Financial exchange rates and international currency exposures[*]

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Abstract

Our goal in this project is to gain a better empirical understanding of the international financial implications of currency movements. To this end, we construct a database of international currency exposures for a large panel of countries over 1990–2004. We show that trade-weighted exchange rate indices are insufficient to understand the financial impact of currency movements. Further, we demonstrate that many developing countries hold short foreign currency positions, leaving them open to negative valuation effects when the domestic currency depreciates. However, we also show that many of these countries have substantially reduced their foreign currency exposure over the last decade. Last, we show that our currency measure has high explanatory power for the valuation term in net foreign asset dynamics: exchange rate valuation shocks are sizeable, not quickly reversed and may entail substantial wealth shocks.

1. Introduction

In recent years, there has been a wave of research that has emphasised that exchange rate movements operate through a valuation channel, in addition to their traditional impact on real-side variables such as the trade balance. The valuation channel refers to the impact of capital gains and losses on the international balance sheet. While such valuation effects have always been present, their quantitative significance has grown in recent years in line with the rapid growth in the scale of cross-border financial holdings (Lane and Milesi-Ferretti (2007a)). Since currency movements are an important contributor to capital gains and losses on foreign assets and liabilities, the goal of our project is to gain a better empirical understanding of the international financial impact of shifts in exchange rates.[1]

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[*] We thank Patrick Honohan, Ted Truman, Pinar Yesin and the participants in the CGFS workshop on "The Use of BIS International Financial Statistics", the Dartmouth College Junior Seminar, the NBER IFM Lunch Group and seminars at the Bank of England, European Central Bank, University of California – (Davis), University of Siena and University of Wisconsin. We are grateful to Philippe Mesny and Dennis Pêtre for the provision of data from the BIS and to Ted Truman for generously sharing his data on reserves and helpful comments. Agustin Benetrix, Vahagn Galstyan and Barbara Pels provided excellent research assistance. Lane's work on this paper is supported by the HEA-PRTLI grant to the IIIS. This work began while Shambaugh was a visiting scholar at the IIIS, and his work on this paper is supported by the Rockefeller Center at Dartmouth. plane@tcd.ie; Jay.C.Shambaugh@dartmouth.edu.

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[1] Gourinchas and Rey (2007a, 2007b) and Tille (2003, 2005) have made studies of the valuation channel for the United States, while Lane and Milesi-Ferretti (2001, 2003, 2005, 2007a, 2007b, 2007c) have examined valuation effects for a large panel of countries in a variety of settings. See also the review by Obstfeld (2004).

This effect varies across countries based on the scale of the international balance sheet, the net value of the position and the currency composition of foreign assets and liabilities. For instance, authors such as Tille (2003), Gourinchas and Rey (2007a) and Lane and Milesi-Ferretti (2003, 2005, 2007b) have highlighted that the foreign liabilities of the United States are mostly denominated in dollars while there is a substantial non-dollar component in its foreign assets. Accordingly, unanticipated dollar depreciation improves the net international investment position of the United States by increasing the dollar value of its foreign assets relative to its foreign liabilities. In contrast, many emerging markets have historically issued significant amounts of foreign currency debt – for these countries, currency depreciation has had an adverse impact on the net foreign asset position.

Although there has been a significant expansion in the availability of data on many dimensions of international balance sheets in recent years, remarkably little is known about the currency composition of the foreign assets and liabilities of most countries. Accordingly, a major contribution of our project is to address this data deficit by building an empirical profile of the international currency exposures of a large number of countries. We exploit the estimated currency positions to create financially weighted exchange rate indices that better capture the valuation impact of currency movements relative to standard trade-weighted indices. In turn, the interaction of the financial exchange rate indices and the gross scale of the international balance sheet allow us to capture the valuation impact of currency movements on net foreign asset positions. In addition, the currency exposure data may be useful in evaluating the new wave of global macroeconomic models that endogenise the composition of international portfolios and analysing the "wealth" channel of monetary policy in open economies. Accordingly, the analysis of currency exposure data may provide new insights into the interaction between financial globalisation and macroeconomic behaviour.

Our analysis yields three important findings. First, financially weighted exchange rates move quite differently from trade-weighted exchange rates. In particular, we find that the mean and median within-country correlation of trade and financial exchange rates is negative. Many countries have effectively stabilised their financial exchange rates by matching currency exposures on the liability side with corresponding asset positions, leading to stable financial exchange rates even when trade-weighted exchange rates move considerably. For others, negative net currency positions generate negative correlations with trade-weighted exchange rates or positive positions generate positive (albeit not complete) correlations with trade-weighted exchange rates. In short, trade-weighted exchange rates are not particularly informative regarding the financial impact of shifts in exchange rates, without knowing the structure of cross-border currency exposures.

Second, in relation to the aggregate net position in foreign currencies, we find that the majority of countries have a net negative exposure, implying that unexpected depreciation generates wealth losses. These net negative positions are quite large in many cases and leave countries exposed to substantial valuation losses in the event of a depreciation. At the same time, over the last decade, many countries have shifted their hedging positions in a positive direction: shifts to equity and direct investment financing of liabilities and large increases in reserves have been more important in alleviating currency mismatches than increases in the share of international debt that is denominated in domestic currency.

Finally, we examine the size and properties of exchange rate valuation shocks. We find that the shocks are substantial and are not reversed by quick exchange rate turnarounds (the autocorrelation of exchange rate valuation shocks is in fact positive). Furthermore, the exchange rate valuation shocks calculated based on our indices are good predictors of the overall valuation shocks an economy faces, especially for developing countries. Their scale and long-lasting nature mean that these wealth shocks may have non-trivial impacts on the wider economy. In addition, since currency movements lead to cross-border wealth redistributions, these are especially important for the international transmission mechanism relative to other asset price shocks.

Our analysis is partial equilibrium in nature, since we effectively treat exchange rate movements as exogenous. That said, the empirical insights in the paper have implications for the design of dynamic stochastic general equilibrium models that feature endogenously determined international portfolios and seek to incorporate the wealth effects of exchange rate changes that feed back into the economy. Understanding why the exchange rate changes does not change the positive aspects of our work – the examination of the wealth effects – but it does have implications in terms of the optimal composition of international portfolios.

Our work is related to several previous contributions on international currency exposures. Along one strand, Eichengreen, Hausmann and Panizza (2003) compiled data on the currency composition of the external debts of developing countries, while Goldstein and Turner (2004) extend the analysis by constructing estimates of net foreign currency debt assets. However, these contributions do not take into account the portfolio equity and FDI components of the international balance sheet. Tille (2003) calculates the foreign currency composition of the international balance sheet of the United States, while Lane and Milesi-Ferretti (2007c) calculate dollar exposures for a large number of European countries, plus Japan and China. Relative to these contributions, we provide greatly expanded coverage for a large number of countries and estimate the full currency composition of the international balance sheet.

While our work represents a dramatic improvement relative to the status quo, it is important to be clear about its limitations. In particular, we have made many assumptions in constructing our estimated international currency exposures. Moreover, in some cases, we infer values for missing data by modelling the relation between known country characteristics and international financial holdings. Obviously, estimated data will not be perfectly accurate, nor will every assumption made fit every country perfectly. We make every effort to cross-check our data where possible, and we detail and defend the choices made in the appendix describing our data methods.

After the description of the conceptual basis of the valuation channel in the next section, Section 3 provides a brief outline of the methods employed to construct the currency position data; the appendix provides a detailed description of the methods by which we construct our dataset on currency exposures and a discussion of our key assumptions, the empirical model that generates values where data are missing and the robustness of these estimates. We turn in Section 4 to the construction of financial exchange rate indices. Section 5 reports the main results of our empirical analysis. Some conclusions are offered in Section 6.

2. Conceptual framework

Traditionally, the main focus of attention in analysing the role of the exchange rate in the international adjustment process has been its impact on real variables such as the trade balance and domestic and foreign levels of output and other macroeconomic variables. However, in recent years, there has been a resurgence in interest in the balance sheet impact of currency movements. While this valuation channel was recognised in the portfolio balance literature that was developed during the late 1970s and early 1980s, the increase in the scale of gross holding of foreign assets and liabilities means that its quantitative importance is larger now than in previous decades.[2]

2 We focus on the valuation impact of currency movements; shifts in domestic and foreign asset prices also influence the overall value of the international investment position.

The recent literature has two main strands. One focuses on emerging market economies, which are characterised by large stocks of foreign currency debt. For these countries, currency depreciation has a negative valuation impact on the balance sheets of domestic entities, since the foreign currency debt increases in value in terms of domestic currency. This feature has led to a large policy and academic literature that investigates whether this channel is sufficiently strong to alter optimal policy decisions, such as the choice of exchange rate regime and the appropriate role for domestic interest rates during periods of financial turmoil.[3]

The other concentrates on the nature of the valuation channel for the major advanced economies.[4] In particular, this line of work highlights that these economies are typically short in domestic currency and long in foreign currencies. That is, a substantial proportion of foreign liabilities are denominated in domestic currency, while foreign currencies play a large role in the composition of foreign assets. With this profile, unanticipated depreciation of the domestic currency boosts the net value of the international investment position, since it raises the value of foreign assets relative to foreign liabilities.

At a general level, the role of the valuation channel in the dynamics of the external position can be expressed using the following accounting framework. Following Lane and Milesi-Ferretti (2005), the change in the net foreign asset position between periods $t-1$ and t can be written as

$$NFA_t - NFA_{t-1} = CA_t + VAL_t \tag{1}$$

where CA_t is the current account surplus and VAL_t is net capital gain on the existing holdings of foreign assets and liabilities

$$VAL_t = KG_t^A - KG_t^L \tag{2}$$

$$= kg_t^A A_{t-1} - kg_t^L L_{t-1} \tag{3}$$

where kg_t^A, kg_t^L are the "rates" of capital gain on foreign assets and liabilities. This expression highlights that the importance of capital gains is increasing in the gross scale of the international balance sheet – given values of kg_t^A and kg_t^L have a bigger impact on VAL_t, the larger A_{t-1} and L_{t-1} are.

In turn, this implies that the valuation impact of a shift in a currency depends on its impact on the capital gains earned on foreign assets and liabilities

$$\frac{\partial VAL_t}{\partial E_t} = \frac{\partial kg_t^A}{\partial E_t} A_{t-1} - \frac{\partial kg_t^L}{\partial E_t} L_{t-1} \tag{4}$$

where E_t is the exchange rate. Accordingly, in order to make such calculations, it is necessary to establish the currency composition of both sides of the international balance sheet. While the literature cited above has emphasised the split between domestic and foreign currency in the international balance sheet, very little is known in terms of the composition of the foreign currency element across the different currencies. In particular, Tille (2003) and Lane and Milesi-Ferretti (2007c) have emphasised that the "finance" currency weights for the United States are quite different from the "trade" currency weights,

[3] See, amongst others, the contributions of Eichengreen and Hausmann (2005), Devereux and Lane (2003) and Devereux, Lane and Xu (2006).

[4] See, amongst others, Tille (2003, 2005), Gourinchas and Rey (2007a) and Lane and Milesi-Ferretti (2001, 2003, 2005, 2006a, 2006b).

with European currencies much more heavily represented in the former. Accordingly, we seek to gain a more comprehensive understanding of the distribution of currency exposures for a large set of countries.

To create these currency composition weights, we combine a number of datasets, augmented by a fair amount of model-generated imputed data. The details of these procedures are reported below. Before we address the details, we consider two broad concerns regarding whether currency weights based on the currency denomination of foreign assets and liabilities accurately represent the currency risk exposure a country faces.

First, local currency asset prices could be negatively correlated with the exchange rate, such that investor currency returns might be insulated from currency movements. However, there is a wealth of evidence suggesting that currency movements do matter for investor currency returns (Lane and Milesi-Ferretti (2005)). For instance, the failure of uncovered interest parity and the success of financial trades such as the carry trade show that returns do not counter exchange rate movements in bond markets, but instead often reinforce them (Burnside et al (2006)). In relation to portfolio equity and FDI positions, a depreciation could be accompanied by an improvement in export performance, boosting the local currency returns on holdings in export-oriented firms and export platform FDI. However, in the other direction, a depreciation is also frequently accompanied by a slowing of the economy, such that local-currency returns on domestically oriented stocks and FDI positions are negatively affected. These conflicting forces may result in a weak average correlation between currency movements and local currency returns on portfolio equity and FDI returns. In related fashion, Pavlova and Rigobon (2006) show that the co-movement between asset prices and exchange rates depends on the relative importance of productivity shocks versus demand shocks: in their model, a positive productivity shock boosts the domestic stock market and induces exchange rate depreciation, while a positive demand shock also boosts equity returns but leads to exchange rate appreciation.

Furthermore, bank loans and deposits, reserves, and other assets or liabilities that are not marked to market do not have price valuation effects, only exchange rate based valuation effects, so there is no offset for these asset classes. Thus, in total, while one would expect exchange rate returns and local currency asset returns to cancel one another out in some ways, in practice there is considerable "pass-through" from exchange rate movements to investor currency returns.[5] While there is some evidence that exchange rate and equity returns negatively covary at high frequencies for industrial countries (Hau and Rey (2006)), there is no evidence of this correlation in annual data such that a depreciation of the foreign currency reduces the home currency value of an equity investment in the foreign country (Lane and Milesi-Ferretti (2005)).

Second, if domestic agents hedge all currency exposure by buying insurance from foreign agents, they will receive offsetting gains on their derivative positions against any spot exchange rate losses. Lack of data means that the extent of cross-border currency hedging is difficult to assess; while the volume of currency-related derivatives trading is very large, much of this is between domestic residents, which does not alter the aggregate net exposure of the economy.[6,7] Hau and Rey (2006) estimate that only 10 percent of foreign equity

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5 In our empirical analysis, we investigate the co-movement between the valuation effects generated by currency movements (VAL^{XR}) and the valuation effects generated by shifts in asset prices (VAL^{MV}). Since we residually calculate VAL^{MV} as the difference between the overall valuation effect VAL and VAL^{XR}, it is not surprising that the two are negatively correlated, but we do find that VAL^{XR} is positively correlated with VAL and has a significant impact on the direction of VAL, such that there is significant "pass-through" from exchange rate movements to the net foreign asset position.

6 However, see Becker and Fabbro (2006) for an extensive study of hedging in Australia that shows that Australia is a net purchaser of currency insurance from foreign investors.

positions are hedged, often due to institutional restrictions on the use of derivatives contracts. Furthermore, as noted above, if the counterparty in a derivatives contract is another domestic resident, the currency risk still resides within the same country. In addition, any hedging that comes through balancing of asset and liability exposure (e.g. simultaneously holding dollar assets and liabilities) is captured in our weights: it is only the more complex derivatives contracts that will be missed. Finally, it is not clear that an optimising agent would hedge out all currency risk, depending on the correlation of particular currencies with the entire portfolio of assets and liabilities and consumption growth in the investor's country (see Campbell et al (2006) for a discussion).[8]

3. Data

We follow a two-step procedure in estimating currency positions. First, we determine the currency composition of assets and liabilities within individual asset classes. Second, we weight the asset classes by their shares in the international balance sheet in order to construct the aggregate index.

The currency composition of assets and liabilities is calculated by combining information from several international data sources. These include: the BIS international banking statistics; the BIS international securities statistics; the IMF's Coordinated Portfolio Investment Survey (CPIS); UNCTAD's database on bilateral FDI positions; the World Bank's Global Development Finance database; data series from the Bureau of Economic Analysis, the US Treasury, the Federal Reserve, the European Central Bank and national central banks; and the "External Wealth of Nations" dataset on foreign asset and liability positions that has been developed by Lane and Milesi-Ferretti (2001, 2007a). The method for determining the currency composition of asset classes varies across asset classes, due to differences in sources and data availability.

Since there are considerable data gaps for some countries, the construction of currency composition weights is not entirely mechanical – inference procedures are required to interpolate some of the missing data. We then rely on recent advances in the modelling of the geographical distribution of international financial portfolios to generate predictions for asset holdings that allow us to fill in missing observations (Lane and Milesi-Ferretti (2007d)). The appendix provides a detailed description of the methods employed to construct estimates of the currency composition of international balance sheets.

Our full sample of countries includes 117 countries where we have full data. We eliminate hyperinflation episodes due to their status as outliers, and start a country's data after the conclusion of a hyperinflation (countries with hyperinflations late in the sample are dropped). Many results examine the change from 1994 to 2004. These results use a smaller 102-country sample that has full data from 1994 to 2004.

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7 In some cases, cross-border hedging can exacerbate overall exposures. In particular, suppose that hedging is mostly carried out by holders of foreign currency liabilities. For countries such as the United States that are net long in foreign currencies, this form of hedging raises the aggregate net currency position.

8 Even more generally, the optimal degree of currency hedging will also depend on the covariances between currency movements and risk factors in production and trade.

4. Index creation

The dataset allows us to build a number of "financially weighted" effective exchange rate indices for a large number of countries. For instance, the "bond-asset-weighted" effective exchange rate index for a country would attach a 50 percent weight to the dollar, a 30 percent weight to the euro and a 20 percent weight to the yen if our procedure indicated that the country's foreign bond asset position had a 50-30-20 split between these currencies. Similarly, the "bank-asset-weighted" index would reflect the relative importance of different currencies in foreign deposits. While the same foreign currencies tend to be involved in most weights, the crucial result from our work is to identify for each country the relative shares of domestic and foreign currencies in foreign assets and liabilities and the relative importance of different international currencies in the foreign currency component of the international balance sheet.

Once we have the currency composition data for each asset class within assets and liabilities, we can combine these asset classes to create aggregate weights, using data from the "External Wealth of Nations" database constructed by Lane and Milesi-Ferretti (2007a). This dataset reports the levels of foreign assets and liabilities for 145 countries over 1970–2004, together with the composition of each side of the international balance sheet between portfolio equity, direct investment, reserves and debt. This is important since two countries could have similar currency exposures within individual asset classes but different aggregate exposures, due to differences in the relative importance of different investment categories across the two countries. Moreover, the structure of international balance sheets has been shifting over time – even if currency exposures were stable for individual asset classes, aggregate exposures could change due to this composition effect.[9] This gives us the currency composition weights for individual asset classes as well as a set of aggregate weights that would take into account differences in the relative importance of the different investment categories across countries and over time. We calculate an aggregate finance-weighted index as well as asset- and liability-weighted indices.

Accordingly, the weights are given by the formulae

$$\omega_{ijt}^{A} = \sum_{k=1}^{k=N} \lambda_{it}^{Ak} \times \omega_{ijt}^{Ak} \qquad (5)$$

$$\omega_{ijt}^{L} = \sum_{k=1}^{k=N} \lambda_{it}^{Lk} \times \omega_{ijt}^{Lk} \qquad (6)$$

where $\omega_{ijt}^{A}, \omega_{ijt}^{L}$ are the weights for currency *j* in period *t* in country *i*'s asset- and liability-weighted exchange rate indices, $\lambda_{it}^{Ak}, \lambda_{it}^{Lk}$ are the relative importance of category *k* (portfolio equity, FDI, debt, reserves) in country *i*'s assets and liabilities in period *t* and $\omega_{ijt}^{Ak}, \omega_{ijt}^{Lk}$ are the weights for currency *j* in period *t* in category *k* for country *i*'s assets and liabilities respectively. Accordingly, the aggregate weights are a function of the weights for currency *j* in period *t* for a particular *k* asset class of country *i*'s assets or liabilities, and the weights across the *k* asset classes (represented by λ_{it}^{k}). This allows us to derive the valuation impact on country *i* of a change in the value of currency *j* in a straightforward manner

[9] See Faria et al (2007) and Lane and Milesi-Ferretti (2007a) on the sources of changes in the external capital structure of countries.

$$\frac{\partial VAL_{it}}{\partial E_{ijt}} = \omega_{ijt}^{A} A_{it-1} - \omega_{ijt}^{L} L_{it-1} \tag{7}$$

where A and L are defined as the size of foreign assets and liabilities relative to GDP and VAL is defined as the change in net foreign wealth (relative to GDP) caused by valuation changes. More generally, we are interested in asset- and liability-weighted exchange rate indices and the overall impact on net foreign wealth of these exchange rate changes.

Finally, it is also useful to define aggregate net financial weights

$$\omega_{ijt}^{F} = \omega_{ijt}^{A} s_{it-1}^{A} - \omega_{ijt}^{L} s_{it-1}^{L} \tag{8}$$

where $s_{it-1}^{A} = A_{it-1} / (A_{it-1} + L_{it-1})$ and $s_{it-1}^{L} = L_{it-1} / (A_{it-1} + L_{it-1})$ are the shares of foreign assets and foreign liabilities in total cross-border holdings. The weights generated by equation (8) indicate the direction of the valuation impact of a movement in currency j. If the net foreign asset position is zero such that foreign assets and liabilities are perfectly balanced, this reduces to simply subtracting the liability weights from the asset weights. Conceptually, an index crafted with these weights will capture the directional effect of a set of bilateral exchange rate changes on the net external position.

An exchange rate index based on weights from equation (8) is conceptually different from a trade-weighted index because it has currencies entering both positively and negatively. Moreover, if net positions and currency compositions are balanced, there is no movement in the index regardless of bilateral exchange rate movements. For this reason, to enable comparisons to other indices, we also separately examine asset- and liability-weighted indices.

The particular details of index creation also warrant some attention. Our index uses the weights (trade or asset or liability) to average the percentage changes of the exchange rate versus other currencies, and this is multiplied by the index from the previous period. The index formula is given by

$$I_{it}^{A} = I_{it-1}^{A} \times \left(1 + \sum \omega_{ijt}^{A} \times \%\Delta E_{ijt}\right) \tag{9}$$

$$I_{it}^{L} = I_{it-1}^{L} \times \left(1 + \sum \omega_{ijt}^{L} \times \%\Delta E_{ijt}\right) \tag{10}$$

where I_{it} is the index for country i, ω_{ijt} is the weight given to currency j in period t and E_{ijt} is the nominal exchange between i and j.

As with a trade-weighted index, however, we cannot assess the scale of the impact without knowing the size of the gross foreign asset and liability positions. Accordingly, another way to summarise the valuation impact is

$$\frac{\partial VAL_{it}}{\partial E_{ijt}} = \omega_{ijt}^{F} \times IFI_{it-1} \tag{11}$$

where the valuation impact is increasing in the gross scale of the international balance sheet $\left(IFI_{it-1} = A_{it-1} + L_{it-1}\right)$.

In turn, this means that the aggregate sensitivity of the net foreign asset position to currency movements (as opposed to total valuation effects) is given by

$$VAL_{it}^{XR} = \%\Delta I_{it}^{A} \times A_{t-1} - \%\Delta I_{it}^{L} \times L_{t-1} \tag{12}$$

where the superscript XR indicates valuation changes from the exchange rate movement.[10] As the absolute value of VAL_{it}^{XR} goes up, the extent to which net foreign wealth is affected by the exchange rate increases.

Equation (12) is the equivalent of multiplying the percentage change in an index based on weights from equation (8) times the sum of assets and liabilities. To see this, define the aggregate index by

$$I_{it}^{F} = I_{it-1}^{F} \times \left(1 + \%\Delta I_{it}^{A} \times s_{it-1}^{A} - \%\Delta I_{it}^{L} \times s_{it-1}^{L}\right) \quad (13)$$

In turn, this allows us to write

$$VAL_{it}^{XR} = \%\Delta I_{it}^{F} \times IFI_{it-1} \quad (14)$$

where $IFI_{it-1} = (A_{it-1} + L_{it-1})$. Equation (15) highlights the fact that the magnitude of currency-related valuation effects depends on two factors: (i) the movement in the financially weighted exchange rate index; and (ii) the gross scale of the international balance sheet. I_{it}^{F} can also be written in the same form as equations (11) and (12) using the aggregate net financial weights defined in equation (9).

Our index is a rough approximation of a geometric average that focuses on the percentage change versus each currency in a given time period as the relevant information, not the level.[11] It will also move similarly to a portfolio that uses these weights to define shares of the portfolio.[12]

Often, when the impact of outliers is an issue, one might prefer a geometric weighted average. However, that is not the appropriate specification in this case. We define the exchange rate in the standard manner, the home price of foreign currency, such that a negative movement represents an appreciation of the home currency. This assumption means that, if a trading partner experiences a major depreciation due to a hyperinflation or some other crisis, that partner's exchange rate in the index will decrease rapidly towards zero – not explode towards infinity. In this way, if the only change in the various bilateral exchange rates were a collapse of a rate towards zero, our index would simply drop by the amount of the weight. This is the equivalent of some portion of a portfolio becoming worthless and thus fits our needs well.

In contrast, a geometric index is strongly affected by such an outlier heading close to zero, even if the weight on it is relatively small. Due to the property of raising the value to the power of the weight, any number that is very close to zero winds up having an unusually large presence in reducing the index towards zero. That is, the index would drop down by far more than the weight on the currency, suggesting that if we simply assumed that all assets in

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10 By definition, then, the total valuation effect is the sum of the exchange rate valuation effect and the asset price valuation effect.

11 Note that the log of a geometric average is the weight times $\log(E)$ for each currency, and thus the approximation of the percentage change of the geometric average would simply be the sum of the change in $\log(E)$, or roughly the percentage change. The approximation breaks down when there is a very large outlier (with a very large percentage change), in which case that outlier will take on a larger weight in our index than in a pure geometric index.

12 A pure geometric index will not move like a portfolio and thus could not be tracked by a portfolio assembled using its weights.

a particular currency were now worthless, the index would drop by more than the amount those assets were worth.[13]

Accordingly, we find that to reduce the impact of outliers and have the index move in a way that matches what the values of a portfolio of assets would do, defining an exchange rate such that an appreciation of the home currency is a negative movement and using the summation index is the appropriate method.

In many settings, when calculating an index and changing the weights over time, one must worry that a change in the weight with no change in the value of the item in question will lead to a change in the index. One, in fact, would like this to happen as, for example, if the weight on more expensive items goes up, this will lead to a cost of living increase: one must chain-weight the weights to appropriately smooth over time. In our case, we are simply concerned with the change in the exchange rate index over time: if the exchange rate for all countries were constant, and the weights changed, we would want zero change in the index. Our index method ensures that this would be the case, since the index combines percentage changes in the exchange rate. Accordingly, more complex chain-weighting is not necessary; we can simply employ new weights whenever they are available.

Thus, in the end, our index tells us about the change in the exchange rate against a set of partners weighted by information for that year. When a gap in years is present, we average across to fill in the missing weights. 1997 weights are extended back to 1990 for asset classes that have their earliest data on currency composition in 1997 (equity and debt asset).

5. Analysis

The weights and indices described open a variety of avenues for analysis that were previously unavailable due to a lack of data. Our analysis proceeds along three lines. First, we examine the various indices described in Section 4. Next, we explore the variation in aggregate foreign currency exposures across countries and over time. Finally, we look at the role played by financially weighted exchange rate indices in driving the valuation component of the dynamics of net foreign asset positions.

5.1 Comparison of exchange rate indices

Our first task is to compare exchange rate indices across trade, asset, liability and net financial weights. A comparison of trade- and finance-weighted exchange rates demonstrates the extent to which we need to know currency exposures in the international balance sheet in order to understand the financial impact of exchange rate changes. If a trade-weighted exchange rate could easily summarise what is happening in our net index, the new index would be far less important. Furthermore, by comparing asset- and liability-weighted indices, we can better understand the extent to which countries have currency mismatches in their assets and liabilities.

[13] For example, if an exchange rate fell from 100 to 0.1 and it made up 10 percent of an index and there were no other changes, the summation index would fall from 100 to 90, but the geometric index would fall from 100 to 50. Again, note that if we had defined the exchange rate such that the outliers were going from 100 to 10,000, the geometric index would go from 100 to 158, but the summation would jump to over 1,000.

5.1.1 Correlations

Table 1 provides the mean and median within-country correlation of the monthly percentage changes in different indices. The asset and liability indices show a high pairwise correlation. In addition, both are individually correlated with the trade index, although the correlation is a bit weaker for the liability index (largely reflecting the importance of domestic currency liabilities). A country tends to have similar financial partners on both the asset and liability side of the international balance sheet, or at least its currency moves in similar directions against the two sets of partners.

Table 1

Correlations between financial and trade-weighted exchange rate indices

Group	Statistic	Assets Liabilities	Assets Trade	Liabilities Trade	Net finance Trade	Exports Imports
All	Mean	0.96	0.90	0.86	–0.30	0.95
	Median	0.98	0.95	0.92	–0.72	0.98
Advanced	Mean	0.97	0.92	0.88	0.41	0.97
	Median	0.98	0.93	0.89	0.70	0.98
Dev. & Emerging	Mean	0.96	0.90	0.86	–0.47	0.95
	Median	0.99	0.96	0.95	–0.82	0.98
Developing	Mean	0.96	0.88	0.84	–0.61	0.94
	Median	0.99	0.95	0.94	–0.89	0.97
Emerging	Mean	0.94	0.93	0.88	–0.13	0.98
	Median	0.97	0.97	0.95	–0.37	0.99

Correlations between the percentage change in monthly Financial and Trade-weighted Exchange Rate Indices. Monthly data, 1990.1–2004.12. Full sample of countries.

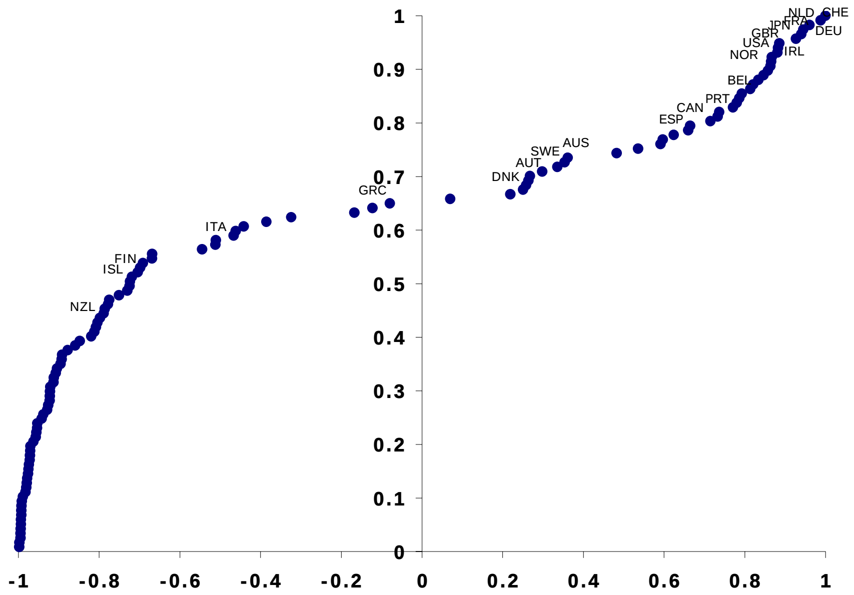
However, Table 1 also shows a strongly negative average correlation between the net financial index and the trade-weighted index for the full sample and the developing sample. This can be reconciled with the high pairwise correlation between the asset and liabilityindices by understanding that it is the net positions and also the size of the movements of asset and liability indices that generate the diverging pattern for the net financial index from the trade index, rather than directly opposing moves of the asset and liability indices. This largely reflects the typical profile of a country with a negative net foreign currency position: if it depreciates, its trade index and net financial index move in opposite directions. Although the typical correlation between these indices is positive for the advanced economies, the magnitude is much lower than for other pairs of indices.[14]

Figure 1 shows the cross-sectional distribution of this correlation. A cluster of countries are correlated near minus 1: these countries typically had very large depreciations at some point

[14] This table, as do many others, breaks countries down into advanced, emerging and developing groups. The advanced countries are the group typically known as industrialised countries (ifs code less than 199 except Turkey). The emerging sample is the group of countries in the Morgan Stanley emerging market index with some additional eastern European countries. The developing sample is all other countries.

during the sample period, while maintaining negative foreign currency positions. Even beyond this group, the correlation between the two indices is quite weak for a large range of countries, since the differences between trade partners and financial partners mean the two indices simply move differently. For example, industrial countries (marked by their country abbreviation), which on average have net positive foreign currency positions, have a mean of 0.41 and a median of 0.70. For comparison, we see that the pairwise correlation between any other type of index (assets and trade, imports and exports, etc.) is above 0.85. Thus, it appears that the trade index does a poor job of summarising the net financial impact on a country when the exchange rate changes.

Figure 1
Distribution of correlation between financial and trade-weighted exchange rate indices: all countries



5.1.2 Exchange rate volatility

Along another dimension, Table 2 shows the volatilities across indices. The liability index is much more stable than the asset index, especially for industrial countries: the average standard deviation of the percentage change of the liabilities index is only 3.5 percent for industrial countries as opposed to 5.9 percent for the assets. This again reflects the greater share of the domestic currency in liability indices. The leader in this regard is the United States, where over 90 percent of liabilities are in dollars and as a result the liability index has a volatility of less than 1 percent a year.

Since the liability index is so much more stable than the asset index, even if the two move directionally together and are highly correlated, the amplitude of the asset index is greater. In turn, this implies that currency movements may generate valuation effects, even for countries with zero net foreign asset positions. Table 2 also shows that net financial indices are far more stable than any other index for all types of countries. This again represents the fact that the net valuation impact of currency movements is limited by the offsetting effects on the value of foreign currency assets and foreign currency liabilities. However, especially for developing countries, there is a fair degree of volatility in this index.[15]

[15] The pattern is the same if one examines the average absolute value of the percentage change of the index instead of the standard deviation of the changes.

Table 2

Exchange rate volatility: financial and trade-weighted exchange rates

Group	Statistic	Trade	Net	Assets	Liabilities
All	Mean	0.123	0.050	0.140	0.105
	Median	0.066	0.023	0.067	0.055
Advanced	Mean	0.050	0.013	0.058	0.035
	Median	0.046	0.010	0.053	0.034
Dev. & Emerging	Mean	0.140	0.058	0.159	0.122
	Median	0.081	0.028	0.071	0.068
Developing	Mean	0.133	0.069	0.153	0.121
	Median	0.071	0.035	0.064	0.068
Emerging	Mean	0.158	0.036	0.173	0.123
	Median	0.090	0.021	0.101	0.071
Sudden Stops	mean % Δ	44%	–8%	54%	41%
Big Change	mean % Δ	88%	–30%	107%	88%

Standard deviation of monthly changes in exchange rate indices over 1994–2004, full sample of countries. The bottom panel shows percentage change in these indices during financial crises, where Sudden Stops represent sudden stop observations and Big Change represents large depreciations (over 50 percent) against the relevant base currency.

The bottom panel of Table 2 shows that, in either sudden stops or in cases where a country depreciates 50 percent or more against its base, the net index both is strikingly more stable and moves in an opposite direction to the trade index. Despite the relative stability, a negative 8 percent move of the net index (for sudden stops) can generate large valuation losses and the negative 30 percent move for the large depreciation countries suggests large losses. In fact, the sudden stop countries lost 6 percent of GDP on average and the large depreciation countries 29 percent of GDP.[16]

5.1.3 Co-movement of asset- and liability-weighted indices

An alternative way of considering the movements of asset- and liability-weighted indices is to regress the change in the liability index on the change in the asset index

$$\%\Delta I_{it}^{L} = \alpha + \beta \times \%\Delta I_{it}^{A} + \varepsilon_{it} \quad (15)$$

This allows us to consider both the direction of the changes and the magnitudes. If $\beta = 1$, it suggests that its currency exposure is well matched in assets and liabilities: a country still may be exposed to valuation changes if it has a positive or negative net foreign asset position, but the problem will not be currency mismatches.

[16] These calculations are based on 17 sudden stops that are not classified as hyperinflations and 52 large depreciations (where the year average exchange rate depreciates against the base by at least 50 percent) that are not hyperinflations. The sudden stop episodes are those listed by Durdu et al (2007).

Table 3 shows that the estimated $\hat{\beta} =$ 0:80 for the full sample and the developing group, with a very high R^2 in each case. For the advanced country group, $\hat{\beta} =$ 0:66 and the R^2 is marginally lower. Again, this difference is intuitive in view of the greater reliance of developing countries on foreign currency liabilities. Since $\hat{\beta} =$ < 1 in all cases, a generalised movement in the value of the home currency against other currencies will induce a shift in the value of the net foreign asset position, even for a country with an initially balanced international investment position.

Table 3

Co-movement of asset- and liability-weighted exchange rates

	(1) All	**(2) Advanced**	**(3) Dev. & Emg.**	**(4) Developing**	**(5) Emerging**
ΔIND_{it}^{A}	0.77 (0.01)***	0.66 (0.01)***	0.77 (0.01)***	0.77 (0.01)***	0.77 (0.01)***
R^2	0.95	0.89	0.95	0.96	0.94
N	1499	308	1191	802	389
Countries	117	22	95	65	30

Fixed-effects panel estimation over 1994–2004 regressing the annual percentage change in the liability index on the annual percentage change in the asset index.

5.1.4 Case studies

We conclude our examination of exchange rate indices by looking at a selection of six countries in Figures 2a–f. In the US case, the indices for assets and liabilities are quite different due to the stability of the liability index. While the net financial index is correlated with the trade-weighted index, the relative magnitude of changes varies from year to year. In the last few years, the asset index has moved more dramatically than the trade index. The net remains more stable due to the offsetting effects from liabilities.

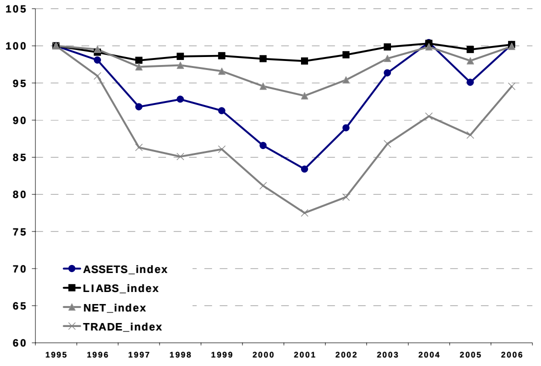
In contrast, for France, we see the liabilities index move more similarly to the asset index, so the net index is flat regardless of fluctuations in the trade index. Also, all the indices are relatively stable, reflecting the role first of the EMS and then EMU in limiting multilateral volatility for France.

The patterns for Brazil are representative of the typical emerging market economy. The exchange rate depreciates for trade, asset and liability weighting, but the net index moves in the opposite direction (a depreciation worsens the net index for indebted countries). Since 2002, we see that Brazil has appreciated against both trade and finance partners and this has led to valuation gains. China's asset, liability and net indices are virtually flat due to the peg against the dollar and the outsized weight of the dollar in all finance indices for China. Alternatively, the trade index for China moves with the dollar versus other non-dollar trade partners (although, in the last year, the Chinese depreciation has been smaller than the US due to the small RMB appreciation against the dollar).

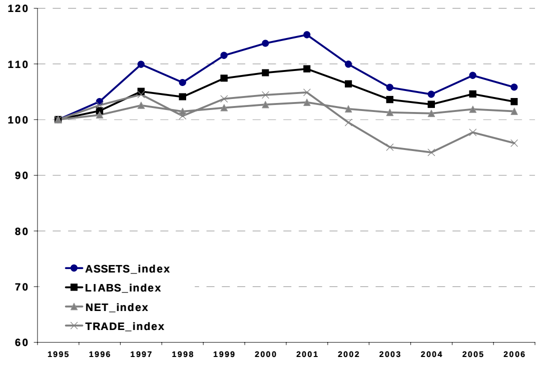
Benin is an example of a country where trade weights and asset and liability weights are quite different with a slowly appreciating trade index moving in an unlinked fashion from the indices for assets and liabilities. The net and trade indices are nearly mirrors. Finally, in Bangladesh, like Brazil, the net index falls as the currency depreciates on a trade, asset and liability basis, although, in final years, the liability index is flattening relative to the asset index as more liabilities are denominated in domestic currency.

Figure 2a–f
Examples of indices

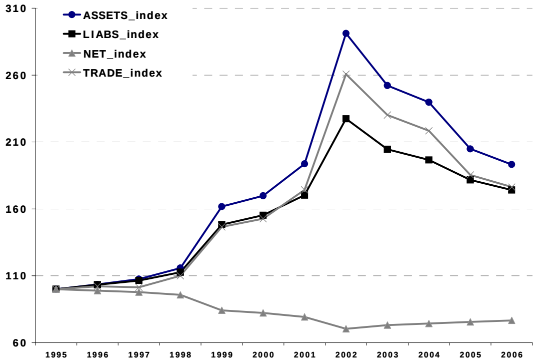
United States



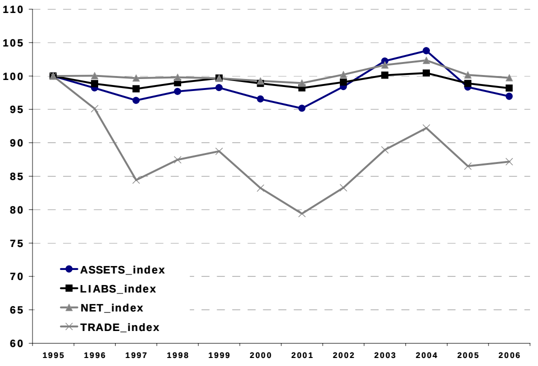
France



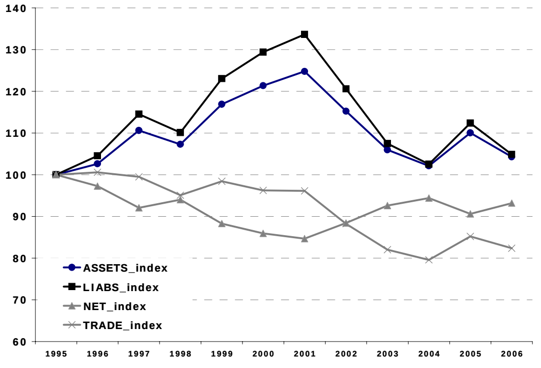
Brazil



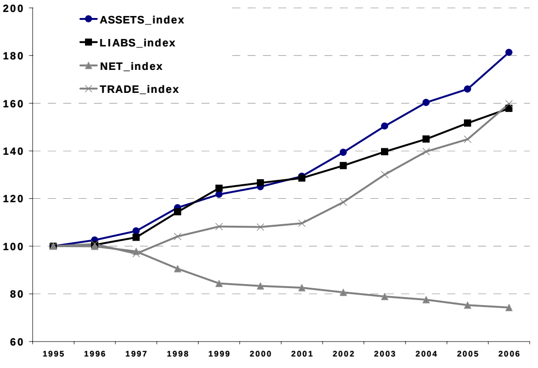
China



Benin



Bangladesh



Comparing the emerging and developing countries can highlight the role of the exchange rate regime. China has pegged to its main financial partner and thus effectively stabilised its asset, liability and net indices, but not its trade index. Alternatively, Benin (a member of the CFA) has a relatively stable trade index due to a stable exchange rate against both local countries and the euro. Its financial indices, though, move considerably as the US dollar plays a large role in these (despite almost no role in trade). The large net negative position against the world (and in particular the dollar) means that as the euro and dollar move back and forth, Benin's net index does as well. Finally, as it has not maintained a tight peg in this era, Brazil sees much more volatility in all these indices.

In summary, we see a diverse range of patterns, with the trade index relatively uninformative about the financial impact of currency movements. We now turn to one of the key drivers of the net financial index: the net foreign currency exposure.

5.2 Net foreign currency exposures

There has been a recent flurry of work that seeks to calculate optimal international portfolios within the framework of dynamic stochastic general equilibrium macroeconomic models (Engel and Matsumoto (2006), Devereux and Saito (2006), Devereux and Sutherland (2006a, 2006b, 2006c), Kollmann (2006), Benigno (2006) Tille and van Wincoop (2007)). One question addressed by this literature is the optimal pattern in nominal exchange rate exposures, with the answer depending on the configuration of shocks hitting the economy and the range of assets that are internationally traded. Although results are typically dependent on the precise specification of the model, the general pattern is that a positive domestic productivity shock raises domestic welfare and induces exchange rate depreciation. Accordingly, a good hedge is to hold a negative position in foreign currency assets. In contrast, a positive domestic demand shock raises domestic welfare but induces exchange rate appreciation. In this case, the hedging portfolio involves a positive position in foreign currency assets.

Another strand in this literature has highlighted the fact that structural differences across economies can help explain the configuration of international portfolios. For instance, Mendoza et al (2007) show a model in which differences in the degree of financial development mean that the advanced economy becomes a net debtor but holds a long equity position in the developing economy. (See Caballero et al (2006) for a related model and Devereux and Sutherland (2007) for a related result.)

In order to inform this literature at an empirical level, we can look at the net weight on the rest of the world to see if countries have taken positive or negative aggregate foreign currency positions.[17]

5.2.1 The cross-sectional distribution of foreign currency exposures

For this purpose, it is useful to work with the concept of aggregate foreign currency exposure. Define foreign currency exposure by

$$FX_{it}^{AGG} = \omega_{it}^{A} s_{it}^{A} - \omega_{it}^{L} s_{it}^{L} \tag{16}$$

where ω_{it}^{A} is the share of foreign assets denominated in foreign currencies, s_{it}^{A} is the share of foreign assets in the sum of foreign assets and foreign liabilities and $\omega_{it}^{L}, s_{it}^{L}$ are defined analogously. Aggregate foreign currency exposure captures the sensitivity of a country to a uniform currency movement by which the home currency moves proportionally against all foreign currencies. In turn, the net impact on the external balance sheet is given by

$$NETFX_{it} = FX_{it}^{AGG} \times IFI_{it-1} \tag{17}$$

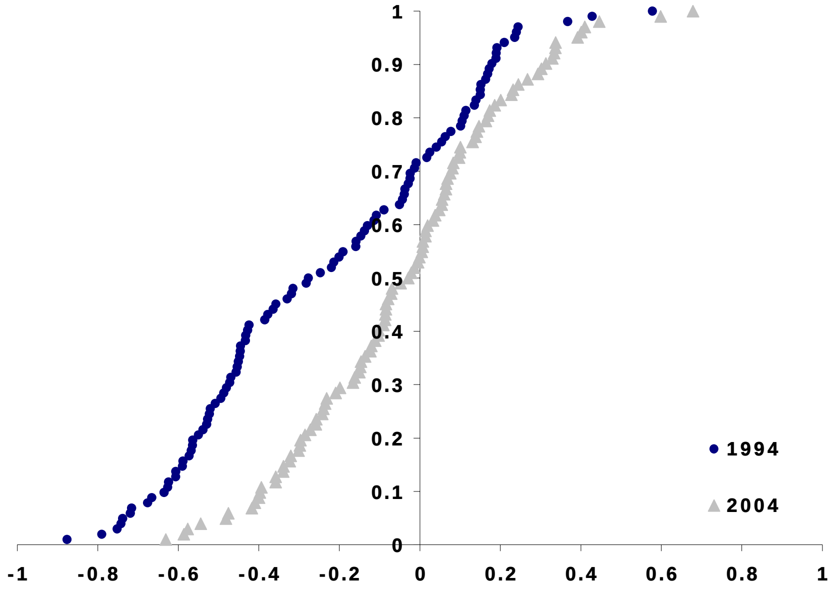
Figure 3 and Table 4 show the cross-sectional distribution of FX^{AGG} in 1994. We see that a majority (70 percent) have a net negative position in foreign currencies with an average weight of –27 percent. Over 20 percent have below –50 percent weight, leaving them with a considerable short position in foreign currencies. On the other hand, industrial countries are

[17] In principle, multi-country versions of these models could deliver predictions about net holdings of different currencies. To our knowledge, these models have not yet been developed in the literature.

on average close to balance (mean and median weight are between zero and 10 percent) and 60 percent of industrial countries have a positive net weight in foreign currencies. Emerging countries are on balance negative, but much closer to zero than the poorer developing countries.

Figure 3 also shows the same distribution but for the year 2004. By 2004, 17 percent more of the sample had taken a positive position against the rest of the world. The mean position and median position have both moved close to zero (–7 percent) and only roughly 10 percent, have positions of –50 percent or worse. The industrial countries still have means and medians close to positive 10 percent with 86 percent of them having net positive exposure. Emerging countries are also on average positive by 2004. It should be noted that shifting to a positive net position does not eliminate exchange rate based valuation effects: it simply means that the sign will be positive when the country depreciates against the rest of the world.

Figure 3
Distribution of aggregate foreign currency exposures: 1994 and 2004



To put these figures in context, a negative foreign currency exposure of 50 percent against the rest of the world means that a 10 percent depreciation would generate a valuation loss of 10 percent times 50 percent times total assets and liabilities divided by GDP (recall that equation (15) shows that the valuation gain is the percentage change in the index times the gross scale of international financial integration). Thus, a country at the average gross position of 200 percent of GDP would experience a 10 percent of GDP loss from such a depreciation. These wealth effects are considerable and demonstrate why the aggregate foreign currency position against the rest of the world is an important indicator.[18]

[18] We also note that there can still be considerable exchange rate shocks due to bilateral movements even if FX_{it}^{AGG} is zero. All but 10 countries are short some other currency in 2004, and 50 percent have a negative weight of 11 percent or more against some other currency. The largest net negative position varies, with half short the dollar and the others roughly evenly split between the euro and yen. All but one country are long another currency, though the average position is smaller (7 percent weight). The long positions are spread across the dollar (33 percent), the pound (20) and the euro (28) along with 16 other currencies which are the largest long position for somewhere between one and three other countries. The more minor currencies become important due to a large FDI holding in the country and no offsetting liabilities in that currency. Thus, even countries with roughly balanced net positions tend to have considerable exposure to movements across bilateral rates.

Table 4

Aggregate foreign currency exposure

	1994		2004	
	mean	**median**	**mean**	**median**
FX^{AGG}				
All	–0.24	–0.26	–0.04	–0.03
Advanced	0.04	0.08	0.11	0.09
Dev. & Emerging	–0.31	–0.43	–0.08	–0.10
Developing	–0.42	–0.47	–0.15	–0.18
Emerging	–0.11	–0.07	0.04	0.06
NETFX				
All	–0.31	–0.22	0.11	–0.04
Advanced	0.17	0.08	0.51	0.36
Dev. & Emerging	–0.45	–0.36	0.00	–0.13
Developing	–0.73	–0.52	–0.21	–0.22
Emerging	0.06	–0.08	0.38	0.06

Note: $FX_{it}^{AGG} = \omega_{it}^{A} s_{it}^{A} - \omega_{it}^{L} s_{it}^{L}$ $NETFX_{it} = FX_{it}^{AGG} \times IFI_{it-1.}$ Sample includes the 102 countries with data from 1994 to 2004.

The bottom half of Table 4 shows the values of $NETFX_{it}$ in 1994 and 2004. This helps to demonstrate the scale at which a change in the exchange rate would affect the economy. The changes from 1994 to 2004 show a similar pattern to the raw FX_{it}^{AGG} statistics in the top half of the table, with the exception that the industrial countries position has improved even more by this measure. While many industrial countries have not shifted FX_{it}^{AGG} dramatically, their scale of financial globalisation (IFI) has increased considerably, so their overall net long exposure to foreign currencies has increased as a share of the economy. Again, they do not risk negative wealth effects following depreciation, but they are exposed to exchange rate movements.

5.2.2 The dynamics of currency exposures

Next, we provide a decomposition of the shifts in currency exposures over the 1994–2004 period. The shift in foreign currency exposure between periods t–N and t can come either from increasing the share of assets relative to liabilities in IFI (s_{it}^{A}) or from reducing the foreign currency weight of liabilities (ω_{jit}^{L}). Table 5 shows the driving factors underlying the changes in FX_{it}^{AGG}. There is a considerable range of behaviour of $FXAGG_{it}$ over the decade. First, to understand why countries' positions have changed, we can divide the sample into quartiles by the extent that FX_{it}^{AGG} has changed (top panel of Table 5). While the lowest quartile sees a small decline in FX_{it}^{AGG}, the top quartile has a 34–92 percentage point increase in the index.

Table 5

Decomposition of shift in aggregate foreign currency exposure, 1994–2004

Quartile	Obs	Mean	Min	Max	Δs_{it}^{A}	$\Delta \omega_{it}^{A}$	$\Delta \omega_{it}^{L}$	EMU	Non-EMU
1	25	–0.09	–0.34	0.04	–0.07	–0.15	–0.17	0.28	0.12
2	25	0.12	0.06	0.19	0.05	–0.06	–0.08	0.12	0.12
3	26	0.26	0.19	0.34	0.07	0.01	–0.21	0.00	0.15
4	26	0.48	0.34	0.92	0.16	–0.02	–0.29	0.04	0.04
All	102	0.20	–0.34	0.92	0.06	–0.05	–0.19		
Advanced	22	0.08	–0.14	0.50	0.03	–0.25	–0.24		
EMU	11	0.00	–0.14	0.41	0.01	–0.52	–0.42		
Non-EMU	11	0.15	–0.04	0.50	0.06	0.02	–0.07		
Dev. & Emg.	80	0.23	–0.34	0.92	0.06	0.00	–0.17		
Developing	52	0.27	–0.26	0.92	0.08	0.00	–0.17		
Emerging	28	0.15	–0.34	0.63	0.03	0.00	–0.18		

Top panel shows the change in FX_{it}^{AGG} in 1994–2004 split across quartiles of the size of the change. Δs_{it}^{A} represents the change in the share of assets in total IFI, $\Delta \omega_{it}^{A}$ shows the change in the foreign currency share of foreign assets, and $\Delta \omega_{it}^{L}$ represents the change in foreign currency share of liabilities. The final two columns show the percentage of each quartile which is EMU and non-EMU industrial countries.

We see that all parts of the decomposition are important in explaining the shift in positions. The top quartile saw a large positive shift in net foreign asset positions (the asset share of gross assets and liabilities has increased strongly, 16 percentage points), as opposed to a decrease for the low quartile. In addition, the top quartile drastically reduced the foreign currency share of their liabilities (29 percentage points) without a shift in the share of assets. The bottom quartile showed a considerable drop in the share of both assets and liabilities.

The drop in assets simultaneously with liabilities is largely an EMU phenomenon (28 percent of the countries in the bottom quartile where this behaviour is strongest are in the euro area). We can see this better by examining the decomposition across country types in the bottom part of Table 5. EMU countries drastically increased the importance of domestic currency on both sides of the international balance sheet, with the foreign currency shares of assets and liabilities decreasing by 52 and 42 percentage points respectively. Combined with an essentially average NFA position, we see why EMU countries did not see much improvement in their aggregate foreign currency exposure.[19]

Non-EMU industrial and developing countries saw much bigger improvements in aggregate exposures. In both groups, the average net foreign asset positions improved (on average s_{it}^{A}

[19] The crucial difference within the EMU countries seems to be the share of foreign currency liabilities at the start. They all reduce their foreign currency liabilities weight to 10—20 percent. Countries such as Finland that were near 90 percent to start with therefore see much bigger changes in the foreign currency liabilities. Also, countries that started with more liabilities tend to see better improvement because even if they reduce the foreign currency share of assets and liabilities simultaneously, the impact of the liabilities is bigger.

went up), and, in particular for the developing countries, the foreign currency share of liabilities has fallen sharply. Only the EMU countries have experienced a substantial shift in the foreign currency components of assets.

Table 6 shows more details of the sources of the change in the foreign currency exposure. We focus on why the share of assets in the international financial integration index rose and why the foreign currency share of liabilities fell. FDI and equity are denominated in local currency, so increasing their share of liabilities will lower the foreign currency component of liabilities. Panel A of Table 6 shows that the top two quartiles (the ones that improved FX_{it}^{AGG} the most) saw substantial shifts towards equity-oriented financing, while Panel B demonstrates that this shift is found most strongly in the emerging and developing countries. On the other hand, there is effectively no change in the foreign currency share of debt liabilities beyond the EMU countries, and these changes are trivial for the top two quartiles.

Table 6

Factors underlying the shift, FX_{it}^{AGG} 1994–2004: quartiles

		$\Delta RES / \Delta A$		ΔNFA^{priv}		$\Delta(\lambda_{Lit}^{PEQ} + \lambda_{Lit}^{FDI})$		$\Delta DebtL^{FC}$	
Quartile	Obs	Mean	Median	Mean	Median	Mean	Median	Mean	Median
1	25	0.21	0.05	–0.18	–0.18	0.09	0.08	–0.13	–0.01
2	25	0.30	0.36	0.08	0.02	0.02	0.03	–0.08	0.00
3	26	0.42	0.46	0.14	0.03	0.21	0.20	–0.01	0.00
4	26	0.50	0.58	0.43	0.37	0.27	0.26	–0.03	0.00
All	102	0.37	0.41	0.12	0.04	0.15	0.15	–0.06	0.00
Advanced	22	0.02	0.00	0.03	0.05	0.07	0.05	–0.27	–0.20
EMU	11	–0.02	–0.01	–0.01	0.01	0.07	0.04	–0.53	–0.51
Non-EMU	11	0.07	0.03	0.08	0.09	0.08	0.05	–0.01	–0.02
Dev. & Emg.	80	0.47	0.52	0.15	0.04	0.17	0.16	0.00	0.00
Developing	52	0.51	0.54	0.28	0.15	0.17	0.16	0.00	0.00
Emerging	28	0.40	0.46	–0.07	–0.06	0.18	0.18	–0.01	0.00

$\Delta RES / \Delta A$ represents the share of asset growth which comes from reserves. ΔNFA^{priv} represents change in private (non-reserve) *NFA*. $\Delta(\lambda_{Lit}^{PEQ} + \lambda_{Lit}^{FDI})$ represents the change in the portfolio equity and FDI shares of liabilities. $\Delta DebtL^{FC}$ represents the change in the foreign currency share of Debt Liabilities. 1994–2004.

As for the improved net foreign asset position of many countries, we examine whether this is purely a result of increases in the accumulation of reserves. We see that all quartiles increased the reserve share of total assets. For the top quartile, over 50 percent of the increase in total assets came from an increase in reserves, while only the top quartile saw a substantial increase in the non-reserve net foreign asset position. Across country groups, we see that only the non-advanced countries were truly stockpiling reserves and that, for emerging countries, it was this behaviour that drove the shift in s_{it}^{A} as the non-reserve net external position was actually negative on average. Thus, the shift away from negative foreign currency positions is not coming from borrowing in domestic currency but from the shift towards equity finance and improvements in the net foreign asset position.

As was shown in equation (17), the net balance sheet impact of a uniform movement of the home currencies against all foreign currencies is given by the product of FX^{AGG} and IFI (the scale of gross holdings of foreign assets and liabilities). Accordingly, the change in the net balance sheet impact over time can be written as

$$\Delta_{t-N,t} NETFX_{it} = \Delta_{t-N,t} FX_{it}^{AGG} \times IFI_{it-N} + FX_{it-N}^{AGG} \times \Delta_{t-N,t} IFI_{it} + \Delta_{t-N,t} FX_{it}^{AGG} \times \Delta_{t-N,t} IFI_{it} \tag{18}$$

Table 7 shows the driving forces behind this decomposition. Table 7 shows that the gross scale of international financial integration has been increasing across all quartiles, which is reinforced by an increase in foreign currency exposure for the top three quartiles. However, the bottom quartile experiences an average decline in $NETFX_{it}$, since the latter effect dominates the former for this group.

Table 7

Decomposition of shift in $NETFX$, 1994–2004

Quartile	Obs	Mean	Min	Max	ΔFX_{it}^{AGG}	ΔIFI	EMU	Non-EMU
1	23	–0.07	–0.52	0.04	–0.04	0.78	0.22	0.00
2	24	0.15	0.08	0.24	0.16	0.56	0.17	0.17
3	24	0.36	0.25	0.50	0.28	0.28	0.00	0.13
4	25	1.17	0.51	3.11	0.33	0.65	0.08	0.16
All	96	0.41	–0.52	3.11	0.20	0.57		
Advanced	22	0.30	–0.52	1.40	0.07	2.18		
EMU	11	0.14	–0.52	0.91	0.00	2.89		
Non-EMU	11	0.46	0.11	1.40	0.15	1.47		
Dev. & Emerging	74	0.45	–0.25	3.11	0.23	0.09		
Developing	48	0.52	–0.14	3.11	0.27	–0.21		
Emerging	26	0.32	–0.25	2.53	0.15	0.64		

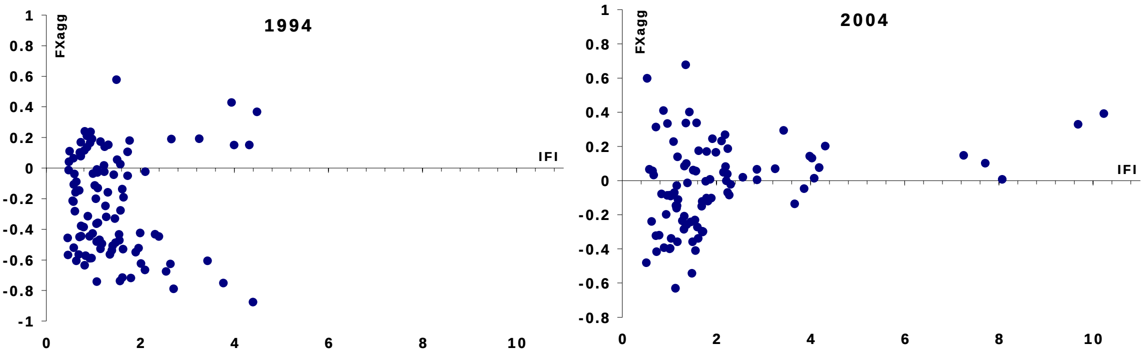
1994–2004.

The bottom panel of Table 7 shows the decomposition by country group. All groups saw an average increase in the importance of foreign currency exposure over this period. However, the difference in composition across groups is striking. First, we see that $NETFX_{it}$ increased for the EMU group, despite the mean fall in FX_{it}^{AGG}: the growth in gross cross-border holdings was sufficiently large to dominate the declining share of foreign currencies in these positions. While the non-EMU group of advanced economies and the developing country group had broadly similar increases in $NETFX_{it}$, this was driven by the growth in gross international financial integration for the former group whereas the compositional shift towards a most positive foreign currency balance was relatively more important for the latter group. Non-emerging developing countries actually pulled back from the global financial economy with a shrinking IFI on average, but, again, their rapidly improving FX_{it}^{AGG} meant that they still saw $NETFX_{it}$ go up.[20]

Finally, Figure 4 shows the FX_{it}^{AGG} and IFI_{it} indices in 1994 and 2004 for all countries. We see that large negative exposures (large negative FX_{it}^{AGG} and large IFI_{it}) were much more prevalent in 1994 than in 2004: countries have pulled back by reducing net external liabilities and net foreign currency exposures. Another noteworthy shift is that there are now a number of countries that combine a high degree of international financial integration with positive aggregate foreign currency exposures. If these countries appreciate against the currencies in which they are long, they will suffer large losses.

Figure 4

Foreign currency exposure and international financial integration in 1994 and 2004



5.2.3 Determinants of net foreign currency exposures

The variation in net foreign currency exposures begs the question of whether the cross-sectional dispersion in foreign currency exposures can be related to country characteristics. We consider an exploratory specification

$$FX_{it}^{AGG} = \alpha + \beta \times Z_{it} + \varepsilon_{it} \qquad (19)$$

where the set of covariates Z_{it} includes GDP per capita, trade openness, an institutional quality indicator, country size and an EMU dummy.[21]

Table 8 shows the results for all-country, advanced and developing country samples for 2004. Across all samples, there is clear positive relation between GDP per capita and FX_{it}^{AGG}: richer countries have more positive net foreign currency positions. For the all-country sample, we also note that larger countries and countries with higher trade volumes also have more positive positions: the positive covariation between country size and foreign

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[20] We also studied the covariation between FX_{it}^{AGG} and IFI_{it} by running cross-country regressions of FX_{it}^{AGG} and IFI_{it} in levels and differences. For the all-country and developing-country samples, the bilateral covariation between the variables was not significant in 1994 but was significantly positive in 2004. In contrast, the bilateral covariation within the advanced-country group was significantly positive in 1994 but was not significant in 2004 (but marginally negative, if an EMU dummy is included). For each sample, the change in FX_{it}^{AGG} and the change in IFI_{it} between 1994 and 2004 were significantly negatively correlated.

[21] Although we lack strong theoretical guidance in formulating this specification, this list of regressors has been employed to consider other dimensions of external capital structure (see, for example, Faria et al (2007)).

currency positions also holds in explaining variation within the developing country group. These results can be explained through the ability of larger and more open developing countries to issue domestic currency liabilities via portfolio equity and FDI channels (see also Faria et al (2007)).

Table 8
Covariates of foreign currency exposure

	(1) All	**(2) All**	**(3) Adv.**	**(4) Adv.**	**(5) Dev.**	**(6) Dev.**
Constant	–89.3 (8.5)***	–128.7 (17.8)***	–207.6 (74.2)***	–171.3 (80.5)**	–112.2 (10.7)***	–126.9 (20.1)***
GDP-PC	10.8 (1.0)***	13.9 (2.3)***	21.6 (7.5)***	18.0 (8.9)*	14.3 (1.5)***	14.4 (2.5)***
Trade		0.1 (0.047)**		0.03 (0.1)		0.07 (0.06)
Inst. Qual.		–4.4 (4.3)		–5.2 (10.6)		–0.63 (5.4)
Population		3.8 (1.7)**		3.8 (3.0)		3.5 (2.0)
EMU		–16.4 (3.9)***		–8.2 (7.1)		
Adj R^2	0.41	0.45	0.28	0.44	0.41	0.39
N	119	113	22	22	97	91

Cross-Section in 2004. Heteroskedasticity-corrected standard errors in parentheses. *, ** and *** denote significance at the 1, 5 and 10 percent levels respectively.

5.3 The valuation channel

We investigate the quantitative importance of our "currency valuation" term by running the regression

$$VAL_{it} = \alpha_{it} + \beta \times VAL_{it}^{XR} + \varepsilon_{it} \qquad (20)$$

where VAL_{it} is the aggregate valuation term defined in equation (2) and VAL_{it}^{XR} is the currency valuation term defined in equation (14), with both scaled by GDP.

If movements in the net financial exchange rate index (interacted with the gross scale of international financial integration) were fully offset by shifts in local currency returns, then we would expect β = 0. In contrast, a non-zero value of β indicates that exchange rate movements exert a valuation impact, whether directly or indirectly (through simultaneous movements in local currency returns).[22]

[22] A complication relates to valuation shocks that cannot be directly tied either to exchange rates or to market price movements. These may include data revisions, debt reduction schemes and capital transfers. In addition to introducing a degree of noise, there may also be some correlation between currency depreciations and debt reduction schemes.

Table 9

The valuation channel and dynamics of net foreign asset positions

	(1) All	(2) Advanced	(3) Developing	(4) Emerging
VAL^{XR}	1.071 (0.05)**	0.574 (0.14)**	1.095 (0.05)**	0.982 (0.12)**
Constant	0.724 (0.15)**	–0.969 (0.07)**	2.529 (0.25)**	–1.745 (0.18)**
N	1,496	304	802	390
R^2	0.65	0.09	0.72	0.51
R^2 (no FE)	0.54	0.06	0.61	0.42

Panel estimation over 1994—2004. Columns (1)–(4) estimated by least squares with country fixed effects. Standard errors clustered by country. Bottom row shows R-squared when regressions are run without country fixed effects. Coefficients are nearly unchanged with or without fixed effects.

The results displayed in Table 9 show an important role for the currency valuation term in explaining that the overall valuation effect. For developing or emerging countries, the "pass through" is approximately one to one: a currency gain of 1 percentage point of GDP (according to our measure) is associated with a 1 percentage point aggregate net capital gain. Moreover, the regression has considerable explanatory power for these groups of countries (between 0.4 and 0.6).

The pattern is quite different for the advanced countries. While the currency valuation term is significant, the explanatory power of the regression is much lower at 0.06–0.09. The estimated $\widehat{\beta}$ is also much lower at roughly 0.6, which suggests that there is some degree of offset by which capital gains via currency movements are partially cancelled out by lower foreign currency returns. The differences between the advanced and other country groups are quite intuitive: the larger equity positions of the former group mean that price valuation shocks play a more important role.[23]

These currency-induced wealth effects are not trivial in size. Table 10 shows that the 75th percentile of absolute movements in VAL_{it}^{XR} is 2.8 percent of GDP for advanced countries, 3.8 percent for emerging countries, and 5.3 percent for developing countries, meaning that one in four observations has a shock of these magnitudes. These effects are sizeable enough to dominate current account flows in some years and, depending on the market capitalisation of a country, may rival the wealth effects of stock market booms and busts.[24] In addition, since these are transfers across borders, these may matter more for the international transmission mechanism than price shifts that cause large transfers across agents within an economy.

[23] The regressions are similar with or without fixed effects. Standard errors are clustered by country.

[24] World stock market capitalisation was roughly 100 percent of world GDP in 2005 (Reuters (2007)). Across major countries, capitalisations range from 50 to 200 percent of GDP, meaning that a change of 10 percent in the stock market would generate wealth shocks in the range of 5 to 20 percent of GDP.

Table 10

***VALX* as a percentage of GDP**

	Mean	Median	75%	90%	
All	5.0	1.7	4.3	11.2	
Advanced	2.4	1.2	2.8	5.0	
Developing & Emerging	5.7	1.8	4.7	12.6	
Developing	6.8	2.3	5.3	15.8	
Emerging	3.4	1.2	3.8	10.0	

	$\rho(VAL)$		$\rho(VAL^{XR})$		$\rho(VAL^{MP})$	
	Mean	**Median**	**Mean**	**Median**	**Mean**	**Median**
All	0.02	–0.01	0.12	0.09	0.01	0.01
Advanced	–0.01	–0.06	0.15	0.15	–0.05	–0.04
EMU	–0.02	–0.04	0.20	0.16	–0.01	–0.04
Non-EMU	0.01	–0.08	0.10	0.14	–0.09	–0.03
Developing	0.02	0.00	0.11	0.06	0.02	0.03

Panel A: Distribution of absolute values of VAL^{XR} as a ratio to GDP. Panel B: Mean and median within-country autocorrelation coefficients of different valuation effects.

Quite importantly, these wealth shocks are not just paper gains and losses that reverse with quick exchange rate reversals. In regressions of *VAL* on lagged *VAL*, we find that all three types of valuation effects are essentially stationary. They all have autocorrelation coefficients of nearly zero. Individual country coefficients are quite noisy, but only a handful have point estimates lower than –0.2 (suggesting some reversals) for the exchange rate valuation shocks. Thus, the wealth gains or losses from VAL^{XR} appear to be sizeable and persistent, opening the possibility that they have a real impact on the economy.

5.4 An example: a dollar crash

We conclude our analysis with an example that demonstrates the differences across trade indices, finance indices and valuation effects by examining what would happen if the US dollar depreciated by 20 percent across all currencies.[25] Table 11 shows interesting divisions across country groups. While all countries face trade-weighted appreciations, emerging markets see the largest shift due to their tight relationship with the US on a trade basis. In contrast, it is non-EMU advanced countries that face the largest net financial index change, a greater than 1 percent change in the index and almost 5 percent of GDP loss from valuation. Non-emerging developing countries in fact benefit from a dollar depreciation on average.

[25] Warnock (2006) examines the losses other countries would face on US-held assets under a set of shocks to US equity and bond prices as well as the US dollar. Our experiment only focuses on the currency, but importantly includes both the assets and liabilities of countries such that some countries can in fact come out ahead if there is a dollar depreciation (if they have sufficient dollar liabilities). See also Lane and Milesi-Ferretti (2007c) for a study of the impact of a dollar shift on individual European countries.

Table 11

Effects of a 20 percent depreciation of the US dollar

Group	Trade		Net financial		VAL^{XR}	
	Mean	**Median**	**Mean**	**Median**	**Mean**	**Median**
All	–2.6	–1.5	1.2	0.2	0.5	0.5
Advanced	–1.3	–1.3	–0.7	–0.7	–3.3	–1.7
EMU	–1.3	–1.2	–0.3	–0.2	–1.9	–0.5
Non-EMU	–1.2	–2.0	–1.1	–1.6	–4.8	–5.1
Developing	–2.8	–1.2	2.7	3.0	3.5	3.1
Emerging	–3.2	–2.5	–0.5	–0.7	–2.9	–0.8

Percentage change in Trade and Net Financial indices in the case of a 20 percent across-the-board depreciation of the US dollar, plus the implied valuation changes.

They have sufficiently large negative positions in the dollar that a dollar depreciation lifts their net index and in fact provides net financial gains in the order of 3 percent of GDP. Whether this sufficiently offsets the effects of an appreciating trade-weighted exchange rate is unclear, but it certainly dampens the effect when compared to emerging market countries that lose on both trade and financial dimensions.

5.5 Discussion

The analysis has several implications for the design of ”new portfolio balance” models. First, our findings highlight the importance of modelling the dual role of exchange rates in the international adjustment process: with the financially weighted exchange rate index operating through the valuation channel, and the trade-weighted index influencing net exports. As we have highlighted, the potential importance of the valuation channel is secularly increasing, in line with the rapid growth in the gross levels of foreign assets and liabilities.

Second, the interaction between external wealth effects and domestic sectoral balance sheets may be important for domestic macroeconomic performance, since the net worth of banks, firms, households and the government may be affected by currency-induced valuation shifts. In this regard, it may be useful to establish the conditions under which such valuation movements may have a stabilising influence versus scenarios under which the impact is procyclical.

Third, an understanding of the financial implications of currency movements is important for the optimal design of monetary and fiscal policies for open economies; moreover, the optimal policy regime plausibly depends on structural characteristics, such as the degree of financial development and the contracting environment in a given economy. Finally, all of these dimensions feed into optimal international portfolio decisions. In view of the potential complexity of such models, it is important to be guided by the empirical regularities in model design and selection.

6. Concluding remarks

Our goal in this paper has been to understand the international financial implications of currency movements. To this end, we have drawn from a wide range of sources to build a large-scale dataset of international currency positions, constructed financially weighted exchange rate indices and calculated net foreign currency exposures.

Our analysis shows that trade-weighted exchange rate indices are an inadequate guide in understanding the wealth effects of currency movements. In addition, we find that many developing countries have historically had a negative net position in foreign currencies, such that depreciations of the domestic currency have generated negative wealth effects. However, we have found that many of these countries have shifted towards a less exposed currency position over the last decade, largely through improvements in their net foreign asset position and an increase in the share of foreign liabilities that are in asset classes denominated in local currency (such as equity and FDI). In addition, many countries, but in particular advanced countries, have increased their international positions so much that, even with relatively balanced net positions, they still may see substantial wealth shocks from currency movements.

Finally, we find that the wealth effects associated with exchange rate changes are substantial, unlikely to reverse quickly, and can explain a sizeable share of the overall valuation shocks that hit the net foreign asset position, especially for developing countries. We view these results as providing an important guide for the appropriate design of the next generation of "new portfolio balance" models of the open economy.

Appendix

A Estimating currency positions: methods

As noted in Section 3, we follow a two-step procedure in estimating currency positions. First, we determine the currency composition of assets and liabilities within individual asset classes. Second, we weight the asset classes by their shares in the country's portfolio in order to construct the aggregate index. This appendix provides a detailed description of how we construct the estimated currency positions.

A.1 Foreign assets

The asset side of a country's international balance sheet is divided into five classes: portfolio equity, direct investment, portfolio debt, other debt (generally bank-related), and reserves. Each requires its own sources and unique methodology, and these methods are described below.

A.1.1 Portfolio equity

The CPIS dataset provides the geographical location of equity asset holdings by country for 68 reporter countries across 220 host countries. In order to provide estimates for country pairs that are missing from the dataset, we employ a gravity-based model of bilateral equity holdings to construct estimated positions in these cases.[26]

Our approach relies on two key assumptions. First, we assume that equity issued by country is denominated in the currency of country. That is, US stocks are denominated in dollars, Japanese stocks in yen and so on. While there is no automatic relation between equity returns and currency movements, it is reasonable to assume that currency-related equity exposures are correlated with the geographical pattern in portfolio and direct investment equity holdings. In particular, especially for smaller source countries, the domestic currency spot value of a foreign equity should move one for one with the relevant bilateral exchange rate if the foreign currency equity value moves orthogonally to the bilateral exchange rate.[27] (See also the discussion in Section 2 regarding the lack of correlation between returns and exchange rate changes.)

Second, following Lane and Milesi-Ferretti (2007d), we eliminate holdings listed in offshore financial centres. Countries report very large holdings in these offshore centres (such as Luxembourg), but these holdings really represent claims on assets in other final destinations. By excluding these holdings, we implicitly assume that the holdings in offshore centres eventually wind up in the same pattern as those that go directly to other countries. After eliminating offshore centres, we are left with 50 reporting countries and 180 hosts.[28]

In order to generate estimated positions for those country pairs that are missing from the CPIS dataset, we employ a modified form of the specification developed by Lane and Milesi-Ferretti (2007d) by running a bilateral equity holding regression of the form

$$\log(1+EQ_{ijt}) = \phi_j + \theta_t + \beta Z_{ijt} + \gamma X_{it} + \varepsilon_{ijt} \qquad \text{(A.1)}$$

where ϕ_j represents host country fixed effects, θ_t year fixed effects and Z_{ijt} is a vector of bilateral variables – distance, longitude gap (to proxy for time zone differences), common language dummies, colonial relationship dummies, and measures of relative GDP such as a dummy for both countries being industrial, the gap in GDP per capita and the gap in GDP.

We do not include source country fixed effects, since our goal is to estimate missing source country data, but we can include a number of source country characteristics in X_{it} such as latitude, landlocked status, population, capital controls, and GDP per capita.[29] Such time-invariant (or nearly time-invariant) data cannot be included for the host country as the host country fixed effect already controls for all host characteristics.[30] This regression has

26 See Lane and Milesi-Ferretti (2007d), Portes and Rey (2005) and Martin and Rey (2004) for theoretical and empirical support for such a procedure. We do not rely on trade flows, but instead are essentially creating an asset allocation model where host GDP proxies for investment opportunities, and distance and other gravity variables proxy for information costs.

27 This also applies if foreign equity is held in the form of an American or global depository receipt. (In measuring the international investment position, the domestic versus foreign status of an asset depends on the residence of the issuer, not on the location of the transaction.) Consider a US investor holding stock in a Chilean firm through an ADR listed in New York. Since these stocks are listed primarily in Chile, the dollar price in New York automatically moves with the peso/dollar exchange rate and the peso value of the stock in Chile.

28 We follow Lane and Milesi-Ferretti (2007d) and primarily use the IMF Background Paper, "Offshore Financial Centres" (2000), as our guide to labelling countries as offshore centres.

29 Geography and other gravity model controls come from the CEPII geography database. GDP data are from the World Bank WDI database.

30 While Lane and Milesi-Ferretti (2007d) show that the level of trade is a predictor for equity positions, once a sufficient number of gravity controls are included, we find that, despite trade receiving a significant coefficient, the R^2 on the overall regression does not move much when trade is included. Since there are many missing observations for the trade data, we do not include it.

considerable explanatory power (R^2 values in the region of 0.79), high enough to generate sensible predicted values, and the coefficients on the independent variables take expected signs and magnitudes.[31]

We then use these predicted values for the missing observations, along with the actual data, to generate currency composition of equity holdings. For non-reporter countries, we are using synthetic data for their weights. As it turns out, these do not play as dramatic a role as one might fear in our overall index creation, since countries that are not CPIS reporters typically hold fairly small equity portfolios. In fact, the External Wealth of Nations data compiled by Lane and Milesi-Ferretti (2007a) show that half of the non-reporters have no equity assets and non-reporters only have an average of 2 to 3 percent of their foreign assets in equity. For this reason, in an overall index, our derived currency composition of their equity assets plays a small role.

A.1.2 Direct investment

We use the UNCTAD database on stocks of bilateral direct investment assets and liabilities. These data give us both outward and inward stocks of direct investment for 73 reporting countries vis-à-vis up to 196 partner countries. Since we have both inward and outward data, we can infer the bilateral direct investment assets of many non-reporting countries from the bilateral direct investment liabilities of the reporters. Since most major destinations are reporters, this process gives us a reasonable gauge of the currency distribution of the non-reporter countries.

The data are available over 1970–2004, although there are many missing observations. The direct investment stocks are valued at book value or historical cost. While it may be preferable to measure direct investment stocks at market value, this limitation has only limited relevance in establishing the weights for an FDI exchange rate index, since the geographical composition of the stock is the key factor. Since we have both inward and outward data, we can use this to establish bilateral patterns for a large number of countries.[32]

We follow our process for portfolio equity and assume that all direct investment is effectively denominated in the currency of the host country. This is plausible to the extent that direct investment assets have a location-specific component (e.g. structures or installed equipment) and/or profits are largely generated in the host country. However, it is more problematic in the case of export platform FDI: while domestic costs still matter for profitability and the value of the FDI position, it also depends on revenues generated in final customer markets. In addition, the FDI data include both equity and intra-company loans, with the latter plausibly more likely to be denominated in the currency of the source country. While we bear these caveats in mind, we proceed with the assumption that the value of direct investment positions are denominated in the currency of the host country.

A.1.3 Portfolio debt

In some cases, as is detailed by Lane and Milesi-Ferretti (2007c), countries report the currency composition of their foreign portfolio debt asset portfolios. This information is reported for the United States in the Report on the US Portfolio Holdings of Foreign Securities published by the US Treasury, while the Bank of Japan released the currency

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[31] Details of these results are available from the authors upon request.

[32] For a small number of countries we rely on flow data to create a general pattern because the stock data are too incomplete. Also, for a handful of countries where FDI is not significant (less than 1 percent of total assets and less than $40 million) and the data appear incomplete, we drop FDI from total assets and rescale remaining assets.

composition of Japanese portfolio debt assets at the end of 2005 in its Portfolio Investment Position Report.

However, for most countries, we do not have direct information on the currency composition of foreign portfolio debt assets. Accordingly, we adopt a multi-step inference procedure. As in the case of portfolio equity, the CPIS dataset provides information on the geographical patterns in bilateral portfolio bond holdings. We again employ a gravity model to fill out the geographical information for missing country pairs (where we have the same number of countries and use the same data as in the equity regressions). For these regressions, the R^2 is approximately 0.77 and again the signs on the coefficients on the independent variables are sensible.

However, since many countries issue foreign currency debt, estimating the currency composition of foreign debt assets requires additional steps. We begin with the international securities dataset maintained by the BIS.[33] This dataset contains information on the currency denomination of international bonds for 113 issuing countries.[34] For some countries (such as the United States), international bonds are issued mainly in domestic currency.

For other countries, international bonds are typically denominated in foreign currency, with the relative importance of the major international financial currencies (dollar, euro, yen, Swiss franc, sterling) varying across countries and over time.

In order to estimate the currency composition of portfolio debt assets, a naïve approach would be to simply assume that if a country holds an amount issued by country A, then the currency composition of those holdings reflects the aggregate currency composition of the international debt issued by country A. However, this would be misleading, since investors from countries whose currencies are popular choices for foreign currency bond issues are apt to disproportionately hold their own currencies when purchasing international debt securities issued by other countries (a tendency seen in the data used below from the US Treasury, Bank of Japan and ECB).

In order to allow for this currency bias, we follow Lane and Milesi-Ferretti (2007c) in exploiting the data provided by the United States Treasury, the European Central Bank and the Bank of Japan regarding the currency composition of the foreign assets of these regions. The United States reports the currency denomination of its portfolio debt assets in each destination country (US Treasury (2004)). From the Bank of Japan data, it is clear that Japanese investors purchase (virtually) all of the yen-denominated debt issued by other countries, while the ECB data suggest that investors from the euro area hold 66 percent of the euro-denominated debt issued by other countries (ECB (2005)).[35] Accordingly, we adjust the currency weights derived from the BIS data to take into account the portfolio choices by

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[33] The construction of this dataset is described in BIS (2003).

[34] Where the BIS dataset lacks data on the currency of issue for a country, we rely on the World Bank's GFD database of the currency composition of external debt. This is an imperfect measure because it includes non portfolio long-term debt (such as bank loans), but the countries which are missing from the BIS data account for a small fraction of internationally held debt assets. Our dataset focuses on international bond issues – while foreign investors have become active in the domestic bond markets of developing countries in very recent years, international bond issues are more important for the vast bulk of our sample period.

[35] Bank of Japan data show the currency composition and amount of Japanese foreign long-term debt assets. When comparing those data with the BIS currency denomination issuance dataset, we see that effectively all yen-denominated debt issued outside Japan is held by Japanese investors.

the investors from the major currency blocs and employ these adjusted weights in working out the currency composition of the foreign holdings of investors from other countries.[36]

In particular, our re-weighting procedure is as follows. For each issuing country, the US Treasury reports the currency composition of portfolio debt holdings in each country, so we are able to directly subtract the exact US holdings from BIS issuance data to generate new "rest of the world" totals for the currency composition of the international bonds issued by each country that are not held by US investors. Since the information from the Bank of Japan shows that Japanese investors hold nearly all the yen debt that is issued outside Japan, yen shares for issuing countries other than Japan are set to zero for investors from outside Japan.[37] Finally, the ECB reports that euro area investors hold 66 percent of euro-denominated debt that is issued by non-EMU countries. In this way, the level of euro-denominated debt issued by a non-EMU country that is held by investors outside the euro area is set equal to 34 percent of the total euro-denominated debt issued by the country. Accordingly, these adjusted levels are the basis for calculating the currency composition of the foreign portfolio debt held by investors from the rest of the world. Then, we can combine the geographical holdings for a country with the "residual" currency composition of all of the countries where a country holds debt to generate the currency composition of its foreign portfolio debt.[38]

For individual members of the euro area, our procedure is as follows. First, we sum across the euro area members to obtain the total holdings of the euro area in each host country. Consistent with the approach described earlier, we assume that the total holdings of the euro area in country A are distributed between euro-denominated debt (equal to 66 percent of the total euro-denominated debt issued by country A) and debt denominated in other currencies. With respect to the latter, the currency denomination is allocated along the lines of the rest of world data described above (using the non-euro proportions, after removing US holdings and yen-issued debt outside Japan). At that point, we have the currency denomination of debt assets held by individual euro area countries across each host destination. This does not generate the same currency weights for each euro area member, since each country has a different geographical pattern in its portfolio.

A.1.4 Other debt

From the BIS, we obtained the breakdown between "domestic currency" and "foreign currency" components for the bilateral foreign assets and liabilities of the bank residents in 20 reporter countries vis-à-vis a large number of counterpart countries over 1977–2005 (on a locational basis).[39,40,41,42] The reporters are the dominant banking centres and, despite the

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[36] That is, if US, European and Japanese investors all hold debt in Brazil and Brazil issues debt in local currency, dollars, euros and yen, then the US investor most probably holds dollar debt, the Japanese investor most probably holds more yen debt and the European investor most probably holds more euro debt.

[37] This is not to say that no country holds yen debt except Japan. Simply, most countries hold yen-denominated securities issued by Japanese entities. When another country issues yen debt, it is typically bought by Japanese investors.

[38] That is, for all other investors, we assume a uniform currency distribution in relation to the international bonds issued by a given host country. In this way, differences in currency exposures among investor countries are driven by dispersion in the geographical distribution of their foreign portfolio debt assets: country A that mostly invests in countries that predominantly issue dollar-denominated bonds faces different country risks compared to country B that mostly targets countries that issue euro-denominated debt.

[39] Although the foreign assets and liabilities of the banking sector include portfolio items, the currency composition of the aggregate should be a good proxy for the predominant non-portfolio debt component. See also BIS (2003, 2006).

[40] Clearly, our study would be enhanced if we could obtain these data for a larger number of reporting countries.

small number, capture the bulk of world bank holdings. Looking at the reporters' assets, 72 to 90 percent of them are in other reporter countries. Furthermore, Turkey, the one reporter most representative of the other non-reporters, has 90 percent of its assets and 91 percent of its liabilities in other reporter countries. Thus, when we use the liabilities of the reporters to infer the assets of the non-reporters, we expect to have good coverage.

We begin with the reporter country asset positions. In calculating the currency composition of non-portfolio debt assets, the "domestic currency" data are useful, since these tell us the levels of dollar-denominated foreign assets owned by the US banking system, yen-denominated foreign assets for Japanese banks and so on.

Regarding the "foreign currency" component, a candidate strategy is to allocate this across the major currencies, in line with the aggregate currency shares in foreign currency assets and liabilities that are reported by the BIS. (Of course, our estimates would be more accurate if it were possible to directly obtain the detailed currency breakdown of the 'foreign currency' component for individual countries.) Furthermore, for those host countries that are also reporting countries (where most of the assets lie), we also know the "domestic currency" versus "foreign currency" split in terms of the foreign liabilities of the banking system. If we assume that this proportion is representative of the claims of foreign banks in the given country, then we only need to use the "world" averages for the non-host currency component of the foreign currency element of the foreign bank claims held by other reporting countries in that destination. Again, because reporters are the dominant banking locations, we are only using world averages for a relatively small portion of assets.

We can make inferences about the currency composition of the foreign assets of the banking systems of non-reporting countries by using the data on currency composition of the foreign liabilities of the banking systems of the reporting countries. These data reveal the geographical pattern of the foreign claims of non-reporting countries vis-à-vis the reporters and the split between the "domestic currency" and the "foreign currency" components for each reporter. Because the currencies of the reporters are dominant currencies, much of their banking liabilities (and hence non-reporters' assets) are in their own currency and directly known (for example, 89 percent of US liabilities are in US dollars). In turn, we can allocate the "foreign currency" component according to the global distribution reported by the BIS. Again, although we only have data for 20 reporters, these include all the major banking centres, so that this approach should yield plausible estimates of the currency composition of the foreign non-portfolio debt assets of the non-reporting countries.

A.1.5 Reserves

The IMF tracks the currency composition of reserves for its member countries, in its COFER (Currency Composition of Official Foreign Exchange Reserves) database.[43] However, for confidentiality reasons, the only reported COFER data are for major aggregates (world, industrial country group, developing country group). Nevertheless, the country-level data have been used on a few occasions in research by IMF-affiliated economists to analyse the determinants of cross-country and time series variation in the currency composition of reserves. We exploit the results from these papers to model currency composition.

The major starting point is Eichengreen and Mathieson (2000). In that paper, the authors run separate regressions by currency to predict the share of reserves held in that currency. The

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[41] The use of the locational data follows balance of payments accounting principles.

[42] Following Lane and Milesi-Ferretti (2007c), some national central banks report the currency composition of the foreign assets and liabilities of the "monetary and financial institutions" sector.

[43] The dataset is described at www.imf.org/external/np/sta/cofer/eng/index.htm.

independent variables are trade shares with major currency countries, the share of debt denominated in these currencies, and exchange rate regime relations with these countries.[44] An important aspect of this work is that it is not simply the trade share with the currency in question included in each regression, but trade and debt shares with the other major currencies are included as well. That way, we can see that having a very large share of trade with Germany can reduce the share of dollars in reserve holdings, even controlling for the share of trade with the United States. The R^2 for these regressions ranges from 0.59 for the US dollar share down to 0.35 for the yen share.

We take the coefficients from these regressions and use them to predict the share for each of the major currencies (the dollar, the Deutsche Mark (euro after 1999), the Swiss franc, the yen and sterling). Once we have predicted values for each currency, we impose an adding-up constraint and re-normalise the results, so that each country has totals that add up to 100 percent.

To ensure that the results match information about world totals and can adjust over time with world trends, we make one more adjustment. The constants reported in the Eichengreen-Mathieson regressions are time-invariant. We assume that these constants could have been allowed to vary over time and alter them such that world totals for our predicted reserves holdings match the world averages reported in the COFER database.

That is, we multiply the predicted currency shares by each country's total reserve holdings and sum across the world. This gives us the world shares. We subsequently adjust the constants such that the predicted shares change until the predicted world averages match the actual world averages. This lets us take into account world trends in reserve holdings over time.[45]

We merge these generated data with actual data on reserves for 2000—2004 for 20 countries from Truman and Wong (2006) and Wong (2007). For any country for which we have actual data, we use actual data for those years. Before 2000, we use data from central banks where available (United States, Canada, United Kingdom) and blend our model-generated data with 2000 actual data where, in 1999 we weigh the actual data .9 and the model data .1, the respective values for 1998 being .8, .2, etc. In practice, our estimates were close to the 2000–04 actual data, so a variety of blending techniques yielded nearly identical results and our model-generated estimates for 2000–04 were quite similar to the actual numbers for most of the 20 countries in question.

We can further confirm that our predictions are sensible by drawing on two additional sources of information. First, some countries occasionally report their reserve shares in announcements or media interviews. Relying on news reports of these currency shares, we compare predicted with actual (or at least reported, since there is no verification) reserve shares. Our results seem to perform quite well on this measure. Countries like Sweden that report roughly equal dollar and euro reserves show 40 percent dollar and 50 percent euro

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44 We use trade data from the IMF DOTS database and exchange rate regime data from Shambaugh (2004). We use debt denomination data from the World Bank GFD database, augmenting with BIS issuance data where necessary. We use the World Bank data as a starting point to be consistent with Eichengreen and Mathieson.

45 To make the adjustment, we increase (decrease) the constants used to make the predicted values for each currency by the amount that currency is underpredicted (overpredicted) when compared to world averages. Then the new predicted values are calculated and the predicted world averages recalculated and again compared to the actual world averages. The iterations are continued until there is a near perfect match between predicted and actual world holdings by currency. The constants that would generate predictions that match the world average are not in fact uniquely determined, but this process brings us to a set of constants as close as possible to the time invariant ones reported in the empirical work, and small differences in the constants make virtually no difference to the final results.

reserves in our calculations. China, which is reported to hold roughly 70 percent dollar, 20 percent euro and 10 percent other currencies, is found to hold 70–75 percent dollar, approximately 15 percent euro, and 10–15 percent other in our calculations (over various recent years). In general, non-EMU European countries tend to hold 40–50 percent each in dollars and euros in our work; Latin American countries tend to hold mostly dollars, Asian countries hold largely dollars with some yen and euros as well, and all these figures seem to mesh reasonably well with the scattered media reports on the subject.

Second, Lim (2006) studies the changing international role of the euro and the dollar and provides some regional information on the currency composition of reserves. Again, due to confidentiality, the results are deliberately reported in a way to make it difficult to back out actual currency composition, but we can use these results as a broad check. Lim breaks countries into two groups that we can try to replicate: a dollar-oriented group of Asia, the western hemisphere, and other dollar pegs; as well as a euro-oriented bloc of countries neighbouring the euro area plus much of Africa. We aggregate our synthetic country-level reserve shares into the same groups. Because the exact members of each group are not reported, we cannot precisely compare our results, and thus we cannot expect to exactly match his output, but these results provide a useful benchmark. Looking at the most recent data for 2004, world average shares were 67 percent US dollar and 25 percent euro. Lim shows the dollar bloc holding 76 percent dollar and 19 percent euro, while we find 71 percent dollar and 21 percent euro. The euro bloc holds 33 percent dollar and 57 percent euro in his grouping, while we find 46 percent dollar and 50 percent euro. We see that our work moves countries towards their actual data from the starting point of the world averages in both cases. As with the media reports, we do not have perfect matches, but we have a reasonable agreement between our data and our available cross-checks.

A.2 Foreign liabilities

The liability side of the international balance sheet is divided into four groups: portfolio equity, direct investment, portfolio debt, and other debt. In many cases, the source information for portfolio and other debt are combined, so we do not try to disaggregate them.

A.2.1 Portfolio equity

Consistent with our treatment on the asset side, portfolio equity liabilities are assumed to be denominated in the currency of the host country. Thus, there is no foreign currency exposure from equity liabilities. The size of these liabilities is important in creating total liability weights, since the larger the relative share of portfolio equity or FDI liabilities, the greater the local currency share in liabilities. Thus we only need the size of the liabilities, not geography or currency denomination. We return to the way different asset class categories are combined below.

A.2.2 Direct investment

Direct investment liabilities are assumed to be denominated in the currency of the host country.[46]

[46] As noted earlier, we plan to refine this choice in a future iteration. The stock of direct investment liabilities includes both equity and debt components. The debt component may at least in part be denominated in the currency of the parent entity or in other major international currencies.

A.2.3 Portfolio and other debt

All debt liabilities are processed in tandem due to data restrictions. We have data from the BIS banking statistics database on banking liabilities for 20 countries (and the implied liabilities to the 20 reporters based on reporters' assets for the remaining countries). In addition, we know the currency composition of portfolio debt liabilities, based on issuance data from the BIS international securities database for 113 reporting countries.

However, neither database includes information on the currency composition of debt owed to official creditors (bilateral or multilateral official debt), which is a prominent source of debt for many developing countries. The World Bank's Global Development Finance database shows that debt to official creditors ranges from 35 to 53 percent of total developing country debt over the time period 1990—2004. The World Bank does report the currency composition of aggregate external debt which merges bank, bond and official debt data. Due to the importance of the official debt composition, we use this World Bank source for all countries where it is available (it is not available for any industrial country and is missing for a small number of developing countries).[47]

For the remaining countries, we create bond-based weights using the currency composition from BIS issuance data and weights for other debt from the BIS banking data. These two weights are merged together to create total debt currency composition weights. The bond-based weights are simply a reflection of the currency shares of debt issued by the country. The banking shares follow a similar procedure as other debt assets. For the 20 reporting countries, we know the location of all bank liabilities and can use the breakdown of domestic versus foreign currency to determine the extent to which liabilities are in the home currency. Then, for locations that are also reporters, we can derive from that country's assets how much is in that country's currency (it is reported as domestic currency in the reporter's assets). For the remainder, we allocate based on world totals. For the few countries that are neither reporters nor have data in the World Bank database, we rely on the assets of the reporters to determine the location and currency of their liabilities. Again, the reporters are involved in one side or the other of the bulk of banking transactions, and we thus have fairly good coverage. See the discussion of other debt assets for details.

A.3 Measurement error

Our approach calculates the currency composition of the international balance sheet on the basis of: (a) the categorical composition of foreign assets and liabilities between equity and debt components; and (b) the currency composition of debt assets and liabilities. We view the categorical composition of the international balance sheet as reasonably well measured, subject to the limitations discussed by Lane and Milesi-Ferretti (2001, 2007a). The main qualification relates to direct investment positions: these are recorded at market value for some major countries but at book value for most countries. While there is a lack of agreement on which is the most robust measurement technique, the differences in method may qualify some comparisons across countries.

In relation to the currency composition of privately held debt assets, we have made use of data on the geographical distribution of portfolio debt and bank debt assets, together with data on the currency composition of portfolio debt issuance and cross-border bilateral bank positions. For officially held debt assets (foreign exchange reserves), we have relied on regression-based estimates. On the debt liability side, we have relied on official World Bank estimates of the currency composition of external debt for developing countries, and

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[47] For the handful of developing countries that show domestic currency international issuance in the BIS database, we adjust the World Bank currency shares to include the domestic currency issuances.

combined the data on portfolio debt issuance and the currency composition of bank liabilities for the advanced economies.

Clearly, these calculations are subject to measurement error, but it is important to be clear about what the scope for error is. For most advanced countries, we have actual data on the geographical distribution of assets and do not need our model-imputed data. In addition, many of these countries were the ones with highest-quality data in the EWN and actual data on reserves. Thus, error on these countries is low. In addition, countries without equity data, for example, tended to have very low shares of equity, so the use of model-imputed data was relatively unimportant. Also, for many of the developing countries that needed large amounts of model-imputed data, their exchange rate moves dramatically against the entire rest of the world, so precise distribution across different major currencies becomes less important for them. Finally, some of our results, notably the results on foreign currency exposure, aggregates the foreign currencies, meaning that these results do not rely on the currency of reserves or the precise distribution of various other foreign currency assets and liabilities as much as simply knowing which are foreign and which are domestic.

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