
Taiwan	1	0.62
Other Asia		
Indonesia	0.94	0.98
Malaysia	0.99	1
Philippines	0.98	0.99
Thailand	0.98	0.87
Central Europe		
Czech Republic	0.88	0.84
Hungary	1	0.98
Poland	0.95	0.89
Russia	1	0.98
Israel	1	1
Turkey	1	1
South Africa	0.91	0.76

Source: OSIN2 ratios from Eichengreen, Hausmann, and Panizza (2002).

the original sin calculations, there is little suggestion either of large differences in aggregate currency mismatch across emerging economies or of sharp variations in these mismatches over time. These original sin ratios certainly don't hint that aggregate currency mismatches are larger in the run-up or during financial crises, and there is no indication that mismatches diminish in the recovery from the crisis.

Another difference is that the original sin calculations imply that debtor countries must have negative net foreign-currency positions, whereas our approach (as seen in tables 4.5 and 4.6) is consistent both with some emerging-market debtors running consistently positive net foreign-currency positions and with emerging economies switching from negative to positive positions (or vice versa). Consider, for example, an emerging economy with a negative NIIP (i.e., a debtor). Assume that the bulk of foreign liabilities is direct foreign investment denominated in the domestic currency. In that case, a net debtor might easily have a positive

net foreign-currency position, especially if it had recently undergone a sharp increase in its holdings of international reserves.[8]

To conclude on the measurement issue, it is possible to do a lot better (than relying on original sin ratios) in measuring currency mismatches at the aggregate level. Our proposed indicator of aggregate effective currency mismatch—shown in tables 4.5 and 4.6—is an attempt to buttress that claim with some illustrative calculations. These estimates could be improved further with a moderate increase in resource costs (at the international financial institutions) devoted to measurement and monitoring of mismatches.

At the sectoral level, the lack of data on the corporate sector is the biggest hole in the data needed to measure and assess currency mismatches. Better data on corporate balance sheets would permit a fuller and more systematic analysis of sectoral currency exposures and vulnerabilities. We therefore argue that the collection of such data ought to merit high priority in efforts by the official sector to monitor and provide early warnings of currency and banking crises. Some promising efforts to bring mismatches in the corporate sector into clearer focus are already under way. For example, Mulder et al. (2002) used the Worldscope database to construct a ratio of corporate foreign debt to exports for 19 emerging economies and found that this currency mismatch variable was helpful in explaining both the probability and severity of currency crises over the 1991–99 period. In another example, Gray (2002) applied contingent claims analysis already so popular in the pricing of corporate default risk in the largest industrial countries to a growing set of emerging economies. One attraction of contingent claims analysis is that because it relies heavily on forward-looking price information (i.e., information on the value and volatility of equity and junior claims), it is relatively parsimonious in its data requirements for corporate balance sheets yet it can still generate estimates of the vulnerability of various sectors (including the corporate sector) to changes in the exchange rate. While Gray's (2002) analysis is currently available for only a handful of the larger emerging economies, it could be extended to a wider sample.

8. In their latest paper on original sin, Eichengreen, Hausmann, and Panizza (2003e) now acknowledge that a net debtor will have an aggregate currency mismatch when there is a net debt to foreigners *denominated in foreign currency* (emphasis added); previously, they had asserted (incorrectly) that "countries with original sin that have net foreign debt as developing countries are expected to have will have a currency mismatch on their national balance sheet" (Eichengreen, Hausmann, and Panizza 2002, 10). See appendix B.